South Africa

COTO

Committee of Transport Officials

Standard Specifications for Road and Bridge Works for South African Road Authorities

Draft Standard (DS)

CHAPTER 13: STRUCTURES

October 2020

Permission is granted to freely copy, print and distribute this Draft Standard document for industry use.

FOREWORD

Compiled under the auspices of the:

Committee of Transport Officials (COTO)

Roads Coordinating Body (RCB)

Road Materials Committee (RMC) – a subcommittee of RCB

Published by:

The South African National Roads Agency SOC Limited

PO Box 415, Pretoria, 0001

Disclaimer of liability:

The document with its Chapters is provided as a Draft Standard (DS) without any warranty of any kind, expressed or implied. No warranty or representation is made, either expressed or implied, with respect to fitness of use and no responsibility will be accepted by the Committee or the authors for any losses, damages or claims of any kind, including, without limitation, direct, indirect, special, incidental, consequential or any other loss or damages that may arise from the use of the document.

All rights reserved:

No part of this Draft Standard document may be modified or amended without permission and approval of the Committee of Transport Officials (COTO). Permission is granted to freely copy, print and distribute this Draft Standard document for use by industry.

Existing publication:

The new COTO Standard Specifications for Road and Bridge Works for South African Road Authorities was approved by COTO on 18 August 2020 as a Draft Standard (DS) and will be replacing the COLTO Standard Specifications for Road and Bridge Works for State Road Authorities (1998 Edition).

Existing contracts and tenders in the design phases based on the COLTO Standard Specifications (1998 Edition) will remain unaffected but will be phased out during the next 6 months and the COTO Standard Specifications (2020 Edition) will be mandatory for use in procurement documents advertised as from 1 March 2021.

Document versions:

Draft Standard (DS). The Draft Standard will be implemented in industry for a period of two (2) years, during which written comments may be submitted to the COTO subcommittee. Draft Standards (DS) have full legal standing.

Final Standard (FS). After the two-year period, comments received are reviewed and where appropriate, incorporated by the COTO subcommittee. The document is converted to a Final Standard (FS) and submitted by the Roads Coordinating Body (RCB) to COTO for approval as a final standard. This Final Standard is implemented in industry for a period of five (5) years, after which it may again be reviewed. Final Standards (FS) have full legal standing.

Comments:

Comments on the Draft Standard Chapters should be provided in writing on the Excel spreadsheet provided on the websites mentioned below and e-mailed to cotorevision@nra.co.za .

Please note:

This document and its various Chapters will only be available in electronic format.

The Draft Standard (DS) Chapters will be made available for download on the South African National Roads Agency SOC Ltd (SANRAL) and Department of Transport websites.

August 2020 version replaced with October 2020 version due to amendments to Chapters.

TABLE OF CONTENTS

CHAPTER 13: STRUCTURES 13-1

13.1 FOUNDATIONS 13-1

PART A: SPECIFICATIONS 13-1

PART B: LABOUR ENHANCEMENT 13-12

PART C: MEASUREMENT AND PAYMENT 13-15

PART D: GUARANTEES AND COMPLIANCE CERTIFICATES 13-22

13.2 FALSEWORK, FORMWORK AND CONCRETE FINISH 13-23

PART A: SPECIFICATIONS 13-23

PART B: LABOUR ENHANCEMENT 13-33

PART C: MEASUREMENT AND PAYMENT 13-34

PART D: GUARANTEES AND COMPLIANCE CERTIFICATES 13-36

13.3 STEEL REINFORCEMENT 13-37

PART A: SPECIFICATIONS 13-37

PART B: LABOUR ENHANCEMENT 13-41

PART C: MEASUREMENT AND PAYMENT 13-42

PART D: GUARANTEES AND COMPLIANCE CERTIFICATES 13-44

13.4 CONCRETE 13-45

PART A: SPECIFICATIONS 13-45

PART B: LABOUR ENHANCEMENT 13-68

PART C: MEASUREMENT AND PAYMENT 13-69

PART D: GUARANTEES AND COMPLIANCE CERTIFICATES 13-73

13.5 PRESTRESSING 13-74

PART A: SPECIFICATIONS 13-74

PART B: LABOUR ENHANCEMENT 13-87

PART C: MEASUREMENT AND PAYMENT 13-88

PART D: GUARANTEES AND COMPLIANCE CERTIFICATES 13-90

13.6 BEARINGS 13-91

PART A: SPECIFICATIONS 13-91

PART B: LABOUR ENHANCEMENT 13-98

PART C: MEASUREMENT AND PAYMENT 13-99

PART D: GUARANTEES AND COMPLIANCE CERTIFICATES 13-101

13.7 JOINTS 13-104

PART A: SPECIFICATIONS 13-104

PART B: LABOUR ENHANCEMENT 13-109

PART C: MEASUREMENT AND PAYMENT 13-110

PART D: GUARANTEES AND COMPLIANCE CERTIFICATES 13-114

13.8 ANCILLARY STRUCTURAL ELEMENTS 13-117

PART A: SPECIFICATIONS 13-117

PART B: LABOUR ENHANCEMENT 13-121

PART C: MEASUREMENT AND PAYMENT 13-122

PART D: GUARANTEES AND COMPLIANCE CERTIFICATES 13-126

13.9 STRUCTURAL STEELWORK FOR MINOR STRUCTURES 13-127

PART A: SPECIFICATIONS 13-127

PART B: LABOUR ENHANCEMENT 13-132

PART C: MEASUREMENT AND PAYMENT 13-133

PART D: GUARANTEES AND COMPLIANCE CERTIFICATES 13-135
13.10 PAINTING OF MINOR STRUCTURES 13-136
PART A: SPECIFICATIONS 13-136
PART B: LABOUR ENHANCEMENT 13-141
PART C: MEASUREMENT AND PAYMENT 13-143
PART D: GUARANTEES AND COMPLIANCE CERTIFICATES 13-145
13.11 STRUCTURAL STEELWORK FOR MAJOR STRUCTURES 13-146
PART A: SPECIFICATIONS 13-146
PART B: LABOUR ENHANCEMENT 13-157
PART C: MEASUREMENT AND PAYMENT 13-158
PART D: GUARANTEES AND COMPLIANCE CERTIFICATES 13-160
13.12 STRUCTURAL STEEL PROTECTIVE TREATMENT OF MAJOR STRUCTURES 13-161
PART A: SPECIFICATIONS 13-161
PART B: LABOUR ENHANCEMENT 13-175
PART C: MEASUREMENT AND PAYMENT 13-176
PART D: GUARANTEES AND COMPLIANCE CERTIFICATES 13-178
13.13 INCREMENTAL LAUNCHING OF BRIDGE DECKS 13-179
PART A: SPECIFICATIONS 13-179
PART B: LABOUR ENHANCEMENT 13-187
PART C: MEASUREMENT AND PAYMENT 13-188
PART D: GUARANTEES AND COMPLIANCE CERTIFICATES 13-191
13.14 SPECIALIST STRUCTURES 13-192
PART A: SPECIFICATIONS 13-192
PART B: LABOUR ENHANCEMENT 13-193
PART C: MEASUREMENT AND PAYMENT 13-194
PART D: GUARANTEES AND COMPLIANCE CERTIFICATES 13-195

CHAPTER 13: STRUCTURES
13.1 FOUNDATIONS

CONTENTS

PART A: SPECIFICATIONS

A13.1.1 SCOPE

A13.1.2 DEFINITIONS

A13.1.3 GENERAL

A13.1.4 DESIGN BY CONTRACTOR / PERFORMANCE BASED SYSTEMS

A13.1.5 MATERIALS

A13.1.6 CONSTRUCTION EQUIPMENT

A13.1.7 EXECUTION OF THE WORKS

A13.1.8 WORKMANSHIP

PART B: LABOUR ENHANCEMENT

PART C: MEASUREMENT AND PAYMENT

PART D: GUARANTEES AND COMPLIANCE CERTIFICATES

A13.1 FOUNDATIONS
PART A: SPECIFICATIONS

A13.1.1 SCOPE

This Section covers foundation and foundation related work which, for the purposes of these specifications, shall comprise amongst others those elements of construction below the level of the bottom surface of conventional spread footings, pile-capping slabs or caisson cover slabs, collectively hereinafter referred to as base or bases, and it covers all the associated permanent and temporary works. Piling is dealt with in Chapter 12. Foundations for prefabricated culverts are not included but are specified in Chapter 3.

A13.1.2 DEFINITIONS

Artificial islands - temporary platforms constructed in rivers and streams to allow access for construction activities.

Banks - a stream bank or river bank is the terrain alongside the bed of a river.

Watercourse - a watercourse means a river or spring; a natural channel in which water flows regularly or intermittently; a wetland lake or dam, into which or from which water flows; and any collection of water that may be declared to be a watercourse in terms of relevant legislation.

Caissons - a watertight retaining structure used, to facilitate founding of bridge structures as an alternative to piling.

Cofferdams - a cofferdam is a temporary enclosure built within a body of water, in waterways, on waterlogged areas or on unsuitable ground and is constructed to allow the enclosed area to be pumped out, creating a dry work environment for the construction of permanent works to proceed.

DWS - Department of Water and Sanitation.

Contractor's Competent Person (CCP) - the Contractor's Competent Person is appointed in writing to administer, inspect and verify the adequacy of temporary work such as excavations and sub-structure work must be registered and competent in relation to the services rendered in terms of the ECSA Engineering Professions Act and construction regulations as contained in the OHS.

A13.1.3 GENERAL

A13.1.3.1 Subsurface data

The Contractor shall take due cognizance of available information regarding site geotechnical conditions and related stability and safety of the excavations. Provision for specialised support systems shall be included in appropriate payment items. If such separate items are not provided they shall be deemed to be included in rates for excavation items.

The provisions of the General Conditions of Contract shall apply with regard to any information supplied regarding any subsurface conditions likely to be encountered.

If it is found during the course of excavating, or caisson work, that the soil or founding conditions differ greatly from those shown on the drawings, the Contractor shall immediately notify the Engineer.

The Engineer shall, whenever he may deem it necessary during the course of excavation, be entitled to call on the Contractor to conduct additional foundation investigations or tests at, or below, the respective founding levels aimed at establishing safe bearing conditions and founding depths. Payment for these investigations shall be made by means of the Provisional Sums provided.

Where the actual foundation conditions encountered are considerably at variance with conditions visualised and described in the contract documents and to the extent that those terms for which the rates or prices provided for in the contract are rendered unreasonable or inapplicable, such other rates or prices consistent with the rates set out in the contract shall be fixed as provided for in the conditions of contract. This is subject always to a founding depth variation not exceeding 2,5 m of the foundation base level of the permanent structure as specified shall not, by itself, be held to constitute cause for variation for the contract rates or prices.

A13.1.3.2 Channel preservation

a) Work on, over, in or adjacent to watercourses

(i) General

The flow of the stream and conservation of marine and freshwater life shall be maintained at all times in accordance with the EMP. Access to cofferdams and artificial islands shall be effected without unnecessarily disrupting the flow of the stream at the point of crossing, unless otherwise specified.

On completion of the work, surplus excavated materials, including materials excavated from caisson compartments and materials used in cofferdams and other temporary works, as well as in situ material, shall be removed and disposed of by the Contractor to the level of the original bed or such elevation as specified or as required for stream channelization.

Special authorisation may be required in terms of applicable legislation for undertaking certain water use activities. These activities may include impeding or diverting flow of water in a watercourse or altering bed, banks, course or characteristics of a watercourse, pollution of water resources or the use of naturally occurring water for construction activities. These requirements shall be specified in the project related Environmental Management Programme.

(ii) Access requirements

As far as reasonably possible, the Contractor shall use existing access paths, tracks and roads to access the construction site to reduce impact thereof. Where no access exists, the Contractor shall take cognizance of sensitive areas (e.g. surface water, natural vegetation, steep banks, etc.) when determining location of access.

As far as reasonably possible, work within a river shall take place outside the rainy season, preferably when flow is at its lowest. During construction of river bridges or structures within a river, the Contractor will only be permitted to construct, subject to the requirements of the EMP, low level causeways to access the rivers that cause negligible backing up; and cofferdams around the piers, abutments or other elements for the construction of the foundations. These obstructions must be removed at the end of the contract and the river and banks restored to their original condition.

(iii) Erosion and sedimentation prevention

The Contractor shall exercise sedimentation and erosion control to the satisfaction of the Engineer. The Contractor shall protect areas susceptible to erosion by installing the necessary temporary and permanent drainage works. The Contractor shall implement measures to prevent migration of fill material from works to existing water bodies. The Contractor shall ensure that any pumped water from foundation excavation, flooded works, etc., passes through a sediment-settling facility before entering the watercourse.

(iv) Water quality requirements

The Contractor shall, if required by the project specification, undertake water quality measurements of the river. The measurements shall be of pH value, turbidity, electrical conductivity and temperature. Sampling and testing shall be undertaken on specified periods for the duration of the project at sampling points selected prior to construction. Monthly water samples should be obtained during the duration of the project and sent to an accredited laboratory for analysis of the same parameters as for daily measurements. Specific acceptable limits for river water quality below the construction site shall be in accordance with the DWS water quality guidelines, or, in case the watercourse in issue already contains contaminated water, the downstream quality shall not at any given time be worse than the upstream quality. Measurement and sampling results shall be presented to the Engineer and environmental control officer as deemed necessary by the Engineer.

(v) Wastewater requirements

The Contractor shall prevent pollution of surface or groundwater from the release, accidental or otherwise of contaminated water as a result of construction activities. The Contractor shall be responsible for the construction and operation of the necessary collection facilities in order to prevent such pollution or settlement of suspended matter, and shall dispose of the collected waste as approved by the Engineer.

(vi) Use of natural water sources for construction activities

Unless otherwise authorised by the Engineer, the Contractor shall not be permitted to utilise any natural occurring water for construction activities.

A13.1.3.3 Compliance with legislation

In all instances the work performed under this Section shall comply fully with the requirements of applicable legislation and regulations which include the following:

a) Environmental Management Programme

b) Occupational Health and Safety Act and Construction Regulations

A13.1.3.4 Method Statements

The method statements and typical drawings submitted by the Contractor with his tender submission where specified, describing key facets such as method, key plant, materials, personnel and, programme constraints of the envisaged construction process, shall form the basis for the detailed method statements required for the works to be executed on the project.

These method statements shall be prepared and submitted to the Engineer for approval for each facet of the work at the start of construction, within time scales specified. The onus lies with the Contractor to ensure that the information is gathered and associated activities are completed expeditiously so as to avoid any delays in the commencement, continuation and completion of the required works. Unless otherwise specified or provided for in the Contract Documentation no permanent works shall be commenced until the Engineer's approval has been obtained. Due allowance shall be made for obtaining alternative materials, resubmissions and redesigns, all to the required/approved standards, methods and practises in attending to these requirements. Particular attention shall be paid to the early submission of materials-, concrete- and grout mix designs where parameters at various ages may be specified. No consideration for extension of the contract period will be entertained for delays incurred in meeting these requirements.

Trials, if applicable, shall be conducted and based on outcomes thereof, may require that changes be made to the relevant method statements. Once approved in writing by the Engineer, these shall become the method statements in accordance whereby the relevant portion of the works shall henceforth be executed. Notwithstanding, the Engineer may require revision from time to time if circumstances during construction arise which warrants change.

The Contractor shall, however, remain responsible for all work-methods, materials, plant and equipment used, notwithstanding acceptance by the Engineer.

A13.1.3.5 Hold points

The Contractor shall comply with the specified hold points relating to approvals required from the Engineer. A hold point is a stage of the work, where the Engineer's approval is required, before commencement or continuance of that particular activity by the Contractor, is permitted. Project specific requirements will be included in the Contract Documentation or agreed upon between the Engineer and the Contractor.

A13.1.4 DESIGN BY CONTRACTOR / PERFORMANCE BASED SYSTEMS

A13.1.4.1 General

In the following instances where design details of temporary works are required, these shall be performed by an ECSA-registered Professional Engineer or Professional Technologist with the relevant experience, in accordance with the appropriate specifications and codes. The Contractor shall submit these site design details to the Engineer for his approval at least 30 days before commencement of the applicable activity.

The Contractor shall ensure that all temporary works undertaken shall comply with the relevant sections of the Occupational Health and Safety Act and the Construction Regulations.

It is a requirement that all temporary works shall be finally inspected and signed off by the CCP, who shall be an ECSA registered Professional Engineer or Technologist with relevant experience, before the permanent works commence.

Unless provided for separately, any additional costs for these pre-approval requirements shall be included in the tendered rates.

A13.1.4.2 Drainage systems

Drainage systems, such as external well point systems for excavations, shall comply with relevant applicable requirements and shall take due cognizance of the existing soil profile, existing water table and possible river water levels which may occur during construction.

The Contractor shall provide complete details of proposed drainage systems and design details for any location where the appropriate system is required.

A13.1.4.3 Cofferdams

The design and construction of cofferdams other than those comprising earth embankments, shall comply with the requirements of BS 8004. Before starting with construction, the Contractor shall submit drawings to the Engineer, which show details of cofferdams and method of construction, for his information. All risks related to such cofferdams, including the risk of flooding, shall remain exclusively with the Contractor.

A13.1.4.4 Excavation support systems

The Contractor shall provide complete details of proposed shoring systems or temporary earth retaining systems including a design details for any location where the relevant system is required.

The Contractor shall ensure all excavation work is carried out under the supervision of the CCP who was appointed in writing for that purpose. The CCP shall, as far as is reasonably practicable and applicable, assess the stability of ground before excavation work begins and as the excavation proceeds strictly in accordance with the applicable OHS regulations. All risks related to such support systems shall remain exclusively with the Contractor.

A13.1.4.5 Temporary access roads

In the event that no existing roads or tracks can be utilised to access the site of the foundation works, proposals for access roads shall be submitted to the Engineer for approval prior to starting any work on the access. If such access road will affect any property or facility outside the road reserve, the proposals shall include written consent from the affected landowner. For details, refer to Clause A4.1.7.1 of Chapter 4.

All such temporary access shall be at the Contractor's cost.

A13.1.5 MATERIALS

A13.1.5.1 General

Material used in the permanent foundation work shall comply with the requirements specified for the particular material in these specifications.

A13.1.5.2 Banks and artificial islands

The Contractor may use any material deemed suitable with due consideration of requirements of the EMP and for water quality.

A13.1.5.3 Rock (for rock fills and plums)

Rocks shall be clean, hard, angular, veld or quarry stones of such quality that they will not disintegrate on exposure to water or weathering. Cobbles and river boulders shall on account of their rounded shape, not be used unless authorised by the Engineer. The rock shall be free from soil, shale, mudstone, basalt and dolomitic soft rock or organic material. Neither the breadth nor thickness of a single stone shall be less than one-third its length. Not more than 10 % of the total volume of rock fill shall consist of rock with a mass of less than half the specified mass and not more than 10 % of the total volume of rock fill shall consist of rock with a mass of more than 5 times the specified mass. At least 50 % of the total volume of rock fill shall consist of stones the mass of which exceeds the specified mass. The minimum specified mass for rock fill shall be 150 kg and for rock plums shall be 50 kg.

A13.1.5.4 Crushed stone

Crushed stone used for the construction of crushed-stone fill shall originate from sound unweathered rock approved by the Engineer.

A13.1.5.5 Granular fill

Granular material used for constructing compacted granular fill under foundations and behind retaining structures shall be approved G5 quality material or better.

A13.1.5.6 Grouting

a) Cementitious grout

Cementitious binder for grout shall meet the appropriate requirements of Clause A13.5.5.7.

b) Proprietary-brand, and chemical, grouts

Proprietary-brand, and chemical, grouts shall be prepared and used strictly in accordance with the manufacturer's instructions and as specified in the applicable Sections of Chapter 14.

A13.1.5.7 Plum concrete

Plum concrete shall consist of either mass concrete with plums in which rock plums are placed into wet concrete protruding into the concrete layer or prepacked concrete in which the rock plums are placed and the concrete placed over and around the plums. Mass concrete or prepacked concrete shall comply with the requirements of Section A13.4 and have a characteristic strength of at least 25 MPa. The water to cementitious binder ratio shall be designed to maintain the flow ability of concrete and to fill all interstices between the rock plums. The rock size used for plums shall be between 200 and 300 mm and they shall meet the requirements for rock as specified in Clause A13.1.5.3. The proportion of plums shall not exceed 60 % of total volume of plum concrete. The plums shall be laid in layers using mortar or flowable concrete to fill all interstices. Plums shall extend above each layer to prevent slip planes between layers. Concrete slush and laitance shall be wire-brushed off proud rock surfaces at day joints between layers. All plum concrete shall be maintained wet for curing purposes for at least 7 days.

A13.1.5.8 Soil cement

Soil cement shall consist of at least C2 quality material as specified in Clause A4.1.5.14 of Chapter 4 or as specified in the project specification, with a cement content which shall not be less than 3 % if handled and compacted with a similar technique to granular materials or 5 % if handled and compacted with a similar technique to concrete respectively.

A13.1.6 CONSTRUCTION EQUIPMENT

The Contractor shall, before construction commences, provide comprehensive details of all plant and equipment, which shall be appropriate for intended use. It shall be clear from the information provided that the required production rates and activities as indicated in the approved construction programme can be achieved.

A13.1.7 EXECUTION OF THE WORKS

A13.1.7.1 Work access and drainage

a) General

This Clause covers the provision of access for the proposed construction activities, which include the construction of access ramps, work platforms, artificial islands and cofferdams. This Clause also covers draining of excavations. The Clause is aimed at conventional construction activities and shall be applicable unless otherwise specified in the Contract Documentation.

The Contractor shall prepare a method statement setting out the proposed approach and methodology for providing the necessary access and drainage. This method statement shall take into account the requirements of the Contract Documentation and in particular the requirements and limitations imposed by the environmental specification in general and specific to the site in question. The Contractor may not commence with the construction of accesses until he has obtained the Engineer's written permission to proceed.

After completion of the permanent works, all temporary works shall be completely removed, the ground levelled and the site left neat. Where this is impracticable, such remaining portions that have not been removed, shall be dealt with in accordance with the Contract Documentation.

b) Work access

(i) Banks and artificial islands

Where temporary banks or artificial islands are constructed in view of affording access to locations where structural members, piling or caissons are to be constructed, banks or islands shall be adequately compacted in view of supporting any plant and material, without any undue settlement that may have an unacceptable effect on the end product.

The Contractor may use any material complying with the requirements of Clause A13.1.5 and deemed by him to be suitable for constructing banks and islands, but he shall note that no separate payment shall be made for any works in terms of payment items in Chapter 12 for any obstructions or hard material occurring in the placed material used.

On completion of the work, the Contractor shall remove banks and artificial islands and reinstate the site as near as possible to its original condition in compliance with the EMP.

(ii) Cofferdams

Where necessary, if it is impracticable to dewater a foundation by pumping methods, cofferdams shall be constructed in waterways, on waterlogged areas and on unsuitable ground to facilitate construction of the permanent works in the dry, to ensure the lateral stability of or to retain the surrounding material and to the protect work under construction against flooding. The Contractor shall not commence with the construction of a cofferdam until he has obtained the Engineer's written permission to do so.

Cofferdams may be constructed in many ways using materials complying with Clause A13.1.5 as suitable for the particular site circumstances. In the case of river structures, where large areas are required it will usually take the form of earth embankments and where smaller areas, such as foundation bases, are required, interlocking metal sheeting (sheet piles) may be used if feasible.

In the latter, cofferdams shall be adequately braced, weighted and anchored and shall be as watertight as practicable. A concrete foundation seal shall be required before the cofferdam is dewatered.

Cofferdams shall be completely removed upon completion of permanent work except that if, in the case of sheet pile cofferdams, the Engineer is of the view that the dislodgment of sheets may disturb the foundation of the permanent structure, the sheeting will be cut at a level instructed by the Engineer, and the lower part will be left in place.

c) Drainage

The Contractor shall apply suitable, effective drainage methods for preventing the ingress of water into excavations and to keep them dry. The preventative measures shall include construction and maintenance of intercepting and diversion berms and drainage channels, with all channels effectively draining towards lower-lying natural drainage routes or sumps, with all necessary bailing and pumping equipment supplied, operated and maintained by the Contractor. The preventative measures shall ensure that the foundation excavations are dewatered sufficiently to allow the necessary construction operations to be properly executed.

The drainage measures, with the exception of pumping, shall be maintained until the backfilling has been completed. Between the various construction stages, pumping may be temporarily interrupted in consultation with the Engineer.

Any draining or pumping of water shall be done in a manner which precludes concrete or materials or any part thereof, from being carried away.

Any damage to the work in progress due to failure of drainage systems or flooding are exclusively the Contractor’s risk.

A13.1.7.2 Excavation

a) General

This work shall include excavations not provided for elsewhere in these specifications, which are required for founding the structures as well as for excavation required in respect of demolition, extension or modification of existing bridges and culverts.

Excavation in the vicinity of existing structures and road formations shall be performed with due care and diligence. The Contractor shall take special care not to disturb the founding material of any existing foundations and road formations. The excavation profile must strictly be as approved by the Engineer and as shown on drawings.

b) Agreed excavation surface level and profiles

Prior to commencing with any excavation, artificial islands, cofferdams, temporary banks or any other works covered by this specification, the Contractor shall notify the Engineer in good time to ensure that levels be taken of the undisturbed ground surface for determining a ground surface from where excavation shall be measured, and this ground surface shall be agreed on by Engineer and Contractor.

In addition, the proposed excavation profile, with due consideration of stability of material, existing structures and existing road formations shall be agreed prior to commencement of excavation. Details of lateral support systems, if any, shall be provided and approved in accordance with all the requirements for temporary works and site designs.

The final foundation depth and suitability of the foundation material shall be approved by the Engineer in consultation with a suitably–qualified, ECSA–Professional Registered Geotechnical Engineer.

c) Excavation

In stable or hard material the Engineer may approve that the excavated surfaces can act as forms for casting of the concrete and the excavations shall then be carried out and trimmed to neat dimensions of the concrete members shown on the drawings. To prevent moisture loss in the concrete where excavated surfaces act as forms, a foundation lining shall be installed as specified in Clause A13.1.7.9. As an alternative, provided that sufficient space is made available during excavation, an additional 50 mm of concrete cover, over and above that specified may also be provided if approved by the Engineer. Excavations in soft material in excess of the authorised dimensions (over-excavation) or overbreak in hard material shall be backfilled with the same class of concrete as that in the base.

In the case where excavations are made to neat dimensions of the concrete members (no formwork), compensation for the backfill of over-break in hard material shall be measured and paid for under pay item C13.1.9 but the cost of backfilling of over-excavation in soft material shall be at the Contractor's own expense. In soft material, the final 0,5 m and in hard the final 0,25 m, shall be removed using suitable hand equipment such as pick and shovel or pneumatic tools to cause minimum disturbance to in-situ founding material. Such hand excavation shall be measured and paid for under payment pay item C13.1.4 4 Where additional excavation width is required for the erection of formwork, no additional compensation for over-excavation or overbreak will be made except as provided for the applicable payment items.

Where blasting is required, the Contractor shall complete the entire foundation excavation before commencing with the construction of any permanent concrete work, unless otherwise approved by the Engineer.

Boulders, logs or any other unsuitable material excavated shall be spoiled.

When material suitable for founding is encountered at or before the specified founding level, it shall be cut and trimmed to a firm surface, either level, stepped or serrated, as may be required.

Where, in the opinion of the Engineer, unsuitable material is encountered at founding level, such material shall be removed and replaced with foundation fill in accordance with Clause A13.1.7.6 and to dimensions and depths as directed by the Engineer. Alternatively, the Engineer may order revised founding levels, based on an assessment of the exposed founding conditions. Unless such new founding depth varies from the specified founding level by more than 2,5 m, it shall not be considered as a variation in terms of the Contract.

d) Classification of excavated material

For payment purposes distinction shall be made between excavation in hard and soft material. All excavation for the foundations of structures shall be classified in accordance with the following classification:

(i) Hard material

Boulders with a volume of 0,1 m^3 or more;

or

material which cannot be excavated except by drilling and blasting or by using pneumatic tools or mechanical breakers.

(ii) Soft material

All material not classified as hard material, shall be classified as soft material.

e) Blasting

Where blasting is permitted, it shall be carried out in accordance with the requirements of Clause A1.2.7.5 of Chapter 1 and Section A12.10 of Chapter 12.

f) Deterioration of foundation excavations

Where soft or hard material, which quickly deteriorates when exposed, is encountered at foundation level, the excavation shall be excavated and trimmed to final slope and level and the blinding placed within four hours after completion of the excavation.

Where bottoms or sides of excavations, in which bases are to be cast, are softened on account of negligence by the Contractor in allowing storm or other water to enter the excavations, this softened material shall be removed and replaced with foundation fill as directed by the Engineer, at the Contractor's expense.

g) The safety and protection of excavations

The Contractor shall take all necessary precautions to safeguard stability and safety of excavations, adjacent structures or road formations.

Personal safety shall not be jeopardised, neither shall any situation be allowed which may result in damage of whatsoever nature to the temporary or permanent work.

Precautionary measures taken by the Contractor shall strictly comply with provisions of the Health and Safety Act, and Construction Regulations. Without derogating from the importance of any provisions, the Contractor shall give due attention to:

- Execution of excavation work under supervision of a CCP,
- Stability of excavations and need (or otherwise) to provide sufficient and suitable shoring or bracing,
- Provision of an effective barrier or fence along the perimeter to safeguard workers, the public and where appropriate, vehicles,
- Prevention of run-off and surface drainage water from entering the excavations,
- Refer to detailed requirements provided in the Contract Documentation.

  The Contractor who performs excavation work, shall take reasonable and sufficient steps in order to prevent any person from being buried or trapped by a fall or dislodgement of material in an excavation. No persons shall work in an excavation which is not adequately shored or braced. Shoring and bracing are not required where sides of excavations are sloped to safe angles as determined and detailed in writing by the Engineer in consultation with a suitably-qualified, ECSA-registered geotechnical Engineer.

Shoring or bracing shall be designed with a suitable margin of safety and constructed in a manner to ensure this value.

No load, material, plant or equipment shall be placed or moved near the edge of any excavation where it may cause collapse and consequently endanger safety of any person, unless precautions such as provision of sufficient and suitable shoring or bracing are taken to prevent the sides from collapsing.

Where stability of an adjoining building, structure or road is likely to be affected by making an excavation, steps shall be taken to ensure stability of such building, structure or road and safety of persons. Such special measures may be specified in the Contract Documentation but the identification and installing of such measures remains the Contractor's obligation regardless.

Convenient and safe means of access shall be provided to every excavation in which persons are required to work, and such access shall not be further than 6,0 m from the point where any worker within the excavation is working.

The Contractor shall ascertain, as far as is reasonably practicable, the location and nature of electricity, water, gas or other similar services which may in any way be affected by work to be performed, and shall before commencement of excavations that may affect any such service, take the steps necessary to render circumstances safe for all persons involved, and to protect such services according to the respective service authority's wayleave or work permit conditions.

The Contractor shall ensure that every excavation, including all bracing and shoring, is inspected (i) daily, prior to commencement of each shift, (ii) after every blasting operation, (iii) after an unexpected collapse or settlement of ground, (iv) after damage to supports, and (v) after rain, by the competent person in order to ensure safety of excavations and persons. The inspection results shall be recorded in a register kept on site and made available on request to an inspector, client, Engineer or, any other Contractor or any employee.

Every excavation accessible to the public or adjacent to public roads or thoroughfares, or whereby the safety of persons may be endangered, shall be (i) adequately protected by a barrier or fence of greater than 1,0 m height and as close to the excavation as is practicable, and (ii) provided with warning illumination or any other clearly-visible boundary indicators at night or when visibility is poor, or any other suitable and sufficient precautionary measures where (i) and (ii) are not practicable.

Any person entering any excavation shall comply with precautionary measures stipulated for confined spaces as determined in the Regulations.

Where excavation works involve the use of explosives, the Contractor shall appoint a competent person in explosives for excavation, and shall ensure that a method statement is developed by that person in accordance with the applicable explosives legislation, all as specified in Chapter 1.

If at any stage during excavation inflow of groundwater is perceived to render the work dangerous, the Contractor shall immediately instruct the evacuation of an excavation until the CCP has inspected the excavations and instructed appropriate actions.

h) Inspection

No concrete shall be placed before excavations are properly cleaned and dewatered by the Contractor and inspected and approved by the Engineer.

i) Excavation by hand

Where circumstances prevent the use of mechanical excavators and material can be removed only by hand implements, the Engineer shall authorise supplementary payment to the Contractor for such work at the tendered rates for excavation by hand should he be satisfied that the Contractor was unable to prevent the necessity for excavation by hand by proper planning and precautionary measures. This supplementary rate for excavation by hand, shall not apply to minor finishing or clearing jobs in excavations done by mass excavation plant.

j) Work on, over, under or adjacent to railway lines

All work carried out on, over, under or adjacent to railway lines shall be carried out strictly in accordance with requirements of the owner of such railway line. Specific requirements in this regard shall be included in the Contract Documentation.

A13.1.7.3 Founding

Variations during construction in anticipated founding conditions may necessitate changes to dimensions and founding levels specified or shown on the drawings.

The Engineer has full and absolute power in terms of the contract to order such variations and to specify actual founding level for each foundation fill, base or caisson during construction.

The Contractor shall not be entitled to any additional payment in consequence of any such variation in dimensions or founding depths over and above that provided in Clause A13.1.3.1 irrespective of stage of construction at which the instruction to alter the dimensions or founding depths is given.

No bases or caissons shall be founded unless authorised by the Engineer. Each founding level shall be accurately measured, recorded and agreed.

The term "founding level" used in these specifications shall be have the following meanings in respect of:

a) Foundation fill

Surface of in situ material that was prepared to receive foundation fill.

b) Bases

Underside of base, or conversely, top of the concrete screed.

c) Piled Foundations

Underside of pile cap.

d) Caissons

Underside of cutting edge.

A13.1.7.4 Utilisation of excavated material

Excavated material and material recovered from temporary works shall, if suitable, be utilised for backfill. Material unsuitable for use as backfill or in excess of required quantity shall be spoiled or utilised as directed by the Engineer.

Excavated material not used for backfill nor taken to spoil but used in construction of embankments or other parts of the work, as directed by the Engineer, will be paid for under foundation excavation as well as under the relevant item for which it is used.

Excavated and stockpiled material shall be so dumped so as to not endanger incomplete structures either by direct pressure or indirectly by overloading fills contiguous to the structure, or in any other way.

A13.1.7.5 Backfill and fill near structures

a) General

When backfill/ or fill is placed, the following precautionary measures shall be taken:

(i) The material shall be placed simultaneously, in so far possible, to approximately the same elevation on both sides of an abutment, pier, or wall where appropriate. If conditions require backfill or fill to be placed appreciably higher on one side than the other, additional material on the higher side shall not be placed until authorised by the Engineer, and preferably not until concrete is more than 14 days old, or until tests show that concrete attained sufficient strength to safely withstand any pressure extended by backfill or fill or the particular method of construction.

(ii) The material behind abutments, directly restrained at top by the superstructure, for example portal- or box-type structures, shall be placed simultaneously with a maximum difference in level of 150 mm, as shown on drawings, or as directed by the Engineer.

(iii) The material behind portal walls of portal structures shall not be placed until the top slab is placed and cured, unless otherwise authorised by the Engineer.

b) Backfill

Excavated areas around structures shall be backfilled, with approved material, G7 or G8 as specified in chapter 4, in horizontal layers less than 150 mm thick after compaction, to the level of original ground surface or to levels specified on the drawings. Each layer shall be moistened or dried to the material's optimum moisture content for and compacted to a density of at least 93 % MDD for soils and gravels, and at least 95 % Maximum Dry Density (MDD) for non-plastic sands if the % passing the 0,075 mm sieve is greater than 20 % and at least 100 % MDD where less than 20 % passes the 0,075 mm sieve.

c) Fill

Before the space between the structure and approach fill, or between the structure and faces of the surrounding excavation is backfilled, the slope of the approach fill, or faces of excavation shall be shaped by benching or serrations to prevent wedge action from occurring between the structure and the approach fill or excavation faces.

Distance between exposed face of the structure and toe of approach fills or excavation faces shall be sufficient to allow proper compaction. In the event that excavations are made together with utilisation of lateral support, backfill distance will be limited to location of the lateral support system.

d) Fill within restricted area

That part of the fill within a horizontal distance of 3,0 m from vertical and inclined concrete faces of the structure, 300 mm above bases, at least 1,0 m above roof slabs and that part between pillars of spill-through abutments or that part shown on drawings, shall be termed "fill within restricted area". Where roof slabs span more than 1,8 m, the depth of restricted area shall be determined by the Engineer.

The quality of fill material within the restricted area shall comply with the requirements of Chapter 4 and except that it shall be compacted to a density greater than 93 % MDD. In order to achieve the specified density, the Contractor shall, where necessary, import material of suitable quality.

Unless otherwise directed by the Engineer, only vibratory compaction equipment that is pushed or drawn by hand or self-propelled static rollers shall be used to achieve required density within a restricted area. Fill-in spaces inaccessible for mechanical compaction equipment below concrete soffits shall be constructed by methods specified or approved by the Engineer.

A13.1.7.6 Foundation fill

If it is found during the course of excavation that material at indicated founding depth does not exhibit the required bearing capacity as specified on the drawings, the excavations shall be extended at the discretion of the Engineer until satisfactory founding material is encountered. The Engineer reserves the right to instruct the Contractor to make up the difference in levels with foundation fill.

Where foundation fill consists of rock or crushed stone, it shall be constructed in accordance with requirements in the Contract Documentation or as directed by the Engineer.

Foundation fill consisting of granular material shall be of the quality and type specified or directed by the Engineer and be constructed in layers less than 150 mm in thickness after compaction. Each layer shall be moistened or dried to optimum moisture content and compacted to a density greater than 95 % MDD for soils, gravels and cohesionless sands with more than 20 % passing the 0,075mm sieve, and at least 100 % MDD for cohesionless sand with less than 20 % passing the 0,075 mm sieve size.

In instances where possible scour or groundwater conditions could result in erosion of foundation fill, the Engineer may instruct that mass concrete or plum concrete fill be used in which case it shall be of class or mix of concrete fill as in the Contract Documentation or as directed by the Engineer and constructed in uniform layers less than 600 mm thick.

Unless otherwise specified or directed by the Engineer, foundation fill below footings shall extend a minimum of 500 mm beyond the horizontal dimensions of the concrete base and constructed from mass concrete (with or without plums), graded rock, crushed stone or compacted granular material. The width in both directions shall extend downwards and outwards at an angle of at least 45° with the horizontal from each outer edge of the plan dimensions at the underside of the footing down to the final founding level. The foundation fill shall be built up in layers of compatible thickness with the type of material used.

A concrete blinding, which complies with requirements shown on the drawings, shall be placed underneath all bases except where mass concrete fill is used or where authorised by the Engineer that this need not be done. Concrete blinding shall extend a minimum of 100 mm beyond the horizontal dimensions of the base.

In the case of structures where excessive ground water is encountered, this blinding layer may extend over the full plan area of the base of the excavation and beyond the edge of the foundation where required.

Where mass concrete or plum concrete fill is constructed under a base, it shall be accurate to final levels of the underside of the base.

Also refer to Clause A13.1.7.9 in cases where the omission of blinding is considered.

A13.1.7.7 Grouting of rock fissures

Where specified, fissures in rock below and around bases shall be sealed by pressure grouting with either cement:water, sand-cement, proprietary brand grout, or chemical grout as specified.

Water to cementitious binder ratio of grout shall be approved in advance by the Engineer.

Extent of fissuring shall be established via water testing under pressure to establish the Lugeon value of in situ rock mass.

Holes greater than 40 mm diameter, shall be drilled at positions indicated by the Engineer and grout shall be pumped into these holes under suitable pressures using a casing at the mouth and a packer. Grouting shall be at 3,0 m increments to maximum depth ordered. Care shall be taken to avoid further fracturing of rock strata by excessive grouting pressures.

Grouting rock fissures shall be conducted by specialised operators with adequate experience in this class of work who are approved by the Engineer.

A13.1.7.8 Foundation dowels

Where required, foundation dowels of specified material, diameter and length shall be installed at positions and to dimensions shown on the drawings or as directed by the Engineer. After exposing, clearing and trimming the rock formation, holes with specified diameters and depths shall be drilled in the rock. Diameter of holes shall be greater than twice the dowel diameter, but never less than 40 mm. After holes are cleared by water-jetting or compressed air and pre-wetted, they shall be filled with grout from the base so as to ensure no air pockets. Within 15 minutes of grout-filling, the dowels shall be carefully driven into the holes. A grout with a maximum water to cementitious binder ratio of 0.40, including an approved expanding additive, complying with requirements of Clause A13.1.5.6 shall be added.

Where chemical grout is approved, hole diameter, depth and preparation shall be in accordance with manufacturers specification and project requirements.

The dowels, and where required corrosion protection, shall comply with the requirements of Section A13.3.

A13.1.7.9 Foundation lining

Where specified or directed by the Engineer, foundation linings shall be installed as described hereafter. The Engineer shall have the right to order use of linings against sides of excavations and undersides of bases and slabs in lieu of formwork and concrete blinding.

All surfaces to be lined shall be covered with an approved sheeting to provide a clean impervious layer. This material shall be of sufficient strength to provide a durable working surface and support concrete and reinforcement without tearing. Joints of material between strips shall have a 200 mm overlap and the lining shall be held firmly in position by nails, pegs, etc.

Polyethylene sheeting with a minimum thickness of 0,250 mm is generally considered to be adequate for use below bridge approach slabs and bases and for sides of excavations.

A13.1.7.10 Caissons

a) General

Caissons, as contemplated in these specifications, shall be hollow concrete vessels which are wholly or partly constructed at a higher level and lowered by internal excavation or ballast to desired founding level to form structural bearing members. Caissons may be of circular, rectangular or any other shape and may contain one or more excavation compartments, all as detailed on the drawings.

Unless otherwise specified hereafter, provisions of BS 8004 shall apply in regard to construction of caissons.

b) Construction and sinking

A firm horizontal base shall be prepared on which the cutting edge of caisson shall be laid horizontally. The level of base shall be determined and shall be agreed by the Engineer and Contractor and shall serve as the ground surface from which the excavation inside the caisson is measured.

Successive stages of the caisson shall be of convenient height, or as directed by the Engineer, and shall be lined accurately with preceding stages.

If specified, all precast elements shall have adequately constructed joints in accordance with drawings to ensure a snug fit.

For in situ phase construction, all construction joints in walls shall be reinforced and joints shall be made as specified in Section A13.4.

The lowest element of every caisson, which contains cutting edges, shall be cured for at least 7 days or shall reach the specified characteristic compressive strength before sinking is commenced. Subsequent elements shall be cast in sufficient time to ensure adequate strength for safely resisting applied forces.

During constructing and sinking, caissons shall be maintained vertically and kept in correct positions.

Position and inclination of each caisson shall be determined accurately by measurement every 2,0 m of sinking, or after sinking through depth of one element, whichever distance is smaller.

To eliminate excess friction, the Contractor may use bentonite or similar lubricant, or a water-jet system.

Excavation inside caisson compartments shall, unless otherwise specified herein, comply with provisions of Clause A13.1.7.2.

In multi-compartmented caissons excavation in any one compartment shall not be taken deeper than 0,6 m below that in any other compartment, except where necessary for correcting deviations.

Cutting edges shall be frequently inspected or probed to locate obstacles, which shall immediately be removed.

The Contractor shall supply all grabs, pumps, diving gear and other plant required for sinking and founding all caissons and shall allow the Engineer to use a diving suit and related equipment for inspection purposes, if required.

The Contractor shall employ a competent diver to carry out work under water and shall make provision in tendered rates for respective items for this cost.

Where the caisson strikes a hard inclined layer and work must be carried out below the cutting edge, such work shall be measured and paid for under relevant items under item C13.1.20 and, where no applicable items exist, such work shall be paid for as extra work.

Should the Contractor wish to apply pneumatic caisson methods (with a compressed air chamber) for construction, he shall furnish the Engineer with full details of plant, equipment and method for his approval.

c) Founding

The material at founding level, if sloping or irregular, shall be cut to as nearly level as possible until the entire cutting edge is evenly and firmly supported on the material. Subject to approval of the Engineer, blasting may be used for this purpose. If blasting is used, only light charges shall be allowed with the caisson protected against damage by suitable cushioning.

Should the sloping surface be of hard rock which cannot be cut or broken by any safe and feasible means, the foundation shall be built up via a solid wedge of concrete which fills the entire space between bedrock surface and the horizontal plane through the cutting edge. This concrete shall be of the same class as that specified on the drawings or in the schedule of quantities for the concrete seal.

Rock or hard material founding material shall be completely uncovered. This founding surface shall be cleared of all loose material before inspection by the Engineer immediately prior to casting the concrete seal.

No concrete shall be placed in the wedge or seal before the Engineer inspected and approved the foundation. For this purpose the Contractor shall adequately dewater the caisson to enable the Engineer to conduct this inspection.

In the event of a caisson not being vertical or in its correct position when it reaches the required depth, or in the event of a caisson being structurally damaged (e.g. cracked) during sinking, the Contractor shall at his own cost carry out all necessary remedial work to the satisfaction of the Engineer.

d) Data

The Contractor shall provide the Engineer with a complete record of types of material excavated during sinking, together with the level at which each type of the material was found. In addition, a log showing rate-of-sinking shall be kept by the Contractor and furnished to the Engineer.

e) Filling the caissons

i) Concrete seal

The seal shall be constructed of mass concrete of class specified and shall be placed in accordance with dimensions and levels shown on the drawings or as prescribed by the Engineer.

If this seal cannot be placed in the dry and must be placed under water, method of placing this concrete shall be approved by the Engineer. The Contractor shall cease placing concrete under water when sufficient concrete was placed to seal the foundation effectively.

After the concrete has been placed, the concrete seal and head of water over it shall remain undisturbed for a period of at least 7 days after which the caisson shall be dewatered by pumping for inspection. If more water is still leaking into the caisson, the process of sealing as specified herein shall be continued until water level within the caisson rises at a rate < 10 mm/ hour.

The relevant requirements of Section A13.4 and Chapter 12 shall apply for placing concrete under water. For concrete placed under water by methods other than tremie, cement content shall be 20 % more than the quantity required for ordinary concrete of the same mix but > 450 kg per m^3 of concrete.

ii) Filling

Subsequent to inspection of caisson compartments above the concrete seal, the compartments shall be filled with sand. The sand shall be sufficiently wetted to obviate bulking.

The first 2,0 m of filling above the concrete seal shall be lowered gently into position. The sand may then be poured from the top and compacted sufficiently to prevent settlement while the cover slab concrete is placed.

Top of sand fill within the caisson shall be finished to level specified below underside of caisson cover slab.

f) Stripping

Where walls of the caisson are overbuilt, concrete shall be stripped to required level without damage to concrete below cut-off level. Vertical reinforcement of caisson shall protect above cut-off level by a distance greater than 50 times the bar diameter.

g) Concrete blinding below the caisson cover slabs

Concrete blinding of specified thickness and class shall be provided to the level shown on drawings over the area of the cover slab, including the area within caissons on top of sand filling, except where the underside of the cover slab is formed with formwork.

A13.1.8 WORKMANSHIP

At commencement of construction the Contractor shall provide detailed process quality assurance procedures with regards to backfill, foundation fill and grouting

A13.1.8.1 Definitions

Except where otherwise specified, the following aspects of construction, to which tolerances apply, shall have meanings attributed to them as detailed below:

Position - the position of a structure or structural member shall be the horizontal position of its centre line(s) or centre point(s) in relation to the overall layout of the works as shown on the drawings.

Alignment - alignment of a structure or structural member shall be the alignment of its centre line(s) in relation to the overall layout of the works as shown on the drawings. Deviation from true alignment shall be measured in degrees of an arc.

Leading and cross-sectional dimensions - the leading and cross-sectional dimensions of a structure or structural member shall be dimensions relating to width, length, height, thickness, etc., which collectively determine its shape, and are shown on the drawings. Dimensional tolerances not relating to leading or cross-sectional dimensions shall be shown on the drawings.

Levels - the level of any structure or structural member shall be the level of the upper or lower surface, as may be relevant, with reference to an established datum-level on the site.

Surface regularity - is the shape of a surface with reference to a 3,0 m straight-edge (or template in the case of curved surfaces) placed on this surface. The tolerance for surface regularity is expressed as a distance by which the surface tested may deviate from a straight-edge (or template in the case of curved surfaces) held against this surface.

A13.1.8.2 Tolerances

For the assessment of acceptance and compliance the tolerances given below shall be the maximum permissible deviations from the specified dimensions, levels, alignment, positions, etc., shown on drawings of the structures or structural members.

a) Foundations

Caissons:

Position of top of caisson ..... 10 % of smallest outer dimension of caisson, measured in plan.

Verticality..... 1,5°

Dimensions:

Wall thickness ..... + 25 mm – 5,0 mm

Outer dimension of circular, rectangular or square cross-section..... ± 25 mm

Level: Upper level of trimmed/cut caisson head:

Maximum deviation of average level..... ± 25 mm

Maximum deviation of any individual level ..... ± 50 mm

Foundation fill:

Average level of top of foundation fill ..... ± 25 mm

b) Footings, pile capping slabs, caisson cover slabs, etc.

Position ..... 15 mm

Alignment:

Alignment of individual member..... 5°

Alignment of members as they collectively determine

alignment of structure as a whole ..... 1 minute

Dimensions: Leading dimension in plan..... ± 25 mm

Thickness..... + 25 mm – 15 mm

Levels: Average level of slabs, footings, etc..... ± 25 mm

B13.1 FOUNDATIONS
PART B: LABOUR ENHANCEMENT

CONTENTS

B13.1.1 SCOPE

B13.1.2 DEFINITIONS

B13.1.3 GENERAL

B13.1.4 DESIGN BY CONTRACTOR / PERFORMANCE BASED SYSTEMS

B13.1.5 MATERIALS

B13.1.6 CONSTRUCTION EQUIPMENT

B13.1.7 EXECUTION OF THE WORKS

B13.1.8 WORKMANSHIP

B13.1.1 SCOPE

This Section covers foundation and foundation related work and relates to the additional specification Clauses for the labour enhanced excavation and backfilling of foundations.

B13.1.2 DEFINITIONS

Definitions as provided in A13.1.2 shall apply.

B13.1.3 GENERAL

Any activity specified in Part A, where hand work is envisaged, shall be executed in such a way as to maximise labour enhancement.

B13.1.4 DESIGN BY CONTRACTOR/PERFORMANCE BASED SYSTEMS

The provisions of Part A shall apply.

B13.1.5 MATERIALS

The provisions of Part A shall apply.

B13.1.6 CONSTRUCTION EQUIPMENT

The Contractor shall before construction commences, provide comprehensive details of all plant and equipment, which shall be appropriate for intended use. It shall be clear from the information provided that the required production rates and activities as indicated in the approved construction program can be achieved.

Plant allowed for the labour enhanced construction work is limited to the following items:

- All and any compaction equipment/ plant.
- Water bowser for compaction water.
- Excavation plant may be used for excavations under water. All excavations in the dry shall be done using labour.
- Air compressors and hand-held breakers for excavating in intermediate excavation.
- Drilling equipment
- Dumpers, flat-bed trucks, tractor-trailer combinations or animal-drawn trailers

B13.1.7 EXECUTION OF THE WORKS

B13.1.7.1 Access and drainage

Not suitable for labour intensive work.

B13.1.7.2 Excavation

a) General

The labour enhanced work shall include excavations not provided for elsewhere in these specifications, which are required for founding the structures as well as for excavating required in respect of demolition, extension or modification of existing bridges and culverts.

Excavation in the vicinity of existing structures and road formations shall be performed with due care and diligence. The Contractor shall take special care not to disturb the founding material of any existing foundations and road formations. The excavation profile must strictly be as approved by the Engineer and as shown on drawings.

Transportation of all materials shall be done with wheelbarrows up to the haul distance of 50 m. For haulage that is longer than 50 m, transportation for the full distance shall be done by hand-loaded dumpers, flat-bed trucks, tractor-trailer combinations or by other approved means.

b) Agreed excavation surface level and profiles

The provisions of Clause A13.1.7.2b) shall apply.

c) Excavation

All excavations in the dry shall be done by using labour. Excavations under water shall be undertaken with suitable plant.

In stable or hard material the Engineer may approve that the excavated surfaces can act as forms for casting of the concrete and the excavations shall then be carried out and trimmed to neat dimensions of the concrete members shown on the drawings. To prevent moisture loss in the concrete where excavated surfaces act as forms, a foundation lining shall be installed as specified in Clause A13.1.7.9. As an alternative, provided that sufficient space is made available during excavation, an additional 50 mm of concrete cover, over and above that specified may also be provided if approved by the Engineer. Excavations in soft material in excess of the authorised dimensions (over-excavation) or overbreak in hard material shall be backfilled with the same class of concrete as that in the base.

In the case where excavations are made to neat dimensions of the concrete members (no formwork), compensation for the backfill of over-break in hard material shall be measured and paid for under pay item C13.1.9 but the cost of backfilling of over-excavation in soft material shall be at the Contractor's own expense. Where additional excavation width is required for the erection of formwork, no additional compensation for over-excavation or overbreak will be made except as provided for the applicable payment items.

The labour enhanced Contractor is not permitted to undertake blasting. Where blasting is required, the Contractor shall complete the entire foundation excavation before commencing with the construction of any permanent concrete work, unless otherwise approved by the Engineer.

Boulders, logs or any other unsuitable material excavated shall be spoiled.

When material suitable for founding is encountered at the founding level, it shall be cut and trimmed to a firm surface, either level, stepped or serrated, as may be required.

Where, in the opinion of the Engineer, unsuitable material is encountered at founding level, such material shall be removed and replaced with foundation fill in accordance with Clause A13.1.7.6 and as directed by the Engineer.

d) Labour Enhancement Classification of Excavated Material

The Engineer shall classify excavated materials as soft or intermediate.

The Contractor shall notify the Engineer of the presence of what he considers to be rock or intermediate material immediately upon discovery thereof. The Engineer will inspect the material and decide whether the material shall indeed be classified as suggested by the Contractor or not. The decision of the Engineer shall be final and binding, subject to the provisions of the Contract.

(i) Intermediate

Intermediate excavation shall include rock banks breakable by conventional means (jack hammers using pneumatic or hydraulic means), and in situ materials containing more than 40 % of any material (by volume) consisting of boulders each not exceeding 0,03 m^3 in size.

(ii) Soft

Soft excavation shall be excavation in normal soft and hard soil containing less than 40 % (by volume) boulders each not exceeding 0,03 m^3.

(iii) Blasting

Blasting will not be permitted.

B13.1.7.3 Founding

All specifications under this sub-heading in the various sections of Clause A13.1.7.3, shall apply.

B13.1.7.4 Utilisation of excavated material

To the provisions of Clause A13.1.7.4 add the following:

The haul distance on excavated material and imported material for backfill shall be 100 m.

B13.1.7.5 to B13.1.7.9

All specifications under Clauses A13.1.7.5 to A13.1.7.9, shall apply.

B13.1.7.10 Caissons

Not suitable for labour intensive work.

B13.1.8 WORKMANSHIP

The provisions of Part A shall apply.

C13.1 FOUNDATIONS

PART C: MEASUREMENT AND PAYMENT

(i) Preamble

The tendered rate for each item shall include full compensation for providing, maintaining and decommissioning upon completion, of all the plant, equipment, labour, tools, incidentals and supervision to carry out the activity or construct the works in the item, unless otherwise stated.

Any prime cost or provisional sums shall be paid in accordance with the provisions of the conditions of contract. The charge or mark-up tendered or allowed for is a percentage of the amount actually paid under the prime cost or provisional sum. This percentage shall cover all the Contractor's handling, supervision, profit and liability costs to provide the services in the prime cost or provisional sum item.

The requirements of Section C1.1 of Chapter 1 shall apply.

Where pay item descriptions include any wording in brackets it is an indication that contract specific information is to be inserted in the Pricing Schedule included in the Contract Documentation.

(ii) Notes on measurement and pay items

1. The ground surface will be that existing after any bulk earthworks have been carried out, i.e. the excavated surface or embankment surface, unless a different sequence of execution has been ordered.
2. Excavations will be measured as if taken out with vertical sides, regardless of whether they have been taken out with sloping sides.
3. Wherever volumetric measurement is required, the volume will be computed from the depth determined as indicated in 1. above and using the authorised width (W) determined in accordance with the specification.
4. Where shoring is specified or ordered, the length of shoring measured for payment will be the length of the centre-line of the open drain or trench.
5. Payment in accordance with item C13.1.9 for the construction of fill within restricted areas shall be made only when specifically provided for in the schedule of quantities otherwise it shall be deemed to be included in the other tendered rates.

(iii) Items that will not be measured separately

The following activities, whether required to complete the specified work or not, will not be measured and paid for separately and the Contractor shall include the cost thereof in other pay items as he deems appropriate:

1. No separate payment will be made for backfilling excess excavations, disposing of surplus material etc. or any other contingent work, unless the work is specifically specified or ordered.
2. No separate payment will be made for setting out the works.
3. No separate payment will be made for the protection or repair as required of any existing or new road furniture, structures, buildings, infrastructure or services damaged by the Contractor's activities.
4. No additional payment shall be made, nor shall any claim for additional payment be considered, for any specified work in confined or restricted areas. Any additional costs associated with working in confined or restricted areas shall be deemed to be included in the standard applicable pay items.
5. No separate payment will be made for the loading of any materials.
6. No separate payment will be made for the hauling of any materials where the material is moved over a distance of less than, and up to 1,0 km and for labour enhanced construction, less than and up to 50 m.
7. No separate payment will be made for transporting materials from commercial sources irrespective of the haul distance.
8. No separate payment will be made for the removal or any surplus material imported to complete the works.
9. For all Works performed, precautionary measures required in terms of the Occupational Health and Safety Act (Act 85 of 1993) and the latest amendments thereof as well as the latest Construction Regulations shall be deemed included in the rates tendered for the relevant products.

(iv) Items to be measured and paid for using items specified elsewhere in the specifications

For activities in Table C13.1-1 pay items specified in other Chapters or Sections of the specifications, where they relate to work under this Section, will be listed in the Pricing Schedule.

Table C13.1-1: Payment items from other Chapters or Sections

Activity	Section 13.1 reference	Section item reference
Fill within a restricted are	C13.1.9	C5.2.2 of Chapter 5 - All applicable items
Hauling materials	C13.1.3, C13.1.4, C13.1.7.2, C13.1.8.2, C13.1.10, C13.1.11, C13.1.14.1, C13.1.14.2, C13.1.14.3, C13.1.15.1, C13.1.15.2, C13.1.15.3, C13.1.30 and C13.1.31	Section C1.7 of Chapter 1 – All applicable items
Mass earthworks	C13.1.23	Chapter 4 – All applicable items

(v) Items specifically for this Section of the specifications

Item	Description	Unit
C13.1.1	**Provision of designs and drawings of temporary works by an ECSA-registered Professional Engineer or Technologist or Geotechnical Engineer (description of works to which applicable):**	**lump sum**

The unit of measurement shall be the lump sum and shall be paid in two payments; 50% on submission of the temporary work designs and the second 50 % on complete removal of all the temporary works.

The tendered rates shall include full compensation for procuring and provision of all drawings of the temporary works, designs by an ECSA-registered Professional Engineer or Technologist or Geotechnical Engineer, including all labour, material, travelling and incidentals, time delays and submission of all the certificates as specified.

Item	Description	Unit
C13.1.2	**Additional foundation investigations:**	
C13.1.2.1	Provisional sum allowed for additional foundation investigations	provisional sum
C13.1.2.2	Handling costs and profit in respect of item C13.1.2.1	percentage (%)

The provisional sum allowed under subitem (a) shall only be expended on submission of actual costs of the appointed sub-Contractor for the additional foundation investigation.

The tendered percentage of subitem (b) is a percentage of the amount actually spent under subitem (a) and shall include full compensation for all charges and incidental costs of the Contractor, profit and overheads.

Item	Description	Unit
C13.1.3	**Excavation:**	
C13.1.3.1	Excavating soft material situated within the following successive depth ranges:	
(a)	0 m up to 1,5 m	cubic metre (m^3)
(b)	> 1,5 m and < 3,0 m	cubic metre (m^3)
(c)	Etc. in increments of 1,5 m	cubic metre (m^3)
C13.1.3.2	Extra over subitem C13.1.3.1 for excavation in hard material irrespective of depth	cubic metre (m^3)
C13.1.3.3	Extra over subitem C13.1.3.1 for additional excavation required by the Engineer after excavation is complete	cubic metre (m^3)
C13.1.3.4	Extra over subitem C13.1.3.1 for excavation by hand	cubic metre (m^3)
C13.1.3.5	Extra over subitem C13.1.3.1 for excavation in restricted areas	cubic metre (m^3)

Item	Description	Unit
C13.1.4	**Excavation by labour enhanced methods:**	
C13.1.4.1	Excavate in soft material situated within the following successive depth ranges:	
(a)	0 m up to 1,5 m	cubic metre (m^3)
C13.1.4.2	Extra over item C13.1.3.1(a) for excavation in intermediate material	cubic metre (m^3)
C13.1.4.3	Extra over item C13.1.3.1(a) for additional excavation required by the Engineer after excavation is complete	cubic metre (m^3)

Limits for successive depth ranges shall be measured vertically down from surface levels agreed (Clause A13.1.7.2b)) to founding level (Clause A13.1.7.3) agreed.

In the case of excavations required for diverting, channelization or widening streams, successive depth ranges for those portions of excavations that are within 5,0 m of a concrete structure shall be measured from surface levels agreed to invert level of channel or stream.

Unit of measurement shall be the cubic metre of material, measured in original position before excavation. Quantity of excavation for each depth range shall be calculated from neat outlines of base or floor and depth of excavation completed within each range.

Excavation required for diverting, channelling or widening streams within 5,0 m of concrete structures shall be measured and paid for under item C13.1.3. Excavations beyond this 5,0 m limit shall be measured and paid under the appropriate items in Chapters 3 and 4 unless otherwise provided for in the Contract Documentation.

To provide working space for erecting formwork, the extremities of the excavation, for purposes of measurement and payment, shall be deemed to be the vertical planes parallel to and 0,5 m outside the perimeter of concrete members for which formwork is provided.

Irrespective of the total depth of excavation, the quantity of material within each depth range shall be measured and paid for separately.

Supplementary payment for the excavation by hand as specified in Clause C13.1.3.4 shall constitute full compensation for incidentals for hand-excavating materials instead of using mass-excavating equipment.

Where foundation fill is constructed in an excavation, the quantity of excavated material measured for payment shall be material excavated between average ground level, as described in Clause A13.1.7.2b), and founding level, from a prism with vertical sides, as described in Clause A13.1.7.6 or as prescribed by the Engineer.

In no case shall any of the following excavations be included in the measurement for payment:

(i) The volume of excavation in excess of above-mentioned limits.
(ii) The volume included within the excavated road prism, contiguous channels, ditches, etc, for which payment is provided elsewhere in the specifications.

The tendered rates shall include full compensation for excavation in each class of material, the spoiling or stockpiling of material, the hauling of excavated material for a haul distance of 1,0 km and in the case of labour enhanced methods a haul distance of 50 m, any additional excavation the Contractor may require for additional working space outside the authorised limits, trimming and cleaning the bottoms and sides of excavations, and safeguarding the excavations. Payment for strutting and shoring the excavations shall be paid under a separate item.

If, after a foundation excavation has been completed, cleaned and trimmed ready for concrete screeding, the Engineer orders further excavations to be made on account of changed dimensions or founding conditions, an extra over payment (item C13.1.3.3 on the additional excavation measured for payment shall be payable in full compensation for any incidentals to the Contractor over and above the normal excavation costs.

Item	Description	Unit
C13.1.5	**Mass excavation within a restricted area (extra over item C13.1.3)**	**cubic metre (m^3)**

Unit of measurement shall be the cubic metre and quantities shall be taken as total volume of material within the restricted area as defined in Clause A13.1.7.5. The quantity shall not include volume of excavation which is measured and paid for under item C13.1.3 above.

Tendered rate shall include full compensation for all additional work necessitated by working in restricted areas.

Item	Description	Unit
C13.1.6	**Access and drainage:**	
C13.1.6.1	Access	lump sum

The tendered lump sum shall include full compensation for providing access, which, inter alia, shall include constructing temporary banks, artificial islands or cofferdams, their protection, safeguarding and maintenance as well as any incidentals in respect of work below standing water.

75 % of the lump sum will be paid when the access is constructed. The remaining 25 % will be paid after the access has been removed.

Payment for draining of excavations shall be made separately under item C13.1.6.2.

C13.1.6.2	Drainage	lump sum

Payment will be made for this work by way of a lump sum for each structure or series of structures appearing separately in the schedule of quantities. The lump sum shall be paid on a pro rata basis as the work progresses.

The tendered lump sum shall include full compensation for draining by pumping or in any other way and for any other work necessary for keeping the excavations dry or for working in the dry.

Where dewatering and keeping dry of excavations is not billed separately as per this item C13.1.6.2 it shall be deemed to be included in rates tendered and paid for excavation and backfill.

Item	Description	Unit
C13.1.7	**Backfill to excavations utilising:**	
C13.1.7.1	Material from excavation	cubic metre (m^3)
C13.1.7.2	Imported material	cubic metre (m^3)
C13.1.7.3	Soil cement	cubic metre (m^3)

Item	Description	Unit
C13.1.8	**Backfill to excavations utilising labour:**	
C13.1.8.1	Material from excavation	cubic metre (m^3)
C13.1.8.2	Imported material	cubic metre (m^3)

C13.1.8.3	Soil cement	cubic metre (m^3)

The unit of measurement shall be the cubic metre of backfill material measured in the excavation. The quantity measured shall be calculated from within the neat outlines defined for excavation under item C13.1.3 and height to which the backfilling is constructed. The volume occupied by the structure shall be subtracted when calculating volume of backfilling.

The height shall be determined by the upper surface of the road prism or reference ground surface (Clause A13.1.7.2b)), whichever is the lower.

The tendered rates shall include full compensation for furnishing and placing all materials within the entire excavation, transporting the material within haul distance of 1,0 km, and in the case of labour enhanced methods a haul distance of 100 m, and preparing, processing, shaping, watering, mixing and compacting the material to the specified densities.

Item	Description	Unit
C13.1.9	**Fill within a restricted area (extra over item C5.2.2)**	**cubic metre (m^3)**

The unit of measurement shall be the cubic metre and the quantity shall be taken as total volume of material within the restricted area as defined in Clause A13.1.7.5 d). This quantity shall not include the volume of backfill measured and paid for under items C13.1.7 and C13.1.8.

The tendered rate shall include full compensation for all additional work necessitated by working in restricted areas and for increased density required in restricted areas.

Item	Description	Unit
C13.1.10	**Haul in excess of 1,0 km on excavated material and on material imported for backfill, foundation fill and fill for caissons**	**cubic metre-kilometre (m^3-km)**

Item	Description	Unit
C13.1.11	**Haul in excess of 50 metres on excavated material and on foundation fill for labour enhanced construction**	**cubic metre-kilometre (m^3-km)**

Haul shall be measured and paid for as specified in Section C1.7 of Chapter 1 and shall apply only to that portion of the material qualifying for payment under items C13.1.3, C13.1.4, C13.1.7.2, C13.1.8.2, C13.1.10, C13.1.11, C13.1.14.1, C13.1.14.2, C13.1.14.3, C13.1.15.1, C13.1.15.2, C13.1.15.3, C13.1.30 & C13.1.31

Haul shall not apply to concrete used in foundation fill.

Item	Description	Unit
C13.1.12	**Overbreak in excavation in hard material:**	**square metre (m^2)**

Item	Description	Unit
C13.1.13	**Overbreak in excavation in hard material for labour enhanced construction:**	**square metre (m^2)**

The unit of measurement shall be the square metre of surface area of the vertical outer faces of the base where excavations are made to “neat” dimensions of the base.

The tendered rate shall include full compensation for the overbreak material removed from the excavation in hard material, for the concrete fill in accordance with Clause A13.1.7.6, and any additional screeding concrete required.

Item	Description	Unit
C13.1.14	**Foundation fill consisting of:**	
C13.1.14.1	Rock fill	cubic metre (m^3)
C13.1.14.2	Crushed-stone fill	cubic metre (m^3)
C13.1.14.3	Compacted granular material	cubic metre (m^3)
C13.1.14.4	Mass concrete (class indicated)	cubic metre (m^3)
C13.1.14.5	Concrete blinding (thickness and class of concrete indicated)	cubic metre (m^3)
C13.1.14.6	Plum concrete (class indicated)	cubic metre (m^3)

Item	Description	Unit
C13.1.15	**Foundation fill placed by labour enhanced methods consisting of:**	
C13.1.15.1	Rock fill	cubic metre (m^3)
C13.1.15.2	Crushed-stone fill	cubic metre (m^3)

C13.1.15.3	Compacted granular material	cubic metre (m^3)
C13.1.15.4	Mass concrete (class indicated)	cubic metre (m^3)
C13.1.15.5	Concrete blinding (thickness and class of concrete indicated)	cubic metre (m^3)
C13.1.15.6	Plum concrete (class indicated)	cubic metre (m^3)

The unit of measurement shall be the cubic metre of approved material placed and compacted below the bases as specified or where directed by the Engineer.

The quantity of foundation fill to be measured for payment shall be the material contained within the prism specified in Clause A13.1.7.6 or shall otherwise be the quantity to the outlines shown on the drawings or as directed by the Engineer.

The tendered rates shall include full compensation for procuring, furnishing, transporting for a haul distance of 1,0 km (subitems (a) to (c) only), placing and compacting material and in the case of labour enhanced methods, a haul distance of 50 m.

Item	Description	Unit
C13.1.16	**Establishment on site for drilling of holes and grouting of rock fissures (type of drilling indicated):**	**lump sum**

The tendered lump sum shall include full compensation for establishment on the site and the subsequent removal of all special equipment and plant for drilling the holes, grouting of rock fissures and any additional plant for carrying out operations, the cost of which does not vary with the actual amount of work to be done.

This work will be paid for by way of a lump sum, 75 % of which will become payable when all equipment is on the site and the first hole has been grouted. The remaining 25 % will become payable after all holes have been grouted and equipment removed from site.

Item	Description	Unit
C13.1.17	**Moving to and setting up equipment at each hole to be drilled for grouting:**	**number (No)**

The unit of measurement shall be number of positions to which the equipment has to be moved and set up for drilling and grouting rock fissures. The number to be measured shall equal number of holes drilled as instructed by the Engineer.

Tendered rate shall include full compensation for all the costs involved in moving and setting up the equipment.

Item	Description	Unit
C13.1.18	**Drilling of holes for grouting (diameter and type of drilling indicated):**	**metre (m)**

The unit of measurement shall be the metre of hole drilled.

The tendered rate shall include full compensation for drilling and clearing the holes as specified.

Item	Description	Unit
C13.1.19	**Grouting of rock fissures (type of grout and for which purpose it is required indicated):**	**kilogram (kg)**

The unit measurement for grouting shall be the kilogram of cementious binder or proprietary grout as may be applicable used in the grouting operation.

The tendered rates shall include full compensation for providing the equipment and all material and mixing and pumping the grout into the prepared holes in accordance with instructions of the Engineer, and also for the water-pressure tests.

Item	Description	Unit
C13.1.20	**Dowel bars:**	
C13.1.20.1	Drilling and preparation of holes (diameter and length indicated)	metre (m)
C13.1.20.2	Supply and installation of dowel bars (type, diameter, length, corrosion protection, together with type of grout, indicated)	kilogram (kg)

The unit of measurement for drilling and preparation of holes in rock shall be the metre of holes drilled while unit of measurement for dowel bars shall be the kilogram of bars provided and secured in position.

The tendered rates shall include full compensation for drilling holes, preparing holes for grouting i.e. saturating and cleaning, supplying all the material and positioning and grouting the dowel bars as specified.

Item	Description	Unit
C13.1.21	**Foundation lining (type of material and thickness indicated):**	**square metre (m^2)**

The unit of measurement for foundation lining shall be the square metre of concrete surface lined.

The tendered rates shall include full compensation for procuring, furnishing and placing all material and incidentals required for completing the work as specified.

Item	Description	Unit
C13.1.22	**Foundation lining (type of material and thickness indicated), using labour enhanced methods**	**square metre (m^2)**

The unit of measurement for foundation lining shall be the square metre of concrete surface lined.

The tendered rates shall include full compensation for procuring, furnishing and placing all material, labour and incidentals required for completing the work as specified.

Item	Description	Unit
C13.1.23	**Lateral support for excavations:**	
C13.1.23.1	Excavation or fill at (indicate location)	
(a)	0 to 2,5 m depth	square metre (m^2)
(b)	2,5 to 5,0 m depth	square metre (m^2)
(c)	Etc. at other locations	

The unit of measurement shall be the square metre of lateral support at a specific location over successive depth ranges. Depth ranges shall be measured down from the level where lateral support is required at each location and agreed with the Engineer.

The rates shall include full compensation for design, supply, fabrication, installation, removal (if required), labour, materials, equipment, plant and incidentals to provide complete lateral support to the excavated or filled faces. The rate shall also include inspections, supervision by safety officer and for maintenance of lateral support. The lateral support shall remain in position as long as required to complete construction and only removed with the approval of the Engineer. Where lateral support for excavations are required, cost for excavating material shall not be included, but paid for under items C13.1.3 or the appropriate mass earthworks items under Chapter 4.

Where lateral is not billed separately as per this item C13.1.23 it shall be deemed to be included in rates tendered and paid for excavation and backfill.

Item	Description	Unit
C13.1.24	**Establishment on site for constructing caissons**	**lump sum**

The tendered lump sum shall include full compensation for the establishment on site and later removing all special plant and equipment necessary for constructing the caissons. This cost shall not vary with number of caissons constructed.

This work will be paid for by way of lump sum, 50 % of which will be paid when all the equipment is on the site and the first caisson is constructed. The second 25 % will be paid after half the caissons are completed, and the final instalment of 25 % after all caissons are complete and equipment is removed from site.

Item	Description	Unit
C13.1.25	**Formwork for caissons (class of finish indicated)**	**square metre (m^2)**

The unit of measurement shall be square metre of formwork, and only area of formwork in contact with finished faces of concrete shall be measured. Formwork for construction joints shall be measured for payment under class F1 surface finish but shall be measured only for the construction joints shown on drawings or as prescribed by the Engineer.

The tendered rate shall include full compensation for supplying all materials, erecting falsework and formwork, constructing forms, forming grooves, fillets, chamfers, stop ends for construction joints, treating forms, all accessories, and stripping and removing the formwork after completion of the work. Payment for the formwork shall be made only after the formwork is stripped and surface finish approved.

Item	Description	Unit
C13.1.26	**Steel reinforcement for caissons:**	
C13.1.26.1	Mild-steel bars	ton (t)
C13.1.26.2	High-yield-stress-steel bars (type indicated)	ton (t)

The unit of measurement for steel bars shall be the ton of reinforcement in place in accordance with drawings or as authorised.

Ties and other steel used for positioning reinforcing steel shall be measured as steel reinforcing under the appropriate subitem.

The tendered rates shall include full compensation for supplying, delivering, cutting, bending, welding, trial welding joints, placing and fixing steel, including all tying wire, spacers and waste.

Item	Description	Unit
C13.1.27	**Cast in situ concrete in caissons and concrete seals (class of concrete indicated)**	**cubic metre (m^3)**

The unit of measurement for cast in situ concrete shall be the cubic metre of concrete in place. Concrete quantities in caissons shall be calculated from dimensions shown on drawings or authorised by the Engineer, and length of caisson from founding level to specified cut-off

level. Quantity of concrete in the concrete seal shall be calculated in accordance with dimensions shown on drawings or authorised by the Engineer.

The tendered rate shall include full compensation for procuring and furnishing all materials, storing material, providing all plant, mixing, transporting, placing and compacting concrete, all sealing, curing of concrete and repairing defective concrete. Payment shall distinguish between the different classes of concrete.

Item	Description	Unit
C13.1.28	**Cutting edge for (diameter/ size indicated) caissons**	**number (No)**

The unit of measurement shall be number of caissons provided with cutting edges, irrespective of constructed material.

The tendered rate shall include full compensation for manufacturing, supplying, delivering and installing the complete cutting edge as well as for joining cutting edge to caisson unit. Where cutting edge is of concrete and forms part of the bottom element, tendered rates shall include full compensation for all additional work required for completing the element.

Item	Description	Unit
C13.1.29	**Sinking (diameter/size indicated) caissons through material situated within the following successive depth ranges:**	
C13.1.29.1	0 m up to 5,0 m	metre (m)
C13.1.29.2	Exceeding 5,0 m and up to 10 m	metre (m)
C13.1.29.3	Etc.in increments of 5,0 m depths	metre (m)

Limits of successive depth ranges shall be measured down from the firm horizontal base (Clause A13.1.7.10b)) to agreed founding level (Clause A13.1.7.3).

The unit of measurement shall be the metre of caisson sunk.

Irrespective of length of caisson sunk, quantity for each depth range shall be measured and paid for separately.

The tendered rates shall include full compensation for locating and holding in position, dewatering, pumping, kentledge and lubricating sides of the caisson, and for all work in connection with sinking the caisson which is not paid for elsewhere.

Item	Description	Unit
C13.1.30	**Excavation for caissons:**	
C13.1.30.1	Excavating soft material situated within the following successive depth ranges:	
(a)	0 m up to 2,0 m	cubic metre (m^3)
(b)	Exceeding 2,0 m and up to 4,0 m	cubic metre (m^3)
(c)	Etc in increments of 2,0 m depths	cubic metre (m^3)
C13.1.30.2	Extra over subitem C13.1.24.1 for excavation in hard material irrespective of depth	cubic metre (m^3)

Limits for successive depth ranges shall be measured from the firm horizontal base (Clause A13.1.7.10b)) to excavated level inside the caisson.

The unit of measurement shall be the cubic metre of material, measured in original position before excavation. Quantity of excavation for each depth range shall be calculated from the gross area of caisson in plan and depth of excavation completed within each depth range.

Irrespective of total depth of excavation, quantity of material within each depth range shall be measured and paid for separately.

The tendered rates shall include full compensation for excavation in the classified material, spoiling or stockpiling material, hauling excavated material for haul distance of 1,0 km, trimming bottom of excavation, dewatering, pumping and removing material leaking into the caisson before sealing.

Item	Description	Unit
C13.1.31	**Filling the caissons**	**cubic metre (m^3)**

The unit of measurement shall be the cubic metre of sand placed above the concrete seal in the caisson compartments.

The tendered rate shall include full compensation for supplying and placing sand, transporting material within a haul distance of 1,0 km, and compacting material as specified.

Item	Description	Unit
C13.1.32	**Stripping (size of caisson indicated) caisson heads**	**number (No)**

The unit of measurement shall be number of caissons of each size stripped.

The tendered rate shall include full compensation for cutting away, trimming and disposing of concrete removed at an approved dump site.

D13.1 FOUNDATIONS

PART D: GUARANTEES AND COMPLIANCE CERTIFICATES

CONTENTS

D13.1.1 SCOPE

D13.1.2 GENERAL

D13.1.3 PERFORMANCE GUARANTEE REQUIREMENTS

D13.1.4 FUNCTIONAL PERFORMANCE ASSESSMENTS

D13.1.5 VISUALLY ASSESSED PROPERTIES

D13.1.6 INSTRUMENTALLY ASSESSED PROPERTIES

D13.1.7 EVALUATION FOR ACCEPTANCE

D13.1.8 ADDITIONAL PROCEDURES TO BE ADOPTED IN THE EVENT OF FAILURE

D13.1.9 NOTIFICATION OF REMEDIAL WORK

D13.1.10 REMEDIAL WORK

No specific items in this Section.

Where applicable, details must be provided in the Contract Documentation.

13.2 FALSEWORK, FORMWORK AND CONCRETE FINISH

CONTENTS

PART A: SPECIFICATIONS

A13.2.1 SCOPE

A13.2.2 DEFINITIONS

A13.2.3 GENERAL

A13.2.4 DESIGN BY CONTRACTOR / PERFORMANCE BASED SYSTEMS

A13.2.5 MATERIALS

A13.2.6 CONSTRUCTION EQUIPMENT

A13.2.7 EXECUTION OF THE WORKS

A13.2.8 WORKMANSHIP

PART B: LABOUR ENHANCEMENT

PART C: MEASUREMENT AND PAYMENT

PART D: GUARANTEES AND COMPLIANCE CERTIFICATES

A13.2 FALSEWORK, FORMWORK AND CONCRETE FINISH

PART A: SPECIFICATIONS

A13.2.1 SCOPE

This Section covers the design, supply and erection of all falsework and formwork used in the construction of permanent work.

This Section also describes the classes of surface finishes on formed and unformed concrete surfaces.

A13.2.2 DEFINITIONS

Falsework - is any temporary construction used to support the loads for a structure until it becomes self-supporting.

Formwork - is the temporary structure, mould or form used to retain plastic or fluid concrete in its designated shape until it hardens.

Formed Surfaces - there are 3 classes of struck off the form surface finishes.

Unformed Surfaces - there are 3 classes of surface finish.

A13.2.2.1 Formwork to exposed surfaces

a) Formwork to faces of structures with a gradient equal to or greater than five vertical to one horizontal shall be classified as vertical formwork.

b) Formwork to faces of structures where the gradient is less than one vertical to five horizontal shall be classified as horizontal formwork.

c) Formwork to faces of structures is outside the limits of vertical or horizontal formwork shall be classified as inclined formwork.

A13.2.2.2 Construction tolerances

Except where otherwise specified, the following aspects of construction to which tolerances apply shall have the meanings attributed to them below:

a) Position

The position of a structure or structural member shall be the horizontal position of its centre line (s) and/or centre point(s) in relation to the overall layout of the works as shown on the drawings.

b) Alignment

The alignment of a structure or structural member shall be the alignment of its centre line(s) in relation to the overall layout of the works as shown on the drawings. Deviation from true alignment shall be measured in degrees of an arc.

c) Leading and cross-sectional dimensions

The leading and cross-sectional dimensions of a structure or structural member shall be the dimensions relating to width, length, height, thickness, etc, which collectively determine its shape, and are shown on the drawings. Dimensional tolerances not relating to leading or cross-sectional dimensions shall be shown on the drawings.

d) Levels

The level of any structure or structural member shall be the level of the upper or lower surface, as may be relevant or defined, with reference to an established datum-level on the site.

e) Surface regularity

Surface regularity is the shape of a surface with reference to a 3,0 m straight-edge (or template in the case of curved surface) placed on the surface.

The tolerance for surface regularity is expressed as a distance by which the surface tested may deviate from a straight-edge (or template in the case of curved surfaces) held against the surface.

A13.2.2.3 Sliding formwork

Vertical slip forming concrete consists of a concrete form which may be surrounded by a platform for workers to stand, place the steel reinforcement into the concrete and ensure smooth casting. The formwork is raised by hydraulically jacks at a rate which permits the concrete to set by the time it emerges from the bottom of the form.

A13.2.2.4 Contractors design

The Contractors design is the design of the falsework and formwork carried out by a competent person who is a Professional Engineer or technologist registered with ECSA with appropriate experience.

A13.2.3 GENERAL

Notwithstanding approval given by the Engineer for the design and drawings prepared by the Contractor for the falsework and formwork and the acceptance of the falsework and formwork as constructed, the Contractor shall be solely responsible for the safety and adequacy of the falsework and formwork and shall indemnify and keep indemnified the Employer and Engineer against any losses, claims or damage to persons or property whatsoever which may arise out of or in consequence of the design, construction, use and maintenance of the falsework and formwork and against all claims, demands, proceedings, damages, costs, charges and expenses and risks whatsoever in respect thereof or in relation thereto.

For works on, over, under or adjacent to any railway line, walkway, existing road or any other facility which is controlled by a statutory authority, the Contractor shall comply, inter alia, with the requirements for the preparation and submission of drawings for falsework and formwork, and the submission of certificates for the proper construction thereof, all in accordance with the official specifications of such authority.

After having constructed the falsework and formwork, and prior to placing the reinforcing steel and/or the concrete, the Contractor shall inspect the falsework and formwork. Dimensions shall be checked, unevenness of surface shall be corrected, and special attention paid to the adequacy and tightness of all bolts, ties and bracings as well as to the soundness of the foundations.

The Contractor shall give the Engineer at least 24 hours' notice of his intention to place the concrete to enable the Engineer to inspect all aspects of the completed work. However, before notifying the Engineer, the Contractor shall satisfy himself that the work complies in all respects with the specifications.

Concrete sections with dimension of smaller than 200 mm shall not be formed with sliding formwork unless authorised by the Engineer.

Where no provision has been made in the schedule of quantities for sliding formwork, the Contractor may, in a covering letter to the tender, submit a lump sum which reflects a saving in the cost for the use of sliding formwork in lieu of conventional formwork. The tendered lump sum quoted shall be accompanied by rates for pay items C13.2.7, C13.2.8, C13.2.9 and C13.3.3 all in accordance with the measurement and payment Clauses. Such submission shall be regarded as an alternative tender for the purposes of tender evaluation, and shall in every respect comply with the provisions of Clause A13.2.4.

The Contractor shall at all times during the supply and erection of falsework and formwork assure that safety standards and requirements as prescribed in the Regulations are adhered to.

A13.2.3.1 Method Statements

The method statements and typical drawings submitted by the Contractor with his tender submission, describing key facets such as method, key plant, materials, personnel and programme constraints of the envisaged construction process, shall form the basis for the detailed method statements required for the works to be executed on the project.

These method statements shall be prepared and submitted to the Engineer for approval for each facet of the work at the start of construction, within time scales specified. The onus lies with the Contractor to ensure that the information is gathered and associated activities are completed expeditiously so as to avoid any delays in the commencement, continuation and completion of the required works. Unless otherwise specified or provided for in the Contract Documentation no permanent works shall be commenced until the Engineer’s approval has been obtained. Due allowance shall be made for obtaining alternative materials, resubmissions and redesigns, all to the required/approved standards, methods and practices in attending to these requirements. Particular attention shall be paid to the early submission of materials-, concrete- and grout mix designs where parameters at various ages may be specified. No consideration for extension of the contract period will be entertained for delays incurred in meeting these requirements.

Trials, if applicable, shall be conducted and based on outcomes thereof, may require that changes be made to the relevant method statements. Once approved in writing by the Engineer, these shall become the method statements in accordance whereby the relevant portion of the works shall henceforth be executed. Notwithstanding, the Engineer may require revision from time to time if circumstances during construction arise which warrants change.

The Contractor shall, however, remain responsible for all work-methods, materials, plant and equipment used, notwithstanding acceptance by the Engineer.

A13.2.3.2 Hold points and approvals

The Contractor shall comply with the specified hold points relating to approvals required from the Engineer. A hold point is a stage of the work, where the Engineer's approval is required, before commencement or continuance of that particular activity by the Contractor, is permitted. Project specific requirements will be included in the Contract Documentation or agreed upon between the Engineer and the Contractor.

A13.2.4 DESIGN BY CONTRACTOR / PERFORMANCE BASED SYSTEMS

A13.2.4.1 General

The Contractor's design and drawings of the falsework and formwork shall comply amongst others with all statutory requirements.

The Contractors design of all falsework and formwork shall be carried out by an ECSA Registered Professional Engineer or Technologist with relevant experience and shall be carried out in accordance with, but not limited to the TMH7 loading as amended from time to time. The drawings and calculations shall be submitted to the Engineer for approval at least 14 days prior to the commencement of the work, in an appropriate format as required by the Engineer.

The Contractor shall submit to the Engineer at least 28 days before the structure is scheduled for construction a detailed analysis showing the effect of the stresses that will be induced by the Contractor's chosen method of construction. The cost of any additional prestressing, reinforcing steel, concrete, etc, required as a result of the Contractor's chosen method of construction shall be to the Contractor's account. No construction shall commence until the Engineer has given his written approval.

The Contractors registered professional shall also sign off on the erection of the falsework and formwork after the erection thereof and submit to Engineer before the Engineer will permit the work to proceed. All work shall be carried strictly in accordance with the Construction Regulations.

Unless specifically measured under item C13.2.10 the cost of the above shall be deemed to be included in the general rates tendered for formwork.

A13.2.4.2 Falsework

The Contractor shall submit his design criteria and detailed drawings of the falsework to the Engineer. The design, signing of the drawings and inspection of the falsework prior to construction of the permanent works shall be undertaken by the Contractor's ECSA Registered Professional Engineer or Technologist falsework designer.

The Contractor shall make his own assessment of the allowable bearing pressure on the foundation material and shall design the footings and falsework to prevent overloading, differential settlement and unacceptable overall settlement and safety. In assessing the allowable bearing pressure, due account shall be taken of the effect of wetting on the foundation material.

The Contractor's falsework designer shall take account of the location of the structure and the possible ingress of water from sources such as watercourses, water table and saturation due to rainfall and assess the resulting effects on bearing capacity

In designing the falsework, cognizance shall also be taken of the redistribution of load which may occur on account of the effect of temperature, wind force, the prestressing of curved and skewed structures, stage construction, flooding and debris.

Cognizance shall also be taken of the lateral forces which may be induced by earth platforms, required for the support of falsework on the substructures resulting in temporary or permanent stresses for which the sub-structures have not been designed.

Particular attention shall be given to providing transverse and diagonal bracing as well as rib stiffeners on cross bearers.

A13.2.4.3 Formwork

a) General

Formwork shall be so designed as to be sufficiently rigid to ensure that the specified dimensional tolerances can be achieved under the combined action of self-weight, dead load and imposed loads as well as the additional loads resulting from the rate of concreting, the layer thickness of the concrete cast in one operation and the method of placing and compaction.

b) Sliding formwork

The Contractor shall be responsible for the design of sliding formwork, if any is intended to be used. Prior to fabrication or bringing the sliding formwork and any additional equipment to the site, the Contractor shall submit drawings of the complete sliding- formwork assembly to the Engineer for approval. The drawings shall show full details of the forms, jacking frames, access ladders, hanging platforms, safety rails and curing skirts as well as details of the jacks and jack layouts.

The Contractor shall be required to submit to the Engineer, before slide casting commences, an instruction manual in which the sliding techniques, jacking procedure, methods of keeping the formwork level, the procedure to be adopted to prevent bonding of the concrete to the forms and a method for releasing the forms in the event of bonding, the instrumentation and monitoring of the slide casting and correcting for verticality, twisting and levelness are described in detail. The manual shall also include detail procedures for corrective actions to be implemented in the event that any problem that might conceivably occur, actually manifests.

The formwork panels shall be inclined to give a small taper, the forms being slightly wider at the bottom than at the top.

The taper shall be so designed as to produce the specified concrete thickness at the mid-lift level of the form.

The spacing of the jacks with their jack rods shall be so designed that the dead load of the sliding-formwork assembly, the frictional load, and the mass of materials, personnel and equipment will be evenly distributed and within the design capacity of the jacks used.

A13.2.5 MATERIALS

A13.2.5.1 General

The materials used in the construction of falsework (including its support system) and formwork shall be suitable for the purpose for which they are required and be of such quality as to produce the specified standard of work. The type, grade and condition of the material shall be subject to the Engineer's approval.

The use of in situ or imported stabilised soil as a support system shall only be permitted in special cases if approved by the Engineer.

A13.2.5.2 Falsework

The timber, structural steel and scaffolding used shall be free from defects that may prejudice the stability of the falsework. The jacks, devices, clamps and fittings shall all be in a good working order and of adequate design and strength.

A13.2.5.3 Formwork

a) Tongue-and-groove boarding

Tongue-and-groove boarding shall be of suitably dried timber which will not warp, distort or cause discolouration of the concrete. The widths of the boards shall be as specified on the drawings or in the schedule of quantities or as prescribed by the Engineer. Boards shall be supplied in lengths not shorter than 3,0 m.

b) Steel forms to exposed surfaces

For classes F2 and F3 surface finish the individual panels shall be assembled sufficiently rigidly and so clamped as not to deform or kick during handling or under the pressure of the wet concrete.

The surfaces of forms which are to be in contact with the concrete shall be clean, free from deposits or adhering matter, ridges or spatter which will impart irregularities and blemishes to the concrete surface, and shall also be free from indentations and warps.

The thickness of the steel forms shall be adequate to support the forces applied by the wet concrete but shall not be less than 2,5 mm.

c) Void formers

Void formers used in permanent work shall be subject to the approval of the Engineer.

Where void formers of a special design are required, details thereof shall be specified.

Void formers shall always be tied down to the falsework using mild steel anchor ties with minimum characteristic yield strength of 250 MPa.

Void formers shall be manufactured from material which will not leak, tear or be damaged during the course of construction and shall be of such tight construction as to prevent undue loss of the mortar component of the concrete through leakage. The units shall be sufficiently rigid so as not to deform during handling or under the pressure of the wet concrete.

For mild-steel spiral-lock-formed void formers, the metal thickness, unless otherwise specified shall be as follows:

(i) Unbraced void formers

1,0 mm for diameters of up to 600 mm

(ii) Braced void formers

1,2 mm for diameters from 600 mm to 1 000 mm

1,6 mm for diameters exceeding 1 000 mm.

The thickness specified for braced void formers shall apply to formers internally braced with timber or equivalent braces. The braces shall be at spacings not exceeding 1,5 m and not further than 1,0 m from the end of each unit. Timber cross braces shall consist of members with cross sectional dimensions of at least 50 mm x 50 mm. The cross bracing shall be vertical and horizontal and have longitudinal walers attached to ends of the bracing of the same cross sectional dimensions.

All hollow void-former units shall be provided with a 12 mm diameter drainage hole at each end.

d) Chamfer and recess fillets

Timber fillets used for forming chamfers and recesses on exposed surfaces shall be made from new suitable material unless otherwise approved by the Engineer.

e) Jack rods for sliding formwork

The jack rods, base plates and couplers shall be strong enough to carry the design load under all operating conditions without buckling, distorting or causing damage to the concrete. Jack rods which are to remain permanently embedded in the concrete shall comply with the requirements of Clauses A13.3.7 and A13.3.8. Under no circumstances shall bent rods be used in the work.

The jack rods used shall have a diameter of at least 25 mm.

A13.2.6 CONSTRUCTION EQUIPMENT

The Contractor shall before the construction commences, provide comprehensive details of all plant and equipment which shall be appropriate for the construction and erection of falsework and formwork. All plant and equipment shall be in a good working condition for the purpose suitable.

A13.2.7 EXECUTION OF THE WORKS

A13.2.7.1 Falsework

Falsework shall be erected in accordance with the approved drawings incorporating such modifications as required by the Engineer.

The Contractor shall take precautions to prevent deterioration of the foundations during the course of construction.

The falsework shall incorporate features which will permit adjustment to the alignment of the formwork to neutralise the unforeseen or expected settlement and deflection under load, prior to commencement of concreting activities.

A13.2.7.2 Formwork

a) General

The formwork for concrete work including bridge decks shall be erected to levels calculated from the information given on the drawings for roadworks and bridges. The levels shall be adapted to make provision for the specified precamber as well as for the expected deflection and settlement of the fully loaded falsework and formwork. The levels shall be set out and checked at intervals not exceeding 2,50 m, to assure compliance with specified construction tolerances of the completed work.

For constructing the formwork, the Contractor may, subject to the provisions of Clause A13.2.5, use any material suitable for and compatible with the class of surface finish and dimensional tolerances specified for the particular member (unless specific type of formwork has been prescribed in the Contract Documentation).

Formwork shall be sufficiently rigid to maintain the forms in their correct position, shape and profile and shall be of such tight construction that the concrete can be placed and compacted without undue loss or leakage of the mortar component of the concrete.

The joints between contiguous formwork elements shall be of a tight fit and, where necessary, the joints shall be caulked, taped or packed with a sealing gasket, all at no extra payment if undue leakage occurs or can be expected. Paper, cloth or similar material shall not be used for this purpose.

The formwork construction shall permit accurate erection and easy stripping without shock, disturbance or damage to the cast concrete. Where necessary, the formwork assembly shall permit the removal or release of side forms Independently of the soffit forms.

Metal supports, ties, hangers and accessories embedded in the concrete shall be removed to a depth of not less than the cover specified for the reinforcement. No wire ties shall be used.

All external corners shall be chamfered by fillet strips being fixed into the corners of the formwork to form 25 mm x 25 mm chamfers, or such other dimensions as may be specified on the drawings. Re-entrant angles need not be chamfered unless specified.

Where polystyrene or similar material, susceptible to damage is used, it shall be lined with a hard surface on the side to be concreted. The hard material shall be sufficiently resilient to ensure that the required quality of work can be achieved.

Where it is specified, all formwork ties shall be provided with recoverable truncated cones between sleeve ends and formwork faces to ensure that sleeve ends are not exposed on concrete surfaces. The cones shall have a minimum depth of 50 mm.

All ferule and tie holes shall be filled using a mortar compatible with the concrete in strength and colour.

The formwork and boards shall be so arranged as to form a uniform and regular pattern in line with and perpendicular to the main axis of the member, unless otherwise approved or directed by the Engineer.

Joints between contiguous members shall, after caulking, taping or sealing, be treated to prevent blemishes, stains and undue marks from being imparted to the concrete surface.

Bolt and tie positions shall be neatly arranged so that they conform to the symmetry of the formwork panels or boards. Bolt and rivet heads which will be in contact with the formed surface shall be of the countersunk type and shall be treated to prevent marks from forming on the concrete surface.

The formwork at construction joints shall be braced to prevent steps from forming in the concrete surfaces at the joints between successive stages of construction.

The formwork at construction joints shall have moulding strips 25 mm x 25 mm neatly butted and set at the position of the construction joint.

Where moulding or recess strips are specified, they shall be neatly butted or mitred.

(i) Protecting the surfaces

The Contractor shall ensure that permanently exposed concrete surfaces are protected from rust marks, spillage and stains of all kinds and other damage during construction.

b) Formed surfaces: Classes of finish

(i) General

In addition to complying with the tolerances specified in Clause A13.2.8, the surface finish on formed concrete surfaces shall also comply with the following requirements:

1. Class F1 surface finish

After repair work has been done to surface defects in accordance with Clause A13.2.7.4, no further treatment of the as-stripped finish will be required. This finish is required on concealed formed surfaces.

2. Class F2 surface finish

This finish shall be equivalent to that obtained from the use of square-edged timber panels and boards wrought to the correct thickness, or shutter boards or steel forms arranged in a regular pattern. This finish is intended to be left as struck but surface defects shall be remedied in accordance with Clause A13.2.7.4. Although minor surface blemishes and slight discolourations will be permitted, large blemishes and

severe stains and discolouration shall be repaired where so directed by the Engineer.

3. Class F3 surface finish

This finish shall be that obtained by first producing a class F2 surface finish with joint marks which form an approved regular pattern to fit in with the appearance of the structure. All projections shall then be removed, irregularities repaired and the surface rubbed or treated to form a smooth finish of uniform texture, appearance and colour This surface finish is required on all exposed formed surfaces unless a class F2 finish is specified.

Unless specified to the contrary, steel forms may be used to form surfaces with a class F3 surface finish.

The use of steel forms shall be permitted to form surfaces for which Class F3 surface finish has been specified, provided that only undamaged forms shall be used for such work and that the forms shall be subject to the approval of the Engineer.

4. Board surface finish

This finish shall be that obtained by using tongue-and-groove timber boarding arranged in an approved regular pattern. The finish is intended to be left as struck but surface defects shall be remedied in accordance with Clause A13.2.7.4 and large fins trimmed where directed by the Engineer.

5. Protecting the surfaces

The Contractor shall ensure that permanently exposed concrete surfaces are protected from rust marks, spillage and stains of all kinds and other damage during construction.

c) Unformed surfaces: Classes of finish

(i) Class U1 surface finish (rough)

This surface finish is required on those portions of bridge decks or culvert decks which are to receive asphalt or concrete surfacing or which are to be covered by backfilling material.

Where the placing and compacting of the concrete have been completed as specified in Clause A13.4.7.11 the top surface shall be screeded off with a template to the required cross-section and tamped with a tamping board to compact the surface thoroughly and to bring mortar to the surface, so as to leave the surface slightly rough but generally at the required elevation.

(ii) Class U2 surface finish (floated)

This surface finish is required on sidewalks; the tops of wing walls and retaining walls; exposed concrete shoulders and unsurfaced areas on bridge decks; the inverts of box culverts; and decks which are to receive surfacings other than asphalt or concrete.

The surface shall first be given a class U1 surface finish and after the concrete has hardened sufficiently, it shall be wood-floated to a uniform surface free from trowel marks. For non-skid surfaces such as on sidewalks and bridge decks, the surface shall then be given a broom finish. The corrugations so produced shall be approximately 1 mm deep, uniform of appearance and width and shall be perpendicular to the centre line of the pavement.

(iii) Class U3 surface finish (smoothly finished)

This surface finish shall be required at bearing areas and the tops of concrete railings. The surface shall first be given a class U1 surface finish, and after the concrete has hardened sufficiently, it shall be floated with a steel float to a smooth surface to within the dimensional tolerances specified in Clause A13.6.8.1.

Rubbing with carborundum stone after the concrete has hardened shall be allowed but under no circumstances will plastering of the surface be permitted.

d) Formwork for open joints

The requirements for formwork for open joints shall, unless otherwise specified, apply only to cases where the distance between opposite concrete surfaces is equal to or less than 150 mm.

Formwork for open joints shall be constructed to produce a class F1 surface finish to concealed surfaces or a class F2 or F3 surface finish corresponding to the in-plane surface finish of the bordering concrete surfaces. The material used and construction of the formwork shall permit its complete removal to form the open joint. All materials to form open joints shall be completely removed along with the adjacent formwork.

No solvent shall be used to remove formwork unless approved by the Engineer.

e) Openings and wall chases

Openings and wall chases shall be provided only where indicated on the drawings or as authorised by the Engineer. Frames for openings shall be rigid and firmly secured in position to prevent their moving. Temporary holes shall be so formed that they will not create an irregular pattern in relation to the rest of the exposed formed concrete surface.

f) Sliding formwork

(i) Plant and equipment

Unless otherwise specified in the Contract Documentation hoisting equipment for sliding formwork, which operates stepwise with upward movements of between 10 mm and 100 mm will be acceptable. However, the use of linked hydraulic or pneumatic jacks is preferable, which are reversible and driven by an electrically operated pump, and which can hoist at a steady rate. The jacks shall have independent controls for regulating verticality and levelness. The jacking system shall ensure that the sliding- formwork assembly can be hoisted evenly.

The use of hoisting systems which operate without jack rods shall be subject to the approval of the Engineer.

All equipment shall be thoroughly tested and inspected before installation and shall be maintained in a good working order throughout the entire sliding operation.

The Contractor shall keep adequate back-up plant, equipment and quantities of materials on the site to ensure that the slide casting can proceed without interruption. All conceivable repairs to this effect, as well as normal day to day maintenance of all plant and equipment, shall be planned to be undertaken within the time span of a normal daily jacking cycle.

(ii) Instrumentation and monitoring

The Contractor shall supply and install suitable instrumentation on the sliding platform and foundations and against the sides of the structure for monitoring the height, verticality, levelness and twisting at regular distances. The equipment used, its utilisation and the frequency of recording any readings shall be approved by the Engineer.

The Contractor shall be responsible for all monitoring work and shall ensure that records of all readings and measurements taken are filed systematically and are at all times available to the Engineer and the person in control of the sliding operation.

Unless otherwise specified, the verticality of the structure shall be controlled with laser alignment apparatus or optical plummets, and the levelness of the sliding forms with a water level system with reference control points placed at strategic locations.

Height and verticality shall be monitored at intervals not exceeding 4 hours. The readings shall be plotted immediately on graphs. When the structure is more than 10 mm out of vertical the Engineer shall be notified immediately.

(iii) Supervision

During the entire period of the sliding operation, a competent person who is fully acquainted with the sliding technique and the Contractor 's methods of construction shall be in attendance on the sliding platform and in control of the sliding operations. Such person shall be authorised and capable to take immediate corrective actions in case the sliding operation goes wrong in any way.

(iv) Construction

The jacking frame shall be constructed with adequate clearance between the underside of the cross members and top of the formwork to allow the horizontal reinforcement and embedded items to be correctly installed. A quality control procedure shall be agreed on by the Contractor and the Engineer to ensure that all the reinforcement is placed. At all times there shall be horizontal reinforcement above the level of the top of the formwork panel.

Guides shall be provided to ensure that the vertical reinforcement can be correctly placed and spliced and the specified concrete cover over the reinforcement maintained.

Where the jack rods are to be recovered, adequate precautions shall be taken in respect of their removal without damage being caused to the concrete.

Where jack rods occur at openings or wall chases, adequate lateral support shall be provided to prevent their buckling.

Equipment and material shall be so distributed on the working platforms that the load will be evenly distributed over the jacks.

Guard plates shall be provided at the tops of the forms to the outside walls to prevent the concrete from falling down the outside.

The framework, forms and platforms shall be regularly cleared and the accumulation thereon of redundant concrete prevented.

The Contractor shall take all precautions to prevent contamination of the concrete by leaking oil or other causes.

(v) The sliding process

The Contractor shall give the Engineer 24 hours' notice of his intention to commence with slide casting. Permission to commence with the sliding shall not be given by the Engineer before the sliding-formwork assembly is fully operative and the complete stock of all materials required for the slide casting as well as back-up plant and equipment are on the site.

The Contractor shall ensure that the rate of sliding is such that the concrete at the bottom of the formwork has obtained sufficient strength to support itself and all loads which may be placed on the concrete at the time, and that the concrete does not adhere to the sides of the forms.

The slide-casting operation shall be continuous, without any interruptions, until the full height of the structure has been reached, and shall be geared and organised so as to maintain an average rate of sliding of 350 mm per hour.

(vi) Interruptions

When the sliding operations are delayed for more than 45 minutes, the Contractor shall prevent adhesion of the setting concrete to the formwork panels by easing the forms or moving them slightly every 10 minutes, or alternatively, where reversible jacks are used, by lowering the forms by 10 mm to 25 mm. Wherever interruptions occur, emergency construction joints shall be formed and treated in accordance with Clause A13.4.7.11g). Before concreting is restarted, the form shall be adjusted to fit snugly onto the hardened concrete so as to prevent steps from being formed on the exposed concrete surface. When slide casting is recommenced care shall be taken to prevent the fresh concrete from being lifted off from the old concrete.

g) Permanent formwork

Void formers shall be secured in position at regular intervals to prevent displacement and distortion during concreting. The void formers shall be supported on precast concrete blocks or rigid welded steel cradles, all subject to approval by the Engineer. The ties securing the void formers shall be attached to the formwork and cross bearers of the falsework. The void formers shall not be tied to or supported on the reinforcement.

Anchor ties shall be designed to resist full buoyancy forces and details of such shall be submitted to the Engineer for approval. Void formers shall be held in position in order that no movement exceeding 1 % of the deck thickness takes place during concreting.

The anchor ties shall be placed to coincide with the position of the internal bracing where applicable.

Fibre-cement plates shall be supported so that the plate spans in the direction parallel to the orientation of the fibres.

h) Preparing the formwork

The surfaces of forms which are to be in contact with fresh (wet) concrete shall be treated to ensure non-adhesion of the concrete to the forms and easy release from the concrete during the stripping of the formwork.

Release agents shall be applied strictly in accordance with the manufacturer's instructions, and every precaution shall be taken to avoid the contamination of the reinforcement, prestressing tendons and anchorages. In the selection of release agents, due regard shall be given to the necessity for maintaining a uniform colour and appearance throughout on the exposed concrete surfaces.

Before the concrete is placed, all dirt and foreign matter shall be removed from the forms and the forms shall be thoroughly wetted with water.

i) Vertical, horizontal and inclined formwork

Formwork to the faces of structures with a gradient equal to or greater than eight vertical to one horizontal shall be classified as vertical formwork.

Formwork to the faces of structures with a gradient less than eight vertical to one horizontal, or equal to or greater than one vertical to eight horizontal, shall be classified as inclined formwork.

Formwork to the faces of structures with a gradient of less than one vertical to eight horizontal shall be classified as horizontal formwork.

A13.2.7.3 Removing the Falsework and Formwork

a) Considerations for falsework and formwork removal

Falsework and formwork shall not be removed before the concrete has attained sufficient strength to:

(i) support its own mass and any loads which may be imposed on it,

(ii) resist damage to the surfaces during stripping,

(iii) avoid deflections beyond the specified tolerances due to the elastic or inelastic (creep) behaviour of the concrete, and

(iv) avoid cracking beyond specified tolerances, with particular reference to serviceability and durability requirements.

All load bearing falsework and formwork shall not be removed before the Contractor has obtained written authorisation to effect such removal from the Engineer. The Engineer shall request documentary evidence from the Contractor proving that the in situ concrete has reached the acceptable strength before stripping. All falsework and formwork shall be carefully removed without exposing the cast concrete to impact, overload or damage.

b) Technical criteria for falsework and formwork removal

The Engineer shall indicate the minimum strength at which load bearing formwork and falsework for the concrete can safely be struck. In the absence of particular requirements, the following guidelines shall apply:

(i) The stripping time for slabs and beam soffits shall be the greater of the values derived from consideration of the strength required to:

1. an equivalent in situ concrete strength equal to 2,0 times the stress to which it will be subjected,
2. a minimum in situ concrete strength of 10 MPa.

Where the above cannot be obtained the following **minimum** stripping times shall always apply:

Table A13.2.7-1: Removing falsework and formwork: Minimum times

Span Length	Days
Up to 3,0 m	4
3,0 m up to 6,0 m	10
6,0 m and over	14

(ii) The stripping time for vertical formwork and unloaded columns shall be the greater of the values derived from consideration of the strength required to:

1. withstand wind loading,
2. the stripping time to avoid early thermal contraction cracking,
3. a minimum in situ concrete strength of 4 MPa

(iii) The stripping time, or minimum strength requirements, for continuously reinforced concrete structures and in particular where a structure is constructed in stages, for formwork and falsework removal shall be calculated from the last concrete pour and shall be specified on the drawings and authorised by the Engineer.

(iv) The stripping time, or minimum strength requirements, for all prestressed concrete structures, for formwork and falsework removal shall be calculated from the last concrete pour and shall only be considered after the full prestressing force relating to the particular stage of construction has been applied and shall be, submitted to the Engineer for approval and verified by the Engineer as acceptable.

c) Strength estimation

The in situ concrete strength may be determined by the following methods:

(i) Compressive strength test on temperature-matched cubes,
(ii) Compressive strength test on cubes stored and cured under the same conditions as the structural member,
(iii) In situ maturity measurements in accordance with ASTM C1074.

Specialist literature such as the CIRIA Report 136 should be consulted where necessary.

d) Releasing of loads and propping

The loads on falsework shall be released in a sequence that ensures that other falsework members are not subject to excessive loads. Special attention shall be given to the removal of falsework and formwork for prestressed concrete structures, especially for continuous members so that unnecessary stresses are not induced into concrete member or element. The falsework shall be released in stages with the stressing of the

bridgedeck in accordance prestressing design and stressing sequence of cables of the bridgedeck. The stability of falsework and formwork shall be maintained when loads are released and during dismantling.

The procedure for propping or re-propping, when used to reduce the effects of the initial load, the imposed loading, to avoid excessive deflections, or all combinations thereof, should be detailed in a method statement for the approval of the Engineer.

e) Curing and surface protection

All unformed surfaces shall be kept moist by means described in Clause A13.4.7.12h). Where curing is achieved by retention of the formwork, the minimum curing period contained in Table A13.4.7-18 shall apply.

A13.2.7.4 Remedial Treatment and Formed Surfaces

a) General

Agreement shall be reached with the Engineer regarding any remedial treatment to be given after the surfaces have been inspected immediately after the formwork has been removed, which treatment shall be carried out immediately after stripping but before the application of curing compounds in accordance with Clause A13.4.7.12h). No surfaces may be treated before inspection by the Engineer.

b) Repairs to surface defects

Surface defects such as small areas of honeycombing, cavities produced by form ties, large isolated blow-holes, broken corner edges, etc., shall be repaired with mortar having a cement and sand ratio equal to that of the concrete being repaired.

For the repair of large or deep areas of honeycombing and defects, special approved methods and techniques, such as sprayed concrete, pressure grouting, epoxy bonding agents, etc., may be used.

Where, in the opinion of the Engineer, the extent of the honeycombing or defects is of such a degree that doubt exists about the effectiveness of repair work, the Contractor shall at his own cost perform a load test in accordance with Clause A13.4.8.3 to prove that the structural safety of the repaired member has not been prejudiced, failing which, the structure shall be rebuilt in part or in full at the Contractor's cost.

Where the concrete has been damaged by adhesion to the formwork panel, the cracked and loose concrete shall be removed; or where the fresh concrete has lifted off at construction joints, the crack shall be scraped out immediately on both sides of the wall to a depth of at least 50 mm. The cavities so formed shall then be repaired as described above.

In addition to the repairs as defined above the Engineer may allow the methods of repair in accordance with Chapter14 for new concrete.

c) Rubbing the surfaces

If the finish of exposed formed surfaces does not comply with the requirements for uniformity of texture, appearance and colour, the Contractor shall, when so instructed by the Engineer, rub down the exposed surfaces of the entire structure or of any part of it as specified below.

The surface shall be saturated with water for at least one hour. Initial rubbing shall be done with a medium-coarse carborundum stone, where a small amount of mortar, having a sand cement ratio equal to that of the concrete being repaired, is used on the surface. Rubbing shall be continued until all form marks, projections and irregularities have been removed and a uniform surface has been obtained. The paste produced by the rubbing shall be left in place. The final rubbing shall be carried out with a fine carborundum stone and water. This rubbing shall continue until the entire surface is of a smooth, even texture and is uniform in colour. The surface shall then be washed with a brush to remove surplus paste and powder.

Where the concrete surfaces formed by sliding formwork require treatment to achieve the surface finish specified for the member, the concrete shall, as soon as the surfaces under the formwork are exposed, be floated with rubber- lined floats to the desired finish.

A13.2.8 WORKMANSHIP

A13.2.8.1 Tolerances

For the assessment of acceptance and compliance the tolerances given below shall be the maximum permissible deviations from the specified dimensions, levels, alignment, positions, etc., shown on the drawings of the structures or structural members.

a) Footings, pile capping slabs, caisson cover slabs, etc.

Position ..... 15 mm

Alignment:

Alignment of individual members ..... 5°

Alignment of members as they collectively determine the alignment of the structure as a whole ..... 1 minute

Dimensions: Leading dimension in plan ..... ± 25 mm

Thickness ..... + 25 mm – 15 mm

Levels: Average level of slabs, Footings, etc ..... ± 25 mm

b) Column, walls, piers, abutments, etc

Position ..... 10 mm

Alignment: Alignment of walls piers, Abutment and column groups ..... 1 minute

Dimensions:

Leading dimensions of walls, Piers and abutment ..... ± 25 mm

Thickness of walls, piers and abutments and cross-sectional dimensions of columns:

Plus-tolerance .....25 mm

Minus-tolerance: 3 % of the specified dimensions within the range of 5,0 mm to 25 mm

Levels: Average level of finished or trimmed /cut column, piers, walls, abutment, etc .....± 10 mm

Verticality:

(i) Using ordinary Formwork : 1 in 400. Maximum 25 mm
(ii) Using sliding Formwork : 1 in 200. Maximum 50 mm

Surface regularity:

(i) Using ordinary formwork .....3,0 mm
(ii) Using sliding formwork.....6,0 mm

c) Bridge and culvert superstructure

Position .....10 mm

Alignment: Superstructure as a whole.....1 minute

Dimension:
Leading dimensions in plan .....± 25 mm

Thickness of slabs, width and depth of beams: plus-tolerance.....15 mm

Minus-tolerance: 3 % of the specified dimensions within the range of 5,0 mm to 25 mm

Surface regularity (all surfaces other than upper surface of deck).....3,0 mm

Bridge and culvert decks, surface tolerances:
The tolerances specified in Clause A5.3.8.4 of Chapter 5 for the base in respect of level, grade, cross-section and surface regularity shall apply. Surface regularity shall be tested by straight- edge.

d) Precast beams

The following tolerances shall apply to precast beams in addition to the requirements stated in Clause A13.2.8.1c) for the superstructure.

The width of the gap between contiguous beams shall not exceed twice the width of the specified nominal gap shown on the drawings or the width of the nominal gap plus 40 mm, whichever is the lesser, and the overall width between the outermost beams of the bridge deck shall be within 40 mm of the specified width.

Straightness or bow: The deviation from the prescribed line measured on the overall length of the beam shall not exceed the following:

(i) In the horizontal plane:

0,5 mm per metre length of the beam within the tolerance range of 6,0 mm to 15 mm.

(ii) In the vertical plane:

(1) I-beams: 2,0 mm per metre length of the beam within the tolerance range of 6,0 mm to 20 mm.
(2) Other beams: 1,0 mm per metre length of the beam within the tolerance range of 3,0 mm to 20 mm.
Camber: The soffits of adjacent beams when placed side by side on the bridge deck shall not at any place differ by more than 2,0 mm per metre length of the beam within the tolerance range of 6,0 mm to 20 mm

The lengths of precast beams before stressing shall be ± 0,1% of the total length within the tolerance range of ± 5,0 mm to ± 20 mm.

Surfacing regularity.....3,0 mm

e) Miscellaneous

(i) Chamfers

Fillets used for forming chamfers shall be within a tolerance of 2,0 mm in cross-sectional dimensions, and the actual chamfer on the concrete shall not vary by more than 3,0 mm from the specified dimensions.

(ii) Barriers, parapets, railings, footwalks, kerbs and copings etc.

The members shall be constructed within a tolerance ± 5,0 mm for all dimensions. The alignment shall not deviate from the true alignment by more than 10 mm in any place, nor shall the alignment deviate by more than 5,0 mm from the true alignment over any length of 5,0 m.

Notwithstanding the above the levels on the above elements shall be fitted to give a smooth, aesthetic vertical alignment.

B13.2 FALSEWORK, FORMWORK AND CONCRETE FINISH
PART B: LABOUR ENHANCEMENT

CONTENTS

B13.2.1 SCOPE

B13.2.2 DEFINITIONS

B13.2.3 GENERAL

B13.2.4 DESIGN BY CONTRACTOR / PERFORMANCE BASED SYSTEMS

B13.2.5 MATERIALS

B13.2.6 CONSTRUCTION EQUIPMENT

B13.2.7 EXECUTION OF THE WORKS

B13.2.8 WORKMANSHIP

B13.2.1 SCOPE

This Section covers the design, supply and erection of all falsework and formwork used in the construction of permanent work. This Section also describes the classes of surface finishes on formed and unformed concrete surfaces. Most of the activities are executed by labour at various skill levels, therefore the specifications derived in Part A can be deemed suitable for labour enhanced work.

B13.2.2 DEFINITIONS

The provisions of Part A shall apply.

B13.2.3 GENERAL

The provisions of Part A shall apply.

B13.2.4 DESIGN BY CONTRACTOR / PERFORMANCE BASED SYSTEMS

The provisions of Part A shall apply.

B13.2.5 MATERIALS

The provisions of Part A shall apply.

B13.2.6 CONSTRUCTION EQUIPMENT

The provisions of Part A shall apply.

B13.2.7 EXECUTION OF THE WORKS

The provisions of Part A shall apply.

B13.2.8 WORKMANSHIP

The provisions of Part A shall apply.

C13.2 FALSEWORK, FORMWORK AND CONCRETE FINISH

PART C: MEASUREMENT AND PAYMENT

(i) Preamble

The tendered rate for each item shall include full compensation for providing, maintaining and decommissioning upon completion, of all the plant, equipment, labour, tools, incidentals and supervision to carry out the activity or construct the works in the item, unless otherwise stated.

Any prime cost or provisional sums shall be paid in accordance with the provisions of the conditions of contract. The charge or mark-up tendered or allowed for is a percentage of the amount actually paid under the prime cost or provisional sum. This percentage shall cover all the Contractor's handling, supervision, profit and liability costs to provide the services in the prime cost or provisional sum item.

The requirements of Section C1.1 of Chapter 1 shall apply.

Where pay item descriptions include any wording in brackets it is an indication that contract specific information is to be inserted in the Pricing Schedule included in the Contract Documentation.

(ii) Notes on measurement and pay items

None.

(iii) Items that will not be measured separately

The following activities, whether required to complete the specified work or not, will not be measured and paid for separately and the Contractor shall include the cost thereof in other pay items as he deems appropriate:

1. No separate payment will be made for setting out the works.
2. No separate payment will be made for the protection or repair as required of any existing or new road furniture, structures, buildings, infrastructure or services damaged by the Contractor's activities.
3. No additional payment shall be made, nor shall any claim for additional payment be considered, for any specified work in confined or restricted areas. Any additional costs associated with working in confined or restricted areas shall be deemed to be included in the standard applicable pay items.
4. No separate payment will be made for the loading of any materials.
5. No separate payment will be made for the hauling of any materials where the material is moved over a distance of less than, and up to 1,0 km and for labour enhanced construction, less than and up to 50 m.
6. No separate payment will be made for transporting materials from commercial sources irrespective of the haul distance.
7. No separate payment will be made for the removal or any surplus material imported to complete the works.
8. For all Works performed, precautionary measures required in terms of the Occupational Health and Safety Act (Act 85 of 1993) and the latest amendments thereof as well as the latest Construction Regulations shall be deemed included in the rates tendered for the relevant products.

(iv) Items to be measured and paid for using items specified elsewhere in the specifications

Not applicable to this Section.

(v) Items specifically for this Section of the specifications

Item	Description	Unit
C13.2.1	**Formwork to provide** (class of finish indicated as F1, F2, F3 or board) **surface finish to** (description of member to which applicable)	**square metre (m^2)**
Item	**Description**	**Unit**
C13.2.2	**Vertical formwork to provide** (class of finish indicated as F1, F2, F3 or board) **surface finish to** (description of member to which applicable)	**square metre (m^2)**
Item	**Description**	**Unit**
C13.2.3	**Horizontal formwork to provide** (class of finish Indicated as F1, F2, F3 or board) **surface finish to** (description of member to which applicable)	**square metre (m^2)**
Item	**Description**	**Unit**
C13.2.4	**Inclined formwork to provide** (class of finish indicated as F1, F2, F3 or board) **surface finish to** (description of member to which applicable)	**square metre (m^2)**

The unit of measurement shall be the square metre, and only the actual area of formwork in contact with the finished face of the concrete shall be measured. Formwork for the different classes of finish shall be measured separately. Formwork for construction joints shall be measured for payment under class F1 surface finish, but only formwork for mandatory construction joints shall be measured for payment.

The tendered rates shall include full compensation for procuring and furnishing all materials required, erecting the falsework and formwork, constructing the forms, forming the grooves, fillets. chamfers up to 100 mm and stop-ends for construction joints, treating and preparing the forms, all bolts, nuts, ties, struts and stays, stripping and removing the formwork after completion of the work, all labour, equipment and incidentals, and rubbing and surface treatment. Payment of 80 % of the amount due for formwork will be made when the formwork has been removed, and payment of the remaining 20 % will be made on approval of the concrete surface finish.

Item	Description	Unit
C13.2.5	**Permanent formwork**	
C13.2.5.1	To form voids of (diameter/ size of void indicated) in (description of member to which applicable)	square metre (m^2)
C13.2.5.2	Of (description of material and member to which applicable)	square metre (m^2)

The unit of measurement shall be the square metre of concrete area formed with permanent formwork.

The tendered rates shall include full compensation for procuring and furnishing all the materials required, installing the formwork, and labour, equipment and incidentials.
The tendered rates shall include for the installation of permanent drainage holes within the void formers at the low points of each void.

Item	Description	Unit
C13.2.6	**Formwork to form open joints** (description of member to which applicable, and location)	**square metre (m^2)**

The unit of measurement shall be the square metre of concrete area formed

Surfaces formed prior to the construction of the final surface for completing the joint, shall be measured under Items C13.2.1, C13.2.2, C13.2.3 or C13.2.4, as may be applicable.

The tendered rate shall include full compensation for procuring and furnishing all the materials required, constructing the formwork and subsequently removing all the material within the joint space, as well as labour, equipment and Incidentals. Payment for formwork to open joints shall be made only after the forms and filler material have been completely removed and approval of the surface finish has been obtained.

Item	Description	Unit
C13.2.7	**Establishment on the site for sliding formwork operations**	**lump sum**

The tendered lump sum shall include full compensation for the establishment on the site and the subsequent removal of the complete sliding-formwork assembly, special plant and equipment, and incidentals for the sliding work, the cost of which does not vary with the actual amount of sliding work done.

This work will be paid for by way of a lump sum, 75 % of which will become payable when the manual is approved, sliding-formwork assembly, plant and equipment have been fully Installed and commissioned at the first structural member on the site, and the remaining 25 % will become payable after all sliding work has been completed and the said items have been removed from the site.

Item	Description	Unit
C13.2.8	**Transporting to and setting up the sliding formwork assembly at** (description of each structure)	**number (No)**

The unit of measurement shall be the number of following similar structures to which the complete sliding-formwork assembly has to be transported and re-erected in position ready to be commissioned, after successful completion of the first structure.

The tendered rate shall include full compensation for all costs involved in dismantling, transporting and re-erecting of the complete sliding-formwork assembly.

Item	Description	Unit
C13.2.9	**Forming the concrete by sliding formwork for** (description of each structure and class of surface finish to exposed surfaces indicated)	**metre (m)**

The unit of measurement shall be the metre height of each structure formed by sliding formwork. The quantity measured shall be the actual height of each structure formed by the sliding technique.

The tendered rate shall include full compensation for sliding, instrumentation and monitoring, the maintenance of the complete sliding-formwork assembly, plant and equipment, supplying, installing and recovering the jack rods, floating, repairing and treating the concrete surfaces, forming the emergency construction joints, and all labour, equipment and Incidentals.

Item	Description	Unit
C13.2.10	**Provision of designs and drawings of falsework and formwork by an ECSA registered Professional Engineer or Technologist** (description of member to which applicable)	**lump sum**

The unit of measurement shall be the lump sum and shall be paid in two payments of 50 % on submission of the falsework and formwork designs and the second 50 % on complete removal of all the falsework.

The tendered rates shall include full compensation for procuring and provision of all drawings for the falsework and formwork designs by an ECSA registered professional, including inspections, supervision where applicable, all labour, material, travelling and incidentals, and the signing off on the erection of the falsework and formwork including submission of all certificates as specified.

D13.2 FALSEWORK, FORMWORK AND CONCRETE FINISH
PART D: GUARANTEES AND COMPLIANCE CERTIFICATES

CONTENTS

D13.2.1 SCOPE

D13.2.2 GENERAL

D13.1.3 PERFORMANCE GUARANTEE REQUIREMENTS

D13.1.4 FUNCTIONAL PERFORMANCE ASSESSMENTS

D13.1.5 VISUALLY ASSESSED PROPERTIES

D13.1.6 INSTRUMENTALLY ASSESSED PROPERTIES

D13.1.7 EVALUATION FOR ACCEPTANCE

D13.1.8 ADDITIONAL PROCEDURES TO BE ADOPTED IN THE EVENT OF FAILURE

D13.1.9 NOTIFICATION OF REMEDIAL WORK

D13.1.10 REMEDIAL WORK

D13.2.1 SCOPE

The scope of this Section covers the following:

- Product conformance specifications
- Warranties for product or element design and installation of proprietary systems
- Performance specifications

Note that the requirements for performance specifications are not limited to that given in Part C only but includes all of the requirements in the Contract Documentation.

D13.2.2 GENERAL

D13.2.2.1 Product conformance specifications

The Contractor shall, within 28 days of entering into the contract with the Employer, submit to the Engineer conformance documentation related to the specifications.

Conformance documentation shall be provided for the following, if required for the execution of the work as specified:

a. Steel falsework members.

b. Timber falsework members.

c. Jacks, devices, clamps and fittings.

d. Steel and Timber formwork.

e. Material in permanent Void formers.

D13.2.3 PERFORMANCE GUARANTEE REQUIREMENTS

D13.2.3.1 Warranties for product or element design and installation of proprietary systems

Certification for erection of falsework and formwork by a suitably experienced ECSA Registered Professional Engineer or Technologist is required.

D13.2.3.2 Performance specifications

Performance based specifications shall be contained in the Contract Documentation for the project, if applicable.

13.3 STEEL REINFORCEMENT

CONTENTS

PART A: SPECIFICATIONS

A13.3.1 SCOPE

A13.3.2 DEFINITIONS

A13.3.3 GENERAL

A13.3.4 DESIGN BY CONTRACTOR / PERFORMANCE BASED SYSTEMS

A13.3.5 MATERIALS

A13.3.6 CONSTRUCTION EQUIPMENT

A13.3.7 EXECUTION OF THE WORKS

A13.3.8 WORKMANSHIP

PART B: LABOUR ENHANCEMENT

PART C: MEASUREMENT AND PAYMENT

PART D: GUARANTEES AND COMPLIANCE CERTIFICATES

A13.3 STEEL REINFORCEMENT

PART A: SPECIFICATIONS

A13.3.1 SCOPE

This Section covers the furnishing and placing of reinforcing steel in concrete structures.

A13.3.2 DEFINITIONS

Cover - shall mean the minimum thickness of concrete between the surface of the outermost reinforcement and the face of the concrete.

A13.3.3 GENERAL

A13.3.3.1 Method Statements

The method statements and typical drawings submitted by the Contractor with his tender submission, describing key facets such as method, key plant, materials, personnel and programme constraints of the envisaged construction process, shall form the basis for the detailed method statements required for the works to be executed on the project.

These method statements shall be prepared and submitted to the Engineer for approval for each facet of the work at the start of construction, within time scales specified. The onus lies with the Contractor to ensure that the information is gathered and associated activities are completed expeditiously so as to avoid any delays in the commencement, continuation and completion of the required works. Unless otherwise specified or provided for in the Contract Documentation no permanent works shall be commenced until the Engineer's approval has been obtained. Due allowance shall be made for obtaining alternative materials, resubmissions and redesigns, all to the required/approved standards, methods and practices in attending to these requirements. Particular attention shall be paid to the early submission of materials-, concrete- and grout mix designs where parameters at various ages may be specified. No consideration for extension of the contract period will be entertained for delays incurred in meeting these requirements.

Trials, if applicable, shall be conducted and based on outcomes thereof, may require that changes be made to the relevant method statements. Once approved in writing by the Engineer, these shall become the method statements in accordance whereby the relevant portion of the works shall henceforth be executed. Notwithstanding, the Engineer may require revision from time to time if circumstances during construction arise which warrants change.

The Contractor shall, however, remain responsible for all work-methods, materials, plant and equipment used, notwithstanding acceptance by the Engineer.

A13.3.3.2 Hold points and approvals

The Contractor shall comply with the specified hold points relating to approvals required from the Engineer. A hold point is a stage of the work, where the Engineer's approval is required, before commencement or continuance of that particular activity by the Contractor, is permitted. Project specific requirements will be included in the Contract Documentation or agreed upon between the Engineer and the Contractor.

A13.3.4 DESIGN BY CONTRACTOR / PERFORMANCE BASED SYSTEMS

A13.3.5 MATERIALS

A13.3.5.1 Steel bars

Steel reinforcing bars shall comply with the requirements of SANS 920. For each consignment of steel reinforcement delivered on the site, the Contractor shall submit a certificate issued by a recognised testing authority to confirm that the steel complies with the specified requirements.

Cold-worked reinforcing bars shall not be used.

The type of bar required shall be indicated on the drawings by the symbols R, Y or Z in accordance with SANS 282.

A13.3.5.2 Welded steel fabric

Welded steel fabric shall comply with the requirements of SANS 1024.

A13.3.5.3 Mechanical couplers

The tensile properties determined on a test sample with a maximum gauge length of 610 mm, and which consists of reinforcing bars butt-jointed by a mechanical coupler shall comply with the following requirements:

(a) When tested in accordance with the relevant requirements of Clause 5.3 of SANS 920, the tensile properties of the test sample shall show an improvement of at least 10 % on the requirements of Clause 3.7 of SANS 920.
(b) Where the test sample is subjected to a load equal to 0,58 of the specified minimum yield force of the bar, the elongation measured on the gauge length shall not exceed the calculated theoretical elongation for a 610 mm length of the bar, based on a stress of 0,58 of the specified minimum yield stress of the bar and a Young's modulus of 200 GPa.

The Contractor shall submit to the Engineer test certificates from a recognised testing authority to confirm that the tensile couplers offered comply with the specified requirements.

All mechanical couplers used shall be subject to the approval of the Engineer.

A13.3.6 CONSTRUCTION EQUIPMENT

A13.3.7 EXECUTION OF THE WORKS

A13.3.7.1 Storing the materials

Reinforcing steel shall be stacked off the ground and in aggressive environments it shall be stored under cover.

A13.3.7.2 Bending the reinforcing steel

Reinforcement shall be cut or cut and bent to the dimensions shown on the bending schedules and in accordance with SANS 282.

No flame-cutting of high-tensile steel bars shall be permitted except when authorised.

Except as described below, all bars shall be bent cold and bending shall be done slowly, a steady, even pressure being exerted without jerking or impact.

If approved, the hot bending of bars of at least 32 mm in diameter will be permitted, provided that the bars do not depend on cold working for their strength. When hot bending is approved, the bars shall be heated slowly to a cherry-red heat (not exceeding 840°C) and shall be allowed to cool slowly in air after bending. Quenching with water shall not be permitted.

Already bent reinforcing bars shall not be rebent at the same position without authorisation.

A13.3.7.3 Placing and fixing

Reinforcement shall be positioned as shown on the drawings and shall be firmly secured in position within the tolerance given in Clauses A13.3.8.4 and A13.4.8.1a)(iv) by being tied with 1,6 mm or 1,25 mm diameter annealed wire or by suitable clips being used, or, where authorised by the Engineer, by tack welding. Tying wires for steel bars shall be bent back after tying and not cut off into the formwork.

The concrete cover over the projecting ends of ties or clamps shall comply with the specifications for concrete cover over reinforcement.

Where protruding bars are exposed to the elements for an indefinite period, the bars shall be adequately protected against corrosion and damage and shall be properly cleaned before being permanently encased in concrete.

In members which are formed with sliding formwork, spacer ladders for placing and fixing the wall reinforcement shall be used at spacings indicated on the drawings or as prescribed by the Engineer. The spacer ladders shall consist of two bars 3,7 m in length with ties 4 mm in diameter welded to them to resemble a ladder. The ties shall be spaced at multiples of the horizontal bar spacing in the wall, and shall be used to secure the horizontal reinforcement. The laps in the horizontal reinforcement shall be staggered to ensure that no part of two laps in any four consecutive layers lie in the same vertical plane.

A13.3.7.4 Cover and supports

The minimum cover shall be as shown on the drawings. Where no cover is indicated, the Contractor shall inform the Engineer who shall, in consultation with the design Engineer, indicate the required cover in writing and the record drawings shall indicate such cover.

The cover shall be increased by the expected depth of any surface treatment, e.g. when concrete is bush hammered or when rebates are provided.

The cover blocks or spacers required for ensuring that the specified cover is obtained shall be made of concrete. The cover and spacer blocks and their spacing shall be as small as may be consistent with their use. Prior to fixing the steel, samples of the proposed cover and spacer blocks shall be submitted to the Engineer for approval, along with a written statement for on-site manufacture, if applicable.

Cover blocks of other materials shall only be used with the Engineer's approval. However, only concrete cover blocks may be used for exposed surfaces.

Concrete spacer blocks shall be made with 7,1 mm maximum sized aggregate and shall be of the same strength, cementitious binder, and aggregate type as those of the surrounding concrete. The blocks shall be hemi-spherical in shape and shall be formed in specially manufactured moulds and the concrete well compacted and cured under water for a period of at least 14 days, all to the satisfaction of the Engineer.

Ties cast into spacer blocks shall be galvanized and shall not extend deeper into the spacer block than half the depth of the spacer block.

The Contractor shall provide stools for support as shown on the drawings, or, where they are not detailed on the drawings, wherever the Engineer requires them to be installed. The stools shall be suitably robust, and fixed securely so that they cannot swivel or move. The stools shall have sufficient strength to perform the required functions, taking into account amongst others temporary loads such as the weight of workmen and wet concrete, and forces caused by vibrators and other methods of compacting the concrete.

A13.3.7.5 Laps and joints

Laps, joints, splices and mechanical couplings shall be applied only by the specified methods and at the positions shown on the drawings or as authorised.

A13.3.8 WORKMANSHIP

A13.3.8.1 Surface condition

When the concrete is placed around the reinforcing steel, the reinforcing steel shall be clean, free from mud, oil, grease, paint, loose rust, loose mill scale or any other substance which could have an adverse chemical effect on the steel or concrete, or which could reduce the bond.

A13.3.8.2 Welding

Reinforcement shall be welded only where shown on the drawings or as authorised.

All welding shall be done in a controlled environment.

Flash butt welding shall be done only with the combination of flashing, heating, upsetting and annealing to the satisfaction of the Engineer, and only those machines which control this cycle of operations automatically shall be used.

Metal-arc welding of reinforcement shall be done in accordance with BS EN 1011, and with the recommendations of the reinforcement manufacturers, subject to approval by the Engineer and the satisfactory performance of trial joints. Hot-rolled high-yield-stress steel shall be preheated to between 240°C and 280°C and low-hydrogen electrodes only may be used.

Trial welding joints shall be made on the site in circumstances similar to those which will govern during the making of production welding joints by the person who will be responsible for the production welding joints.

Other methods of welding e.g. resistance welding, may be used subject to approval by the Engineer and to their satisfactory performance in trial joints.

Welded joints shall be full-strength welds and their strength shall be assessed by destruction tests on samples selected by the Engineer.

A13.3.8.3 Storage of materials

Stacking of reinforcing steel shall be executed under the supervision of persons with specific knowledge and experience. Any support structure used for stacking shall be structurally sound and shall be able to support the reinforcing steel.

A13.3.8.4 Tolerances

In addition to the requirements given below, the reinforcing steel shall be neatly and accurately fixed in a manner which is consistent with proper workmanship and the structural integrity of the structural member.

Specifically the following requirements shall apply:

a) Tension steel

The actual position of tension steel shall not deviate from the true position by a distance which would reduce the effective lever arm by more than 2 % of the overall depth of the member, or 10 mm, whichever is the greater.

b) Concrete cover

The concrete cover on reinforcing steel shall nowhere be less than the specified cover, reduced by the tolerance given in Clause A13.4.8.1a)(iv).

c) Spacing between bars

The spacing between closely spaced parallel bars, especially in beams and columns, shall, unless otherwise specified, be not less than the maximum size of the aggregate used in the concrete plus 5,0 mm.

d) Bending of reinforcement

The requirements of SANS 282 regarding dimensional tolerances for cutting and bending of the reinforcing steel shall apply, with the proviso that the other requirements set out in this Clause shall be complied with even if the tolerances in SANS 282 are not exceeded.

B13.3 STEEL REINFORCEMENT
PART B: LABOUR ENHANCEMENT

CONTENTS

B13.3.1 SCOPE

B13.3.2 DEFINITIONS

B13.3.3 GENERAL

B13.3.4 DESIGN BY CONTRACTOR / PERFORMANCE BASED SYSTEMS

B13.3.5 MATERIALS

B13.3.6 CONSTRUCTION EQUIPMENT

B13.3.7 EXECUTION OF THE WORKS

B13.3.8 WORKMANSHIP

B13.3.1 SCOPE

This Section covers the furnishing and placing of reinforcing steel in concrete structures. This is deemed to be ideally suited for labour enhanced work at varying skills level, therefore provisions provided in Part A, shall apply

B13.3.2 DEFINITIONS

The provisions of Part A shall apply.

B13.3.3 GENERAL

The provisions of Part A shall apply.

B13.3.4 DESIGN BY CONTRACTOR / PERFORMANCE BASED SYSTEMS

The provisions of Part A shall apply.

B13.3.5 MATERIALS

The provisions of Part A shall apply.

B13.3.6 CONSTRUCTION EQUIPMENT

The provisions of Part A shall apply.

B13.3.7 EXECUTION OF THE WORKS

The provisions of Part A shall apply.

B13.3.8 WORKMANSHIP

The provisions of Part A shall apply.

C13.3 STEEL REINFORCEMENT

PART C: MEASUREMENT AND PAYMENT

(i) Preamble

The tendered rate for each item shall include full compensation for providing, maintaining and decommissioning upon completion, of all the plant, equipment, labour, tools, incidentals and supervision to carry out the activity or construct the works in the item, unless otherwise stated.

Any prime cost or provisional sums shall be paid in accordance with the provisions of the conditions of contract. The charge or mark-up tendered or allowed for is a percentage of the amount actually paid under the prime cost or provisional sum. This percentage shall cover all the Contractor's handling, supervision, profit and liability costs to provide the services in the prime cost or provisional sum item.

The requirements of Section C1.1 of Chapter 1 shall apply.

Where pay item descriptions include any wording in brackets it is an indication that contract specific information is to be inserted in the Pricing Schedule included in the Contract Documentation.

(ii) Notes on measurement and pay items

None.

(iii) Items that will not be measured separately

The following activities, whether required to complete the specified work or not, will not be measured and paid for separately and the Contractor shall include the cost thereof in other pay items as he deems appropriate:

1. No separate payment will be made for setting out the works.
2. No separate payment will be made for the protection or repair as required of any existing or new road furniture, structures, buildings, infrastructure or services damaged by the Contractor's activities.
3. No additional payment shall be made, nor shall any claim for additional payment be considered, for any specified work in confined or restricted areas. Any additional costs associated with working in confined or restricted areas shall be deemed to be included in the standard applicable pay items.
4. No separate payment will be made for the loading of any materials.
5. No separate payment will be made for the hauling of any materials where the material is moved over a distance of less than, and up to 1,0 km and for labour enhanced construction, less than and up to 50 m.
6. No separate payment will be made for transporting materials from commercial sources irrespective of the haul distance.
7. No separate payment will be made for the removal or any surplus material imported to complete the works.
8. For all Works performed, precautionary measures required in terms of the Occupational Health and Safety Act (Act 85 of 1993) and the latest amendments thereof as well as the latest Construction Regulations shall be deemed included in the rates tendered for the relevant products.

(iv) Items to be measured and paid for using items specified elsewhere in the specifications

For activities in Table C13.3-1 pay items specified in other Chapters or Sections of the specifications, where they relate to work under this Section, will be listed in the Pricing Schedule.

Table C13.3-1: Payment items from other Chapters or Sections

Activity	Section 13.3 reference	Section item reference
Concrete Cover	C13.3.1	C20.1.2.1d) of Chapter 20

(v) Items specifically for this Section of the specifications

Item		Description	Unit
C13.3.1		**Reinforcement for:**	
	C13.3.1.1	(Description of portion of structure to which applicable):	
	(a)	Mild-steel bars	ton (t)
	(b)	High-yield-stress-steel bars (type indicated)	ton (t)
	(c)	Welded Steel Fabric	kilogram (kg)
	(d)	Stainless steel bars (type indicated)	ton (t)
	(e)	Other Materials (specify material)	ton (t)
	C13.3.1.2	Etc. for other structures or parts of structures	ton (t)

The unit of measurement for steel bars shall be the ton of reinforcing steel in place in accordance with the drawings or as authorised.

The unit of measurement for welded steel fabric shall be the kilogram of welded steel fabric in place, the quantity of which shall be calculated from the nett area of the mesh used in accordance with the drawings or as authorised.

Ties, stools and other steel used for positioning the reinforcing steel shall be measured as steel reinforcement under the appropriate sub-item.

The tendered rates shall include full compensation for supplying, delivering, cutting, bending, welding, trial weld joints, placing and fixing the steel reinforcement, including all tying wire, spacers and waste.

Where the concrete cover specified has not been achieved after cover tests have been carried out in accordance with Clause A13.4.7.10f) reduced payment as determined under Clause A20.1.7.6 of Chapter 20 shall be applied to all the relevant pay items under Section C13.3.

Item	Description	Unit
C13.3.2	**Mechanical couplers** (type of coupler and diameter of bar indicated)	**number (No)**

The unit of measurement shall be the number of mechanical couplers for each bar diameter installed.

The tendered rate shall include full compensation for supplying all the material, preparing and modifying the bar ends to be joined, and all tools, equipment and labour required for completing the work.

Item	Description	Unit
C13.3.3	**Spacer ladders for** (description of part of structure to which applicable)	**ton (t)**

The unit of measurement for spacer ladders shall be the ton of steel in place in accordance with the drawings or as authorised.

The tendered rate shall include full compensation for supplying, delivering, cutting, bending, welding, placing and fixing the ladders, including all tying wire, spacers and waste.

Item	Description	Unit
C13.3.4	**Extra-over item C13.3.1 (a), (b), etc. for galvanising of reinforcement**	**ton (t)**

The unit of measurement shall be the ton of reinforcing steel hot-dip galvanised with an 85 micrometre coating in accordance with the detail on the drawings, SANS 121 and Clause A13.9.7.1m).

The tendered rate shall include full compensation for all materials, labour, tools and equipment required to galvanise the specific bars of reinforcement as required as well as transporting and handling costs.

D13.3 STEEL REINFORCEMENT
PART D: GUARANTEES AND COMPLIANCE CERTIFICATES

CONTENTS

D13.3.1 SCOPE

D13.3.2 GENERAL

D13.3.3 PERFORMANCE GUARANTEE REQUIREMENTS

D13.3.4 FUNCTIONAL PERFORMANCE ASSESSMENTS

D13.3.5 VISUALLY ASSESSED PROPERTIES

D13.3.6 INSTRUMENTALLY ASSESSED PROPERTIES

D13.3.7 EVALUATION FOR ACCEPTANCE

D13.3.8 ADDITIONAL PROCEDURES TO BE ADOPTED IN THE EVENT OF FAILURE

D13.3.9 NOTIFICATION OF REMEDIAL WORK

D13.3.10 REMEDIAL WORK

D13.3.1 SCOPE

The scope of this Section covers the following:

- Product conformance specifications
- Warranties for product or element design and installation of proprietary systems
- Performance specifications

Note that the requirements for performance specifications are not limited to that given in Part C only but includes all of the requirements in the Contract Documentation.

D13.3.2 GENERAL

D13.3.2.1 Product conformance specifications

The Contractor shall, within 28 days of entering into the contract with the Employer, submit to the Engineer conformance documentation related to the specifications.

Conformance documentation shall be provided for:

(a) Steel reinforcement: each type and batch;

(b) Galvanising of steel reinforcement

(c) Welding of reinforcement, where relevant; and

(d) Mechanical couplers.

(e) Stainless Steel.

(f) Other special materials.

D13.3.3 PERFORMANCE GUARANTEE REQUIREMENTS

D13.3.3.1 Warranties for product or element design and installation of proprietary systems

No additional requirements.

D13.3.3.2 Performance specifications

Performance based specifications shall be contained in the Contract Documentation for the project.

13.4 CONCRETE

CONTENTS

PART A: SPECIFICATIONS

A13.4.1 SCOPE

A13.4.2 DEFINITIONS

A13.4.3 GENERAL

A13.4.4 DESIGN BY CONTRACTOR / PERFORMANCE BASED SYSTEMS

A13.4.5 MATERIALS

A13.4.6 CONSTRUCTION EQUIPMENT

A13.4.7 EXECUTION OF THE WORKS

A13.4.8 WORKMANSHIP

PART B: LABOUR ENHANCEMENT

PART C: MEASUREMENT AND PAYMENT

PART D: GUARANTEES AND COMPLIANCE CERTIFICATES

A13.4 CONCRETE

PART A: SPECIFICATIONS

A13.4.1 SCOPE

This Section covers the supply and storage or stockpile of all materials, manufacture, transport, placing, finishing, curing, protection and testing concrete in bridges, culverts and miscellaneous structures. The completed concrete elements shall conform to the lines, grades, and dimensions shown on the drawings and as specified in Section A13.2. The work includes elements of structures constructed by cast-in-place and precast methods using either plain (unreinforced), reinforced, or prestressed concrete or any combination thereof.

A13.4.2 DEFINITIONS

Characteristic strength - characteristic strength of concrete is the compressive cylinder or cube strength below which no more than 5 % of the test results in a statistical population shall fall, tested as specified in Section A20.1 and applicable Clauses of Chapter 20.

Environment - the physical and chemical actions to which the concrete is exposed and which results in effects on the concrete or reinforcement that are not considered as loads in structural design.

Fresh phase of concrete - concrete that has been fully mixed, that has not yet reached initial set and is still capable of being compacted by the chosen method.

Hardened phase of concrete - concrete in a solid state and which has developed a certain amount of strength.

Normal-Weight Concrete - concrete in the oven –dry state having a density greater than 2000 kg per cubic metre but not exceeding 2600 kg per cubic metre, determined in accordance with SANS 3001-C02-8.

Self-compacting concrete - concrete that is able to flow and compact under its own weight, fill the formwork with its reinforcement, ducts, etc., while remaining homogeneous.

Valid test result (Fcu) - a valid test result, for the purpose of evaluating compressive strength, shall comprise of the arithmetic mean of three cube or cylinder specimens where the difference between the highest and lowest result does not exceed 15 % of the arithmetic mean of the specimens.

Water: cementitious binder ratio - the ratio of the total water content to total cementitious binder content by mass in the mixed concrete.

A13.4.3 GENERAL

This section describes work that encompasses the design, production and placing of concrete conforming to the set of performance criteria in both the fresh and hardened phases. Irrespective of the originating concrete supply and production source, for example commercially-sourced ready mixed concrete or precast concrete, the Contractor shall ensure the full conformance to all aspects of this specification.

A13.4.3.1 Method Statements

The method statements and typical drawings submitted by the Contractor with his tender submission, describing key facets such as method, key plant, materials, personnel and programme constraints of the envisaged construction process, shall form the basis for the detailed method statements required for the works to be executed on the project.

These method statements shall be prepared and submitted to the Engineer for approval for each facet of the work at the start of construction, within time scales specified. The onus lies with the Contractor to ensure that the information is gathered and associated activities are completed expeditiously so as to avoid any delays in the commencement, continuation and completion of the required works. Unless otherwise specified or provided for in the Contract Documentation no permanent works shall be commenced until the Engineer's approval has been obtained. Due allowance shall be made for obtaining alternative materials, resubmissions and redesigns, all to the required/approved standards, methods and practices in attending to these requirements. Particular attention shall be paid to the early submission of materials-, concrete- and grout mix designs where parameters at various ages may be specified. No consideration for extension of the contract period will be entertained for delays incurred in meeting these requirements.

Trials, if applicable, shall be conducted and based on outcomes thereof, may require that changes be made to the relevant method statements. Once approved in writing by the Engineer, these shall become the method statements in accordance whereby the relevant portion of the works shall henceforth be executed. Notwithstanding, the Engineer may require revision from time to time if circumstances during construction arise which warrants change.

The Contractor shall, however, remain responsible for all work-methods, materials, plant and equipment used, notwithstanding acceptance by the Engineer.

A13.4.3.2 Hold points and approvals

The Contractor shall comply with the specified hold points relating to approvals required from the Engineer. A hold point is a stage of the work, where the Engineer's approval is required, before commencement or continuance of that particular activity by the Contractor, is permitted. Project specific requirements will be included in the Contract Documentation or agreed upon between the Engineer and the Contractor.

A13.4.4 DESIGN BY CONTRACTOR / PERFORMANCE BASED SYSTEMS

The Contractor shall design and be responsible for the performance of all concrete mixes used in structures. The mixture proportions selected shall produce concrete that is able to be sufficiently worked and finished for all uses intended and shall produce concrete of desired strength, durability and particular performance requirements in both the fresh and hardened phases as specified. The mix design shall be based upon obtaining an average concrete compressive strength sufficiently above the specified characteristic compressive strength considering the expected variability of the concrete and test procedures. Concrete durability index and post-concreting cover testing shall individually comply with stated minimum or maximum values or specified nominal values adjusted by permissible deviations. Mix designs may be modified during the course of the work when necessary to ensure compliance with strength, durability parameters and consistence requirements, provided such changes meet the approval of the Engineer.

The concrete mix design and preconstruction laboratory test results shall be recorded and submitted for approval prior to the commencement of concreting activities. The concrete operations shall only commence with the approval of the concrete mix design. The Contractor shall adequately allow sufficient time in his programme for the design and approval of the concrete mix design, particularly where durable concrete is applicable.

A13.4.5 MATERIALS

A13.4.5.1 Cementitious binder

The cementitious binder shall comprise either cement, complying with SANS 50197-1, or an approved site blend of such cement and supplementary cementitious materials that take appropriate cognizance of environmental conditions, durability and strength requirements of the structural member. The site blending of cement with supplementary cementitious materials shall only be conducted on the basis of an acceptable quality assurance system approved by the Engineer. Further limitations of the cementitious binder for prestressed concrete members or units shall be strictly enforced. The cementitious binder shall comprise the following:

a) Cement

Cement shall comply with SANS 50197-1 (EN 197-1) with a strength class of 32,5 or greater, and a rate of strength gain N or greater. Cement shall hold valid certification in the form of a Letter of Authority issued as certified approval pursuant to the Compulsory Specification for cement published by Government Notice R.544. Masonry cement shall not be used.

In order to promote resource sustainability principles, cement shall have a maximum average carbon dioxide emission value of 925 kg CO_2e per ton, determined in accordance with the World Business Council for Sustainable Development Greenhouse Gas Protocol.

b) Supplementary cementitious materials

Additional supplementary cementitious materials may be added at the batchplant and used to replace specific proportions of the cementitious binder. The maximum supplementary cementitious material replacement values shall be cumulative, comprising proportions both pre-blended into the cement and supplementary cementitious materials added at the batchplant. The further blending of cements that contain a factory-blended proportion of supplementary cementitious materials exceeding 5 % by mass of cement, except in the particular case of limestone, with supplementary cementitious materials of a different generic type or nature, e.g. site-based ternary blending, shall not be permitted. The site blending of CEM III/B, CEM III/C, CEM IV/B and CEM V cements with supplementary cementitious materials shall not be permitted. Supplementary cementitious materials added at the site batchplant shall be classified and conform to the following requirements:

(i) Ground granulated blastfurnace slag or ground granulated corex slag, conforming to SANS 55167-1, up to maximum cumulative replacement value of 65 % by mass of cementitious binder;

(ii) Fly ash, conforming to SANS 50450-1, up to maximum cumulative replacement value of 40 % by mass of cementitious binder;

(iii) Silica fume, conforming to SANS 53263-1, up to maximum cumulative replacement value of 10 % by mass of cementitious binder; or

(iv) Other supplementary cementitious materials, blends of supplementary cementitious materials, and appropriate proportions thereof, shall be generally accepted by the construction industry and approved by the Engineer for use in concrete on the basis of published, comprehensive long-term research including in-field performance tests conducted over a minimum period of 10 years in a range of typical African exposure environments.

c) Particular requirements for prestressed concrete

In prestressed concrete members, only the use of CEM I and CEM II cements with a strength class of 42,5 or greater, and a rate of strength gain N or R, shall be permitted. A site blend of cement and ground granulated blast furnace slag or ground granulated corex slay conforming to SANS 55167-1 up to a maximum cumulative replacement value of 40 %, fly ash conforming to SANS 50450-1 up to a maximum replacement value of 20 %, or silica fume, conforming to SANS 53263-1 up to a maximum replacement value of 7 %, by mass of total cementitious binder may be used only if authorised in the Contract Documentation or by the Engineer in writing.

A13.4.5.2 Aggregates

All aggregates for concrete shall fully comply with the requirements of SANS 1083, subject to the following amendments and additional project requirements:

a) Coarse aggregates

(i) The flakiness index of the coarse aggregate as determined by SANS 3001-AG4 shall not exceed 35;

(ii) The 10 % FACT value as determined by SANS 3001-AG10 shall be minimum 150 kN when tested dry or minimum 110 kN when tested wet;

(iii) Alternatively to the 10 % FACT and if required by the Contract Documentation, the aggregate crushing value as determined by SANS 3001-AG10 shall be maximum 25 % by mass; and

(iv) The soundness of mudrock, shale, basalt and dolomitic aggregates as determined in accordance with SANS 3001-AG13 shall have maximum 15 % mass loss where magnesium sulfate is used.

b) Fine aggregates

(i) The fineness modulus of the fine aggregate as determined by SANS 3001-PR5 shall not vary by more than ± 0,2 from the approved modulus;

(ii) The sand equivalent of the fine aggregate shall be determined in accordance with SANS 3001-AG5 and shall be minimum 65 %. The sand equivalent shall be considered as an indicator test, together with the clay content and methylene blue absorption value, where non-compliance may be established. However the satisfactory performance in concrete shall be evaluated by drying-shrinkage tests in accordance with Clause A13.4.5.2c)(i); and

(iii) Tests for organic impurities in natural sands shall be determined in accordance with SANS 5832 and shall be not darker than the reference solution.

c) Additional project requirements

(i) The drying-shrinkage of both the fine and coarse aggregate, when either is obtained from the Karoo Series or from newly developed sources, shall be tested in accordance with SANS-AG-33 (SANS 5836) shall not exceed the following limits:

1. For use in prestressed concrete, concrete bridge decks and slender columns the shrinkage of both fine and coarse aggregate shall not exceed 150 % of that of the reference aggregates;
2. For use in other reinforced concrete members the shrinkage of the fine aggregate shall not exceed 200 %, and of the coarse aggregate 175 %, of that of the reference aggregates; and
3. For use in mass concrete substructures and unreinforced concrete head walls and wing walls, the shrinkage of both the fine and coarse aggregate shall not exceed 235 % of that of the reference aggregates.

(ii) Aggregates shall not contain any deleterious amounts of organic materials such as grass, timber or similar materials, as assessed by visual inspection;

(iii) Where instructed by the Engineer, aggregates shall be checked and shall be free of the following deleterious substances:

1. Tests for the presence of sugar shall be determined in accordance with SANS 3001-AG-30 (SANS 5833) and shall be free from the presence of sugar;
2. Tests for soluble deleterious impurities shall be conducted in accordance with SANS 3001-AG-31 (SANS 5834) and shall have minimum compressive strength of 85 % of the reference;
3. Test for the presence of material of low density shall be determined in accordance with SANS 5837 and shall have maximum 0,5 % by mass;
4. Tests for soluble salts shall be determined in accordance with SANS 3001-AG-40 (SANS 5849) and shall have maximum 0,5 % by mass;
5. Tests for water soluble sulfates shall be determined in accordance with SANS 3001-AG-31 (SANS 5850-1) and shall have maximum 0,2 % SO_3 by mass; and
6. Tests for the presence of shell shall be determined in accordance with SANS 3001-AG-35 (SANS 5840) and shall be maximum 5 % by mass of unbroken shell, or maximum 25 % by mass of broken shell fragments, in the coarse aggregate.

(iv) Where there is any danger of a particular combination of aggregate and cementitious binder giving rise to a harmful alkali-aggregate reaction, the particular combination shall be tested in accordance with SANS 6245 as described in Clause A13.4.7.2a), and where the result points to such reaction, either the aggregate or the cementitious binder or both shall be replaced so that an acceptable combination may be obtained; and

(v) Where aggregate size of larger than 28 mm is used in concrete, the aggregate shall be supplied in two nominal sizes, and the smaller shall be either 20 mm or 14 mm. The relative proportions of larger and smaller nominal sized aggregate shall be determined by the mix design.

d) Plums and boulders

Plums and boulders may be used in plain (unreinforced) concrete elements with a minimum thickness of 350 mm and be included to replace concrete for up to 20 % of the total volume, subject to the following requirements:

(i) The plums and boulders shall be clean, and have no adhering films or coatings;

(ii) The aggregate crushing value may not exceed 25 % and all plums and boulders shall be hard, durable, unweathered and inert;

(iii) The mass of each plum and boulder shall be between 15 kg and 55 kg;

(iv) Each plum or boulder is surrounded by at least 80 mm of concrete when placed;

(v) Each plum or boulder is more or less rounded or cubic in shape with no dimension being less than 60 % of the longest dimension; and

(vi) No dimension of any plum or boulder shall be less than 150 mm or exceed 500 mm.

A13.4.5.3 Water

The Contractor shall prove by way of laboratory tests that all water used for mixing and curing concrete complies with SANS 51008.

A13.4.5.4 Admixtures

The use of admixtures is encouraged to produce durable concrete and to achieve particular fresh phase properties of concrete. All admixtures for concrete shall comply with the requirements of SANS 50934 (EN 934), ASTM C494 or AASHTO M194. Admixtures shall be of a brand approved by the Engineer and type compatible with the exposure environment and cementitious binder composition. Admixtures shall have no deleterious effects on the reinforcement, prestressing or concrete, and shall not contain any chlorides, nitrates, sulphides or sulphites, which may be detrimental to the reinforcement. Admixtures shall generally be supplied in liquid form and accurately dispensed by a mechanical dosing unit in a manner appropriate to the method batching e.g. dry versus wet batching. Unless extraordinary circumstances dictate otherwise, under no circumstances shall a mixture be dispensed on to mix components. Where extraordinary circumstances do exist, other methods of feeding into the concrete mixture shall be agreed with the Engineer. Where specified, air entraining agents may alternatively comply with the requirements of SANS 50934 (EN 934), ASTM C260 or AASHTO M154.

Where combinations of two or more admixtures are utilised, they shall be tested for compatibility.

The total amount of admixtures shall not exceed the maximum dosage recommended by the admixture producer and also shall not exceed 5 % by mass of the total cementitious binder, unless the influence of the higher dosage of admixture on the performance and durability of the concrete is established and taken into account.

If the total quantity of liquid admixture equals or exceeds 3 litres per cubic metre of concrete, the admixture quantity shall be included in the water content of the concrete mixture when calculating the water: cementitious binder ratio.

The alkali content (Na_2O-equivalent) of all admixtures shall form part of the calculation of the alkali content of concrete in order to limit the degree of reactivity as specified in Clause A13.4.7.2a).

A13.4.5.5 Integral permeability reducing technology

Where water-tight concrete is indicated on the drawings, the concrete shall incorporate a crystalline permeability reducing additive or alternative technology with proven effectiveness against hydrostatic pressure, approved by the Engineer. The Contractor shall supply the Engineer with documented evidence, published by an independent laboratory meeting the requirements of ASTM E329 or Board of Agrément certification, that the crystallising capability of the permeability reducing technology is evidenced by independent Scanning Electron Microscope photographs verifying crystalline formations within the concrete matrix.

The integral permeability reducing technology shall be tested in accordance with either: EN12390-8 for applications up to 18 m head or US Army Corps of Engineers CRD-C48-73 or later. “Permeability of concrete” for applications greater than 18 m head. Minimum performance criteria for testing according to EN 12390-8 shall be maximum water penetration of 30 mm while for testing according to CRD-C73 (or later) treated specimens shall exhibit no measurable leakage after pressure testing to 1,05 MPa (equivalent to 106 m head of water). The integral permeability reducing technology shall also have demonstrable benefits proving self-healing capability, improved chemical resistance to sulphuric acid exposure, improved compressive strength, and certified approval for use on structures holding potable water. The dosage of the integral permeability reducing technology shall be recommended by the product manufacturer to achieve the minimum performance criteria per test method but shall not be less than shown in Table A13.4.5-1.

Table A13.4.5-1: Minimum dosage of integral permeability reducing technology

Water cementitious binder ratio	Minimum dosage of integral permeability reducing technology (% weight of cementitious binder)
Less than 0,40	0,8 %
0,40 – 0,49	1,0 %
0,50 – 0,54	1,5 %
0,55 – 0,59	2,0 %
0,60 or greater	3,0 %

A13.4.5.6 Fibres

Steel fibres for concrete shall comply with EN 14889-1 or ASTM A820 and polymer fibres shall comply with EN 14889-2 or ASTM D7508. Fibres shall be submitted to the Engineer for approval prior to the commencement of work.

A13.4.5.7 Pigments and integral colouring agents

Pigments and integral colouring agents for concrete shall comply with ASTM C979 or EN 12878, in particular only Category B pigments shall be used for reinforced or prestressed concrete.

A13.4.5.8 Evaporation retarders

Protection of the concrete during the plastic phase, should be carried out continuously from time of concrete casting, until initial set is achieved (normally coincides with cessation of bleeding and commencement of final surface finishing with power floats etc). Where liquid evaporation retarders are used to effect protection of the concrete, they shall be supplied by a reputable admixture manufacturer and shall be approved by the Engineer. They shall be applied immediately after compaction of the concrete and initial screeding of the concrete has been completed, with the proviso that this is as soon as possible after the concrete has been cast. Evaporation retarders shall be applied using a fine mist sprayer, at a rate recommended by the manufacturer. Environmental conditions experienced on sites may necessitate several applications during the concrete fresh (plastic) phase.

A13.4.5.9 Curing compounds

Liquid membrane-forming compounds used to cure concrete shall be tested in accordance with SANS 418 (ASTM C156) and shall comply with the requirements of SANS 423 (ASTM C309), except that the water loss requirement be substituted with the efficiency-index as determined in accordance with BS 7542. The efficiency-index shall exceed 90 % at an application rate as recommended by the manufacturer, or where no application rate has been recommended 0,2 litre per square metre. Only suitable application equipment as prescribed by the product supplier shall be used. A recent test certificate certifying that the curing compound complies with the specifications at the recommended application rate, with a maximum validity period of 12 months, issued by an approved independent testing laboratory shall be submitted to the Engineer. All curing compounds and the proposed application rate shall be approved by the Engineer. Due caution should be exercised when selecting curing compounds to avoid curing compounds that discolour, stain or damage the concrete surface or reduce the adhesion of future concrete or coatings. No water-based curing compounds are to be used.

A13.4.5.10 Storing the materials

a) General

All constituent materials shall be stored and handled so that their properties do not change, for example due to climate conditions, intermingling or contamination, and that their conformity with the respective standard is maintained.

b) Cement and supplementary cementitious materials

Cement and supplementary cementitious materials stored on the site shall be kept separately under cover which provides adequate protection against moisture and other factors which may promote deterioration of the cement or supplementary cementitious material.

Cement and supplementary cementitious material may only be used if stored and maintained at a temperature less than 45°C. In hot weather concreting conditions, the cement and supplementary cementitious material storage facilities shall be painted with white high solar reflectance paint and insulated to reduce any temperature rise in the stored cement or supplementary cementitious material.

Cement or supplementary cementitious material supplied in bags shall be closely and neatly stacked, separately to a height not exceeding 12 bags and arranged so that they will not be in contact with the ground, the floor or the walls, and can be used in the order in which they were delivered to the site.
Cement or supplementary cementitious material supplied in bulk shall be stored separately in waterproof containers so designed as to prevent any dead spots from forming, and the cement or supplementary cementitious material drawn for use shall be measured by mass.

Cement shall not be kept in storage for longer than 8 weeks without the Engineer's permission, and different brands or types of the same brand of cement or supplementary cementitious material shall be stored separately.

c) Aggregates

Aggregates of different nominal sizes, sources or types shall be stored separately. Intermixing of different materials and contamination by foreign matter shall be avoided. Aggregates exposed to a chloride (XS) environment (refer Table A13.4.7-2) shall be covered to protect them from salt contamination. Sufficient quantity of fine aggregate shall be stockpiled on site and handled in a manner that ensures the thorough mixing of the various deliveries in order to achieve a stable fineness modulus within the specified limits.

In hot weather concreting conditions, both the coarse- and fine-aggregate stockpiles shall be shaded from the sun. When the ambient temperature reaches and at all times when it exceeds 30°C, only the coarse aggregate shall be sprayed with water to assist cooling by evaporation. Water shall be delivered by means of an approved water droplet sprayer system. The Contractor shall ensure adequate drainage of the aggregate stockpile area.

Where concrete is batched on site, the aggregates shall be stored in bins with a minimum 150 mm thick concrete floor constructed below the aggregate stockpile to prevent contamination during the storage and handling the aggregate. The floor slab shall be appropriately sloped to facilitate drainage of the stockpile area. A 3,0 m wide concrete apron slab shall be constructed around the entrance and outer edge of the aggregate stockpile area and sloped for drainage away from the main stockpile area. The aggregates shall be tipped on the concrete apron slab to prevent contamination during the process of tipping and hoisting the aggregate.

d) Water

In hot weather concreting conditions, the sides and tops of water tanks for mixing water, including pipework leading to and from tanks, shall be insulated.

e) Storage capacity

The storage capacity provided and the quantity of material stored, whether cement, supplementary cementitious materials, aggregates, admixture or water, shall be sufficient to ensure that no interruptions to the progress of the work will be occasioned by any lack of materials.

f) Deteriorated material

Deteriorated or contaminated or otherwise damaged non-conforming material shall not be used in concrete. Such material shall be removed from the site without delay.

A13.4.6 CONSTRUCTION EQUIPMENT

A13.4.6.1 General

Plant used to manufacture, transport, place and test concrete shall be based on proven technology within the industry, and shall be in good working order. The plant shall be inspected, serviced and calibrated at regular intervals and tested to ensure that the system functions efficiently and accurately, all to the satisfaction of the Engineer.

The plant and equipment utilised shall be selected to ensure that the peak output required by the approved construction programme can be achieved and maintained at all times.

A13.4.6.2 Commercially-sourced concrete

Where concrete is supplied by a commercial source outside the direct control of the Engineer, the concrete supplier shall ensure compliance with the requirements of SANS 50206 (SANS 878), and the Contractor shall have full responsibility to implement process acceptance control testing in accordance with the specification. Commercial concrete suppliers shall ensure that the plant, measuring, mixing, transport and associated processes are audited by a recognised independent body in accordance with the following requirements for commercially-sourced concrete:

a) ISO 9002 (standardisation);
b) ISO 14001 (environmental);
c) ISO 39001 (road transport safety management);
d) OHSAS 18001 (legal compliance); and
e) SANS 50206 (SANS 878), ISO 22965-2 or ISO 9001 (quality management system for concrete production)

The audit shall be valid for a period of no greater than 12 months.

A13.4.6.3 Measuring the materials for the production of mixes

a) Cementitious binder

Where cementitious binder is supplied in standard bags, the bags shall be assumed to contain 50 kg for batching purposes. Cementitious binder taken from bulk storage containers and from partly used bags shall be batched by mass, accurate to within 2 % of the required mass.

b) Water

The mixing water for each batch shall be measured, either by mass or by volume, accurate to within 2 % of the required quantity. The quantity of water added to the mix shall be adjusted to make allowance for any moisture in the aggregates.

c) Aggregates

All aggregates for concrete shall be measured separately by mass, except as otherwise provided in this Clause, accurate to within 3 % of the required quantity.

Aggregates for strength concrete may be volume batched subject to the approval of the Engineer, and to the quantity of cementitious binder being increased, at the cost of the Contractor, by 25 kg per cubic metre of concrete over and above the quantity which would have been necessary were the aggregate to have been batched by mass. The concrete mix revision shall be verified to ensure that the total alkali content (Na_2O-equivalent) of concrete shall be limited taking into account the degree of reactivity of aggregates as specified in Clause A13.4.7.2a).

Batching boxes for volume batching shall be filled without in any way tamping, ramming or consolidating the material (other than that occurring naturally during the filling of the container), and shall be screeded off level with their topmost edges.

Any adjustment to the volume shall be made by supplementary containers of a suitable size being used. Adjustments to the volume, by the incomplete filling of batching boxes to marks on their inside faces, will not be permitted.

Fine aggregate shall be tested for bulking at the beginning of and halfway through each concreting shift, and adjustment shall be made to the batch volume to give the true volume required.

If applicable, the volume batching of aggregate shall be so planned as to use full bags of cementitious binder.

d) Admixture

Admixtures shall generally be supplied in liquid form and accurately dispensed by a mechanical dosing unit, into solution with the mixing water, except where the admixture cannot be dispersed homogenously into the mixing water, in a manner appropriate to the method of batching, e.g. dry versus wet batching. Unless extraordinary circumstances dictate otherwise, under no circumstances shall admixtures be dispensed on to dry mix components. Where such extraordinary circumstances do exist in such cases, other methods of feeding into the concrete mixture shall be agreed with the Engineer.

All admixtures shall be dispensed in quantities accurate to within 2 % by mass of the desired quantity. The mechanical dosing unit shall be checked daily for accuracy using a nominal dispensing volume, typically 2 litres, or as recommended by the dosing unit manufacturer or admixture supplier. At least once a week, the dosing unit shall be checked for accuracy using the full dispensing volume suited to the concrete mixing procedures employed on site, typically for 6,0 m^3 concrete batch mixed by a standard mixing truck and proportionally for other standard batch volumes.

A13.4.6.4 Mixing

a) General

Mixing the material for concrete shall be conducted by an experienced operator. Unless otherwise authorised, mixing shall be carried out in a mechanical mass batch-mixer of an approved type which will be capable of producing a uniform distribution of ingredients throughout the batch.

b) Charging the mixer

The sequence of charging the ingredients shall be subject to approval by the Engineer, and, unless otherwise instructed, the same sequence of charging the ingredients shall be maintained.

The volume of the mixed material by batch shall not exceed the volume recommended by the manufacturer of the mixer.

Fibres, integral permeability reducing technology, pigments and colouring agents shall be added to the mix in a manner that ensures that they are uniformly dispersed in the mix.

c) Mixing and discharging

The period of mixing shall be measured from the time when all the materials are in the drum until the commencement of discharge.

The mixing period for the materials shall be at least 90 seconds and may be reduced only if the Engineer is satisfied that the reduced mixing time will produce concrete with the same strength and uniformity as concrete mixed for minimum 90 seconds. The reduced mixing time, however, shall be not less than 50 seconds or the manufacturer's recommended mixing time, whichever is the longer. A suitable timing device shall be attached to the mixer to ensure that the minimum mixing time for the materials has been complied with.

The first batch to be run when starting with a clean mixer, shall contain only 75 % of the required quantity of coarse aggregate to make provision for coating the mixer drum. Refer Clause A13.4.7.11g) for a similar provision for richer concrete mix placed at horizontal construction joints.

Discharge shall be so carried out that no segregation of the materials will occur in the mix. The mixer shall be emptied completely before it is recharged with fresh materials.

d) Maintaining and cleaning the mixer

If the mixer has stopped running for a period in excess of 30 minutes, it shall be thoroughly cleaned out with particular attention being given to the removal of any build-up of materials in the drum, in the loader, and around the blades or paddles.

Before any concrete is mixed, the inner surfaces of the mixer shall be cleaned and all hardened concrete shall be removed.

Worn or bent blades and paddles shall be replaced.

e) Standby mixer

When sections are cast where it is important for the casting to continue without interruption, a standby mixer shall be held in readiness to run on 15 minutes notice should the stock mixers break down.

A13.4.7 EXECUTION OF THE WORKS

A13.4.7.1 General

Concrete shall comply with the prevention and mitigation requirements for deleterious alkali-silica reaction, limitation on the sulfate content, limitation on the chloride content, determination of nominal aggregate size and the particular performance requirements for strength concrete, durable concrete, or prescribed-composition concrete as specified in Clauses A13.4.7.2, A13.4.7.3, A13.4.7.4, A13.4.7.5, A13.4.7.6 and A13.4.7.7 below. Concrete shall concurrently comply with the desirable properties of fresh and hardened phases as specified in Clauses A13.4.7.8 and A13.4.7.9.

The Contractor shall be responsible for the performance, in both the fresh and hardened phases, of all concrete irrespective of the variation of cement or supplementary cementitious material quality between consignments. The actual concrete mix proportions used, as well as any changes thereto, shall be subject to the Engineer's approval. The Contractor's quality control system and work scheduling shall also allow for recognition of the hydration phase of concrete. During that phase adequate measures shall be implemented to assure that freshly placed concrete is properly protected against any activities which might affect the hydration process.

A13.4.7.2 Prevention and mitigation of deleterious Alkali-Silica Reaction (ASR)

The active proportion of the total alkali content (Na_2O-equivalent) of concrete, including contributions from the cement, supplementary cementitious materials, admixtures and, if required, aggressive environmental conditions, shall be limited taking into account the degree of reactivity as specified in Clause A13.4.7.2a) below.

a) Laboratory testing and evaluation

(i) Laboratory evaluation of potential alkali reactivity of aggregates using accelerated mortar prism, or mortar bar, method in accordance with SANS 6245 (with sample test age 14 days) or ASTM C1260 (with sample test age 16 days) shall be conducted.

1. Aggregates with the expansion, at the sample test age, determined as equal to or more than 0,20 % are categorised as 'rapidly expansive', the maximum permitted equivalent sodium oxide (Na_2Oeq) of the concrete mixture shall be 2,1 kg per cubic metre of concrete, except where Witwatersrand Quartzite aggregate is used the maximum permitted equivalent sodium oxide (Na_2Oeq) shall be 2,0 kg per cubic metre of concrete;

2. Aggregates with the expansion, at the sample test age, determined as equal to or more than 0,10 % but less than 0,20 % are categorised as 'slowly expansive', the maximum permitted equivalent sodium oxide (Na_2Oeq) of the concrete mixture shall be 2,8 kg per cubic metre of concrete; or

3. Aggregates with the expansion, at the sample test age, determined as less than 0,10 % are categorised as 'innocuous', the maximum permitted equivalent sodium oxide (Na_2Oeq) of the concrete mixture shall be 4,0 kg per cubic metre of concrete.

(ii) Where untested sources of cement or supplementary cementitious materials are proposed, laboratory evaluation of potential alkali reactivity of cementitious binder-aggregate combinations using the concrete prism method in accordance with ASTM C227 shall be conducted.

1. Cementitious binder-aggregate combinations with the expansion of more than 0,05 % at 52 weeks shall be considered a deleteriously expansive combination and shall be rejected; or
2. The maximum permitted equivalent sodium oxide (Na_2Oeq) of the concrete mixture shall be 2,4 kg per cubic metre of concrete, until the aggregate has been classified by laboratory evaluation, unless the aggregate can be geologically linked with a previous SANS 6245 or ASTM C1260 evaluation and classified according to Clauses A13.4.7.2a) (i), (ii) or (iii).

(iii) Where potentially alkali reactive aggregates are used in a marine (XS) environment (refer Table A13.4.7-2), nominal aggressive environmental contributions to the active alkali content of the concrete mixture under investigation shall be 0,01, 0,02 or 0,03 % of the total binder content for XS1, XS2 or XS3 environments respectively.

b) Prevention and mitigation measures

ASR prevention measures may include the substitution of the cement source, supplementary cementitious material or aggregate types. ASR mitigation measures shall include the redesign of the cementitious binder composition to incorporate ameliorating measures suggested in specialist literature, such as Fulton's Concrete Technology.

A13.4.7.3 Limitations on the sulfate content

The total acid soluble sulfate content of the concrete mix, expressed as SO_3, shall not exceed 4 % by mass of the cementitious binder content in the mix. The sulfate content shall be calculated as the cumulative total from the various constituents of the mix according to SANS 5213.

A13.4.7.4 Limitation on the chloride content

The total acid soluble chloride content of reinforced concrete shall not exceed 0,35 % by mass of the cementitious binder content of the mix where there is no further possibility of additional chloride contamination. For prestressed concrete, in chloride (XS) environments or where chloride contamination is a possibility, the total acid soluble chloride content shall not exceed 0,20 % by mass of the cementitious binder for all intended structural uses. The chloride content shall be calculated as the cumulative total from the various constituents of the mix.

A13.4.7.5 Determination of nominal aggregate size

The aggregate sizes shall be selected in accordance with SANS 1083 and shall be selected after giving due consideration to the specified nominal cover, reinforcement spacing and layout and particular congested areas of reinforcement, for example around prestressing anchorages, etc. The Contractor may propose amendment of the nominal aggregate size to facilitate the selected aggregate properties or the agreed construction method. Amendment of aggregate size from that specified on the drawings shall be subject to the approval of the Engineer in writing and shall conform to the requirements of Table A13.4.7-1 nominal sizes of aggregates for concrete.

Table A13.4.7-1: Nominal sizes of aggregates for concrete complying with SANS 3001-AG1

Coarse aggregate Nominal sieve aperture size, mm	Fine aggregate Nominal sieve aperture size, mm
63	5
50	2
37,5	1
28	0,600
20	0,425
14	0,300
10	0,150
7,1	0,075

A13.4.7.6 Strength (Class C) concrete

The compressive strength class is indicated by the designated concrete code C, the characteristic 28-day cylinder strength in MPa, the characteristic 28-day cube compressive strength in MPa and the nominal size of coarse aggregate in the mix. For example, C28/35-20 means strength concrete class with a characteristic cylinder strength of 28 MPa at 28 days or characteristic cube compressive strength of 35 MPa at 28 days and a nominal size coarse aggregate of 20 mm.

Typical applications of strength concrete may include:

(i) in benign exposure environments (X0) where there is no risk of corrosion or attack;
(ii) where relatively short service life (typically 25 years) is anticipated;
(iii) temporary structures; or
(iv) as specified on the drawings where compressive strength is the governing criteria.

A13.4.7.7 Durable (Class D) concrete

Durable concrete shall be utilised for structures requiring extended service life of 100 years and in typical environments that require a minimum of 80 % of the service life to be free from the risk of corrosion.

The class of concrete is indicated by the designated durable concrete code D, the characteristic28-day cylinder strength in MPa, the characteristic 28-day cube strength in MPa, the nominal size of coarse aggregate in the mix, and the environmental class designation. for example D35/45-20-XC4 means durable concrete class with a characteristic cylinder compressive strength of 35 MPa after 28 days or characteristic cube compressive strength of 45 MPa after 28 days, a nominal size coarse aggregate of 20 mm, and a corresponding set of particular durability index values suitable for an XC4 environment.

The environmental classes as determined by the design engineer, suitable for the general South African environments are listed in Table A13.4.7-2.

Table A13.4.7-2: Environmental Classes

Environmental Class	Limited description
X0	No corrosion risk
Corrosion induced by carbonation	
XC1a	External concrete exposed to low humidity (<50% RH) and sheltered from moisture; arid areas; interior concrete
XC1b	Permanently wet or saturated-damp
XC2	Wet, rarely dry
XC3	External concrete exposed to moderate humidity (50-85% RH) and sheltered from rain in non-arid areas
XC4	External concrete exposed to rain or condensation, or alternately wet and dry conditions
Corrosion induced by seawater, sea spray and saline groundwater	
XS1	Exposed to airborne salt but not in direct contact with seawater or inland saline water
XS2a	Permanently submerged in sea (or saline) water
XS2b	XS2a with abrasion
XS3a	Tidal, splash and spray zones
XS3b	XS3a with abrasion

Specialist literature, such as BRE Special Digest 1: 'Concrete in aggressive ground', should be consulted where sulfate-bearing water, aggressive groundwater, aggressive chemical environments or aggressive environments not classified in Table A13.4.7-2 are encountered.

Class D concrete mix shall meet the following criteria:

(i) the specified 28-day characteristic cylinder or cube compressive strength;
(ii) the specified 28-day nominal oxygen permeability index;
(iii) the specified 28-day nominal chloride conductivity value; or
(iv) a characteristic 28-day cylinder or cube compressive strength corresponding to the maximum water: cementitious binder ratio for chloride (XS) environments.

Durable concrete for environments where corrosion induced by carbonation presents the governing risk, the desirable properties shall conform to Table A13.4.7-3 for 100 year service life.

Table A13.4.7-3: Nominal Durability Index and cover values for 100 year service life in typical carbonating environments

Environmental class	Cover (mm), as specified	OPI (log scale)
For 100 year service life		
XC1a, and XC1b	40 50 60	9,15 9,00 9,00
XC2	40 50 60	9,40 9,10 9,00
XC3	40 50 60	9,65 9,35 9,05
XC4	40 50 60	9,85 9,55 9,30

Durable concrete for environments where corrosion induced by chlorides in water or in the atmosphere presents the governing risk, the desirable properties shall conform to Table A13.4.7-4 for 100 year service life.

Table A13.4.7-4: Nominal Durability Index and cover values for 100 year service life in typical chloride environments

Environmental class	Cover (mm), as specified	Chloride Conductivity (mS/cm)			
		Typical Cementitious Binder System[3]			
		Fly ash (30 %)	Blastfurnace slag (50 %)	Corex slag (50 %)	Silica fume (10 %)
For 100 year service life					
XS1	40	1,20	1,30	1,60[2]	n/a[1]
	50	1,85[2]	1,95[2]	2,20[2]	0,40
	60	2,15[2]	2,35[2]	2,75[2]	0,65
XS2a	50	0,85	1,00	1,20	n/a[1]
	60	1,25	1,45[2]	1,70[2]	n/a[1]
XS2b	60	1,10	1,30	1,55[2]	n/a[1]
XS3a	50	0,65	0,80	0,95	n/a[1]
	60	0,95	1,10	1,40	n/a[1]
XS3b	60	0,85	1,00	1,30	n/a[1]

Note: 1) n/a means cementitious binder system is not suitable for the indicated purpose.

2) Maximum water: cementitious binder ratio for all binder systems shall be maximum 0,550.

A13.4.7.8 Prescribed-Composition (Class P) concrete

Where performance of concrete is influenced by mix composition limitations placed on strength class concrete in the Contract Documentation, the concrete shall be referred to as prescribed-composition concrete and designated by the prefix "P". This may include the specification of a particular aggregate type or source, for example dolomitic aggregate, for incorporation into the concrete mix. For example, P32/40-20 means prescribed-composition concrete class with a characteristic cylinder strength of 32 MPa at 28 days or characteristic cube compressive strength of 40 MPa at 28 days and a nominal size coarse aggregate of 20 mm. For Class P concrete, the characteristic strength of the mix shall be based on the higher of the following values:

(i) the specified 28-day characteristic cylinder or cube compressive strength;
(ii) a characteristic 28-day cylinder or cube compressive strength corresponding to the maximum water: cementitious binder ratio;
(iii) a characteristic 28-day cylinder or cube compressive strength corresponding to the minimum cementitious binder content; or
(iv) a 28-day characteristic cylinder or cube compressive strength corresponding to the maximum water content.

A13.4.7.9 Properties of fresh concrete

a) Bleeding and settlement

The concrete mix shall be so proportioned with suitable materials that bleeding is not excessive, is limited to maximum 3 % and that settlement is minimised. Bleeding shall be determined in accordance with ASTM C232, or where the effect of the admixture dose is reported, in accordance with EN 480-4. Excessive bleeding and settlement that may adversely affect the structural performance or durability of concrete through the formation of voids under coarse aggregate particles and the reinforcement or by plastic settlement cracking, shall at least be counteracted by strictly monitored revibration and recompaction efforts (refer Clause A13.4.7.11d)(i)) during concreting activities or approved revision of the concrete mix design.

b) Air content

Where required, the air content of fresh concrete mix shall be determined in accordance with SANS 3001-CO1-8.

c) Consistence and workability

The consistence of concrete in the fresh state shall be classified in accordance with the desirable consistence classes described in Tables A13.4.7-5, A13.4.7-6, A13.4.7-7, A13.4.7-8 or A13.4.7-9. Self-compacting concrete shall comply only with Table A13.4.7-9 and Clause A13.4.7.8c)(i). Pumped concrete shall comply with Clause A13.4.7.8c)(ii). The Contractor shall be responsible to select the consistence class appropriate for his construction method and shall record the selection in the mix design before the commencement of concreting activities.

Slump tests shall be conducted in accordance with SANS 3001-CO1-3.

Table A13.4.7-5: Slump classes and values

Consistence Class	Slump (mm) determined in accordance with SANS 3001-CO1-3
ZA-S1	30 ± 20
ZA-S2	75 ± 20
ZA-S3	125 ± 25
ZA-S4	180 ± 30

Where slump may be less than 10 mm and Vebe time is the desirable measure of consistence, Vebe tests shall be conducted in accordance with SANS 3001-CO1-4.

Table A13.4.7-6: Vebe time classes and values

Consistence Class	Vebe time (s) determined in accordance with SANS 3001-CO1-4
ZA-V1	5 to 10
ZA-V2	11 to 20
ZA-V3	21 to 30

Where the degree of compaction is the desirable measure of consistence, the compacting factor shall be determined in accordance with SANS 3001-CO1-5 (EN 12350-4).

Table A13.4.7-7: Degree of compaction classes and values

Consistence Class	Compaction factor determined in accordance with SANS 3001-CO1-5 (EN 12350-4)
ZA-C1	0,80 or less
ZA-C2	0,81 to 0,89
ZA-C3	0,90 or greater

Where slump may exceed 150 mm and flow is the desirable measure of consistence, flow shall be conducted in accordance with SANS 3001-CO1-6.

Table A13.4.7-8: Flow classes and values

Consistence Class	Flow diameter (mm) determined in accordance with SANS 3001-CO1-6
ZA-F1	500 to 545
ZA-F2	550 to 595
ZA-F3	600 to 650

Where high workability concrete is used and the slump flow is the desirable measure of consistence, slump flow shall be conducted in accordance with SANS 3001-CO1-9 (EN 12350-8).

Table A13.4.7-9: Slump flow classes and values

Consistence Classes	Slump flow diameter (mm) determined in accordance with SANS 3001-CO1-9 (EN 12350-8)
ZA-SF1	550 to 650
ZA-SF2	660 to 750
ZA-SF3	760 to 850

(i) Additional properties of self-compacting concrete

The additional properties of self-compacting concrete, in particular viscosity, passing resistance and sieve segregation, are classified and described in Tables A13.4.7-10, A13.4.7-11, A13.4.7-12, A13.4.7-13 or A13.4.7-14 below.

Viscosity shall be assessed using the time to reach 500 mm flow, T_{500}, determined in accordance with SANS 3001-CO1-9 (EN 12350-8) or the V-funnel flow time, T_v, determined in accordance with SANS 3001-CO1-10 (EN 12350-9).

Table A13.4.7-10: T_{500} Viscosity classes and values

Viscosity Class	500 mm Flow time T_{500} (s) determined in accordance with SANS 3001-CO1-9 (EN 12350-8)
ZA-VS1	Less than 2,0
ZA-VS2	2,0 or greater

Table A13.4.7-11: T_v Viscosity classes and values

Viscosity Class	V-funnel flow time T_v (s) determined in accordance with SANS 3001-CO1-10 (EN 12350-9)
ZA-VF1	Less than 9,0
ZA-VF2	9,0 to 25,0

Passing resistance shall be assessed using either the L-box determined in accordance with SANS 3001-CO1-11 (EN 12350-10) or J-ring tests determined in accordance with SANS 3001-CO1-13 (EN 12350-12).

Table A13.4.7-12: L-Box passing resistance classes and values

Passing Resistance Class	L-box ratio determined in accordance with SANS 3001-CO1-11 (EN 12350-10)
ZA-PL1	At least 0,80 with 2 rebars
ZA-PL2	At least 0,80 with 3 rebars

Table A13.4.7-13: J-Ring passing resistance classes and values

Passing Resistance Class	J-ring step (mm) determined in accordance with SANS 3001-CO1-13 (EN 12350-12)
ZA-PJ1	Maximum 10,0 with 12 rebars
ZA-PJ2	Maximum 10,0 with 16 rebars

Sieving segregation resistance shall be determined in accordance with SANS 3001-CO1-12 (EN 12350-11).

Table A13.4.7-14: Sieve segregation resistance classes and values

Segregation Resistance Class	Segregation portion (percent) determined in accordance with SANS 3001-CO1-12 (EN 12350-11)
ZA-SR1	Maximum 20
ZA-SR2	Maximum 15

(ii) Additional properties of pumped concrete

Where concrete is transported and placed by pumping, the concrete mix to be pumped shall be so designed that:

1. the consistence and workability shall conform to the range of slump values stipulated in Table A13.4.7-5.
2. the maximum slump shall be 210 mm.
3. graded aggregate, controlled fines content and suitable admixtures shall be used, wherever necessary, with a view to improving the pumpability and cohesiveness of the mix.
4. the initial drying shrinkage capacity of pumped concrete determined in accordance with SANS 3001-CO2-7 shall not exceed 0,040 % for prestressed members or 0,045 % for reinforced members.

A13.4.7.10 Properties of hardened concrete

a) Compressive strength

For the purposes of determining compressive strength, the characteristic cylinder strength shall be determined using 150 mm diameter, 300 mm high cylinder or the characteristic cube compressive strength shall be determined using 150 mm cubes and all test specimens shall be prepared strictly in accordance with SANS 3001-CO2-2 and tested in accordance with SANS 3001-CO2-3 at 28 days. All concrete shall be categorised in the compressive strength classes, using both a characteristic cylinder strength and characteristic cube strength, as shown in Table A13.4.7-15.

Table A13.4.7-15: Compressive strength classes for normal-weight aggregates

Compressive strength class	Minimum characteristic cylinder strength, MPa	Minimum characteristic cube strength, MPa
C12/15	12	15
C16/20	16	20
C20/25	20	25
C25/30	25	30
C28/35	28	35
C32/40	32	40
C35/45	35	45
C40/50	40	50
C45/55	45	55
C50/60	50	60
C54/65	54	65
C57/70	57	70
C60/75	60	75
C65/80	65	80
C70/85	70	85
C75/90	75	90
C80/95	80	95
C85/100	85	100
C90/105	90	105
C100/115	100	115

For particular uses, it may be necessary to specify the compressive strength at ages earlier or later than 28 days, for example massive structural elements, or after storage under special conditions, for example heat treatment. In assessing the strength, other sizes of mould and other curing regimes may be used provided the relationship to those standardised has been established and documented and subject to the approval of the Engineer.

b) Tensile splitting strength

The tensile splitting strength shall be determined at 28 days in accordance with SANS 3001-CO2-6.

c) Flexural strength

The flexural strength shall be determined from beam specimens prepared in accordance with SANS 3001-CO2-3 and tested at 28 days in accordance with SANS 3001-CO2-5.

d) Energy absorption capacity of fibre reinforced concrete

The minimum energy absorption capacity shall be specified on the drawings. The energy absorption capacity shall be determined from a slab specimen, tested at 28 days in accordance with EN 14488-5, save that the fibre reinforced concrete shall be cast into the formwork using conventional concreting techniques. The energy absorption capacity shall conform to the specified energy adsorption class defined in Table A13.4.7-16.

Table A13.4.7-16: Energy absorption classes and values

Energy absorption class	Energy adsorption for deflection up to 25mm (J)
E500	500 to 690
E700	700 to 990
E1000	1000 and greater

e) Concrete durability index testing

Test specimens shall be prepared in accordance with SANS 3001-CO3-1 from test panels. Test panels shall have dimensions of 600 mm high by 400 mm wide and 150 mm thick and be placed, constructed and cured in the same manner as the Contractor utilised for the representative structural element. Test samples shall be obtained perpendicular to the casting direction between 26 and 35 days after casting. A maximum of six test specimens can be cored from the formed face of each test panel, excluding the outer 100 mm along the perimeter of the test panel. Additional test panels may be required in instances where more than six test specimens are required.

The oxygen permeability test shall be conducted in accordance with SANS 3001-CO3-2. The chloride conductivity test shall be conducted in accordance with SANS 3001-CO3-3. If required, the water sorptivity test shall be conducted in accordance with Clause A20.1.6.5.1f) of Chapter 20 (or SANS 3001-CO3-4).

f) Verification of concrete cover depth

All reinforced and prestressed concrete elements shall be subject to the verification of concrete cover over reinforcing in the two following ways.

(i) Visual inspection prior to concrete placement

Prior to the placement of concrete, all elements shall be inspected for concrete cover. The minimum cover shall be as specified on the drawings, and spacers shall be manufactures accordingly. The placing and spacing of spacers shall be carefully controlled. For the visual inspection, no reduction in cover from the specification will be permitted and the Contractor shall ensure that he manages his construction tolerances to achieve the specified cover.

The maximum cover shall be 10 mm greater than specified for elements less than 500 mm thick, 15 mm greater than specified for elements greater than or equal to 500 mm thick, or 25 mm greater than specified for elements cast against ground.

(ii) Post-casting verification of concrete cover depth

All reinforced, prestressed and precast concrete shall be subject to the verification of cover depth. The cover survey shall be conducted using the manual, grid or block survey method and cover metre devices that comply with BS 1881 Part 204 or ACI 228. Cover surveys shall be conducted after removal of the formwork, including the repair of form tie holes, or after the completion of the curing period.

Cover surveys shall be conducted for all element types, including both formed and unformed surfaces, at a minimum sampling ratio of 2 % of surface area of concrete elements placed. The Engineer shall select the particular structural elements and specific areas for cover verification. Particular elements that will require extensive cover depth verification shall include all parapet surfaces, including parapet beam and aesthetic detail recesses, all buried surfaces of abutments, piers, wingwalls and walls, up to 1,5 m above the design fill lines prior to the commencement of backfilling operations.

Cover analysis should be conducted in accordance with Clause A20.1.5.1h) of Chapter 20. Should another cover survey method be proposed, for example linear or quick scan method, a calibration procedure shall be conducted strictly according to Clause A20.1.5.1h) of Chapter 20 and shall be submitted to the Engineer for approval prior to use.

g) Drying shrinkage

The drying-shrinkage of concrete specimens determined in accordance with SANS 3001-CO2-7 shall not exceed 0,040 % for prestressed concrete or 0,045 % for reinforced and plain concrete;

A13.4.7.11 Protection of Concrete from Adverse Environmental Conditions

a) General

Precautions shall be taken as needed to prevent concrete from damage due to adverse weather or other environmental conditions before or during the placing and curing operations. The fresh phase of concrete shall be protected from rain and hot or cold weather, and once placed, shall be protected from vibration, movement and impact that could disrupt the concrete hydration phase and adversely affect its bond to the reinforcement. Hardened phase concrete shall also be protected from mechanical damage and contamination until curing has been completed.

The temperature of the concrete mixture immediately before placement shall be between 10°C and 30°C, except as otherwise provided herein.

b) Rain protection

Concrete shall not commence or shall be stopped unless adequate protection is provided to prevent damage to the exposed surface.

c) Hot weather protection

When the ambient temperature exceeds 30°C, the Contractor shall ensure that the temperature of the concrete mixture is maintained within the stipulated limits. The formwork, reinforcing steel, structural steel components and other surfaces that will come into contact with the concrete mix shall be cooled to below 30°C by means of a water spray or other methods approved by the Engineer.

The temperature of the concrete mixture at the time of placement shall not exceed 30°C. The Contractor shall take the necessary measures to control the temperature of the mixture ingredients by preventative measures which may include:

(i) Insulating cement and supplementary cementitious material silos and water bulk storage containers;
(ii) Spraying of coarse aggregate stockpiles with water to promote cooling down by evaporation;
(iii) Shading the aggregate stockpiles;
(iv) Shading the area where concreting is to be carried out;
(v) Cooling the external surface of the mixer truck drum which may be lagged with hessian and kept damp, or with running water during mixing and again prior to discharge on site;
(vi) Cooling the aggregates or water by refrigeration or replacing a portion of all of the mix water with ice that is flaked or crushed to the extent that the ice will completely melt during mixing of the concrete; or
(vii) Liquid nitrogen injection directly into the mix.

d) Cold weather protection

Unless suitable protection measures are in places, concrete shall not be placed during falling temperatures when the ambient temperature falls below 7°C and shall only be placed during rising temperatures when the ambient temperature is above 5°C. When concrete is placed at ambient temperatures below 5°C the concrete temperature shall not be below 10°C, for which purpose heating of the water, heating of the aggregate or the concrete mixture shall be permitted. The Contractor shall make all the necessary arrangements for heating the materials and the methods used shall heat the materials uniformly. Neither the aggregates nor the water shall be heated to over 65°C. Heated water and aggregate shall first be mixed and the cementitious binder shall then be added only while the temperature of the mix is below 30°C.

The temperature of placed concrete shall not be allowed to fall below 5°C until the concrete has attained the compressive cube strength of at least 5 MPa, determined from cube samples stored under the same conditions as the structural member, and the Contractor shall be responsible for all protective measures necessary to this end. If external heating is employed, the heat shall be applied and withdrawn gradually and uniformly so that no part of the concrete surface is heated to more than 35°C or caused to change temperature by more than 20°C in 8 hours. All concrete damaged by frost or by the formation of ice in the concrete shall be removed and replaced by the Contractor at his own expense.

e) Particular requirements for slabs, bridge decks and unformed surfaces

When typical slab elements are cast, in particular the ambient temperature, the relative humidity, concrete temperature and wind speed shall be actively monitored to ensure that the rate of evaporation is minimised and at all times limited to maximum 1 kg per square metre per hour in accordance with ACI 305R or the Concrete Society of Southern Africa technical report on Concrete Curing (November 1991, ISBN 0-620-16248-1). During periods of low humidity, wind or high temperatures and prior to the application of the curing measures, unformed concrete being placed and finished, shall be protected from damage due to rapid evaporation. Such protection shall be adequate to prevent plastic shrinkage cracking, premature crusting of the surface or an increase in drying shrinkage cracking. Such protection shall be provided by:

(i) Raising the humidity of the surrounding air with fog sprayers operated upwind of the slab;
(ii) The use of wind-breaks and sun-shades;
(iii) Additionally reducing the temperature of the concrete; or
(iv) Scheduling placement during cooler parts of the day or nights.
(v) Application of liquid evaporation retarders.

f) Concrete exposed to aggressive water or soil

Where increased risk of damage due to early age exposure of concrete surfaces to aggressive water or soil is anticipated, additional precautionary measures shall be required. In addition to measures contained in specialist literature such as BRE Special Digest 1: 'Concrete in aggressive ground', the protective measure shall also include:

(i) No construction joints shall be permitted for concrete elements in permanent contact with the aggressive water or soil;
(ii) Formwork, and where necessary drainage provisions in excavations, shall be continuously maintained for at least 96 hours after casting;
(iii) Except for the repair of any isolated areas of grout loss and the plugging of form tie holes, the original formed surfaces shall be left undisturbed; or
(iv) All external surfaces permanently exposed to aggressive water or soil shall be protected with a waterproofing system or protective coating as specified on the drawings.

g) Thermal gradients in concrete elements

For all concrete pours, the maximum temperature difference between any two points in the pour shall be limited to 22°C and the maximum temperature shall be 70°C. Where these values may be exceeded, specialist literature such as The Highways Agency (UK) BD 28/87: 'Early thermal cracking of concrete', shall be consulted.

h) Precautionary measures for using sliding formwork

During sliding operations in cold weather, the water only, or the water and the aggregate, shall be heated to ensure that the concrete temperature will not drop below 10°C until it has attained a compressive strength of 5 MPa, determined from cube samples stored under the same conditions as the structural member.

During cold weather the rate of sliding shall be suitably decreased to ensure sufficient strength in the concrete which leaves the tail of the formwork.

A13.4.7.12 Placing and Compaction

a) General

Concrete shall be transported and placed in a manner that will prevent segregation or loss of constituent materials or the contamination of the concrete. Immediately prior to discharge of the concrete transported by mixer trucks, the drum shall be rotated at the highest revolution per minute for a minimum period of 4 minutes per typical 6 cubic metre volume and proportionally for other mixing volumes.

Concrete shall not be placed in any part of the works until the Engineer's approval has been given. If concreting is not started within 24 hours of approval having been given, approval shall again be obtained from the Engineer.

Concreting operations shall be carried out only during daylight hours unless proper lighting arrangements have been made subject to the approval of the Engineer, and the lights are in good working order by noon. Workmen shall not be allowed to work double shifts and the Contractor shall provide a fresh team for night shifts.

Placing and compacting the concrete shall at all times be under the direct supervision of an experienced concrete supervisor. In order to accept each concrete delivery, the official batch ticket shall be examined and assessed for compliance, the consistence or workability assessed, and the temperature of the concrete at delivery recorded as part of the Contractor's process control obligations. Concrete delivered with temperatures or with consistence and workability outside the particular range as stipulated in Clauses A13.4.7.8c) and A13.4.7.11, shall be rejected.

Once the casting of concrete has begun, it shall be carried out in a continuous process between construction joints. Concrete shall be placed within 60 minutes from the start of mixing. This time may be extended by the Engineer where a retarding admixture has been used. All excavations and other contact surfaces of an absorbent nature such as timber formwork shall be damp but no standing water shall be permitted to remain on these surfaces. The formwork shall be clean on the inside.

b) Placing

Whenever possible, concrete shall be deposited vertically into its final position. Subject to the approval of method statements for particular concrete pour operations, the maximum height concrete will be permitted to free-fall shall be limited to 3,0 m. Unless a specific method statement has been approved by the Engineer the pour will be at the Contractor's risk. Preventative measures to avoid segregation shall be employed whenever deemed necessary, particularly for concrete pours exceeding 2,4 m high. Where chutes are used, their length and slope shall be such as not to cause segregation, and suitable spouts and baffles shall be provided at the lower end to minimise segregation. The displacement of concrete by vibration instead of by direct placing shall be done only when approved by the Engineer.

Care shall be taken when casting bridge decks of a substantial thickness to avoid layering of the concrete, and the entire thickness shall be placed in one pass, except when permanent void formers are used. Fresh concrete shall not be placed against concrete which has been in position for more than 60 minutes unless a construction joint has been formed or unless a set-retarding additive has been used in the concrete. Particular care shall be exercised when incorporating permanent void formers within a concrete section, where additional measures may be required, to restrain and comprehensively ensure that permanent void formers are not displaced during concrete placement.

The pumping of concrete shall be subject to approval by the Engineer. Aluminium pipes shall not be used for this purpose.

In plain concrete with a thickness greater than 350 mm, plums and boulders may, if approved, be included to displace concrete for up to 20 % of the total volume, provided that the strict compliance with Clause A13.4.5.2d) is maintained.

c) Placing under water

Placing under water shall be allowed only in exceptional circumstances where it is unfeasible to dewater the location before the concrete is placed. No concrete shall be placed in running water.

Underwater concrete shall be placed by means of tremies or other approved methods. Full details of the method proposed by the Contractor shall be submitted in advance for approval. Placing by skip or pipeline will also be considered in certain circumstances.

During concreting by tremie, the pipe shall be kept filled with concrete at all times to prevent air and water from entering the tremie. When the tremie is charged, an approved sliding plug shall be used. Once concreting has begun by tremie, the discharge end of the tremie shall be kept well below the surface of the concrete. Should this seal be broken, the tremie shall be lifted and plugged before concreting is recommenced. Distribution of concrete by lateral movement of the tremie will not be permitted.

The concrete mix to be placed underwater shall be specially designed and approved for this purpose to ensure good flowability, plasticity and cohesion. Increased sand and cementitious contents over those of normal mixes and viscosity-modifying, anti-washout admixtures shall be required. Sillica fume may also be incorporated into the mix to improve cohesion.

d) Compaction

Concrete shall be fully compacted by approved means during and immediately after placing. It shall be thoroughly worked against the formwork, around reinforcement bars, tendons, ducts and embedded fittings and into corners to form a solid mass free from voids.

The concrete shall be free from honeycombing and planes of weakness, and successive layers of the same lift shall be thoroughly bonded together.

All concrete, except concrete placed under water, self-compacting concrete and unless otherwise permitted by the Engineer, shall be compacted by means of mechanical vibration immediately after placement. Internal vibrators shall be capable of operating at a frequency of more than 10,000 cycles per minute and, where permitted, external vibrators at a frequency of more than 3,000 cycles per minute. Sufficient standby vibrators shall be kept available in case of breakdowns.

Vibration shall be applied by experienced workmen, for sufficient duration and intensity to thoroughly compact the concrete, but over-vibration resulting in segregation, surface water and leakage shall be avoided. Internal vibrators shall be inserted and withdrawn out of the concrete slowly. Application of vibrators shall be at points uniformly spaced and not further apart than 8 times the vibrator diameter. Internal vibrators shall not be used to transport concrete in the formwork. Vibration shall be supplemented by such spading as is necessary to assist the uniform placement and compaction of the concrete. Contact with reinforcement and formwork shall, in so far as is practicable, be avoided when internal vibrators are used. Concrete shall not be subjected to disturbance by vibration within the hydration phase of 4 to 24 hours of it having been compacted.

Whenever vibration is applied externally, the design of the formwork and positioning of vibrators shall be such as to ensure efficient compaction and avoidance of surface blemishes.

Special attention shall be given to the compaction of concrete in the anchorage zones and behind the anchor plates and in all places where high concentrations of reinforcing steel or cables occur. Vibration shall be supplemented by tamping with suitable rods and spades as is necessary to ensure dense concrete along formwork surfaces and in corners and locations where internal vibrators cannot reliably reach.

Where the placing and compaction of concrete is difficult, self-compacting concrete or an alternative mix containing smaller sized aggregate may be used and only after a revised mix containing such aggregate has been designed, tested and approved by the Engineer.

(i) Revibration or recompaction

The detrimental effects of excessive bleeding and settlement shall be counteracted by the revibration or recompaction technique. The revibration or recompaction of the concrete shall be conducted at a time as long as possible (typically 1 to 2 hours) after initial compaction but while the concrete retains sufficient workability to respond plastically to the compactive effort. It should not be attempted once the hardened phase of the concrete has commenced. Revibration is usually achieved in practice through the use of internal vibrators but surface vibrator can also be used. Particular application of this technique will normally be required in the following typical applications:

1. the upper zones of walls and columns;
2. any formed shapes that have abrupt changes in cross section, such as T-beams, I-beams and coffered slabs;
3. any elements that have horizontal reinforcement placed near the top surface of the concrete member;
4. water-tight structures; and
5. structures constructed from durable (class D) concrete or exposed to aggressive environmental conditions.

e) Requirements in respect of sliding formwork

Where sliding formwork is used, the following additional requirements shall apply:

(i) The Contractor shall take all the necessary measures to ensure the continuity of operations. All the necessary lighting and standby equipment for mixing, hoisting, placing and compacting shall be provided and all the materials required for completing each structure shall be ready on the site before casting commences;

(ii) For vertical sliding, concrete shall be cast in uniform layers in the formwork so that the level of the top surface of the concrete differs by no more than 250 mm between any two points in the formwork. In addition, the top level of the concrete shall never be so low down in the formwork as will cause structural instability in the formwork. The working platform shall be kept clean and no concrete which has dried out in part may be swept into the formwork;

The concrete shall be compacted during and immediately after placing. Successive layers must be knitted together, i.e. the previous layer must distribute to minimise lifting cracks and to ensure integrity. To ensure the proper bonding of successive layers, not more than 60 minutes shall elapse between the placing of successive layers except where an approved admixture has been applied or fine mist sprayers used to avoid drying out of the previous layer, in which case the delay may be amended as approved by the Engineer in consideration of such circumstances; and

(iii) The slump of concrete may be up to 210 mm should the approved method of sliding so require.

f) No fines concrete (Class NF)

(i) General

No-fines concrete shall be classified by the prefix "NF" and the size of the aggregate to be used. Class NF-20 means a no-fines concrete with a 20 mm nominal aggregate size. No fines concrete may be cast in place or precast.

(ii) Materials

Cement shall comply with the requirements of Clause A13.4.5.1a) and site-blending with supplementary cementitious materials shall not be permitted.

Each nominal size of aggregate shall be a single-sized aggregate complying with the requirements of Clause A13.4.5.2.

Water shall comply with the requirements of Clause A13.4.5.3.

(iii) Classes of no-fines concrete

The classes of no-fines concrete and volume of aggregate per 50 kg cement for each class of concrete shall be as indicated in Table A13.4.7-17.

Table A13.4.7-17: Volume of aggregate in class NF concrete

Class	Aggregate per 50 kg cement
NF-37,5	0,33 m^3
NF-28	0,32 m^3
NF-20	0,30 m^3
NF-14	0,27 m^3

Compressive strength, determined from 150 mm cube samples, shall be minimum 4,0 MPa at 28 days.

(iv) *Batching and mixing*

Cement shall be measured by mass or in full bags of 50 kg each and aggregate shall be measured by volumes in approved measuring boxes or barrows.

The aggregate shall be moist or wetted before the cement is added.

The quantity of water added shall be just sufficient to form a smooth grout which will adhere to, and completely coat, every particle of aggregate, and which is just wet enough to ensure that, at points of contact of aggregate, the grout will run together to form a small fillet to bond the aggregate together. The mix shall contain no more than 20 litres of water for every 50 kg of cement.

Mixing shall be done in an approved batch-type mechanical mixer, but small quantities may be hand mixed.

(v) *Placing*

No-fines concrete shall be placed in accordance with the procedure approved by the Engineer. If cast in situ, it shall be placed in its final position, and if precast it shall be placed in the mould, within 30 minutes of mixing.

The no-fines concrete shall be worked sufficiently to ensure that it completely fills the space to be concreted and that adjacent aggregate particles are in contact with one another. Excessive tamping or ramming shall be avoided and under no circumstances may the no-fines concrete be vibrated. Due care must be taken to ensure that any geosynthetic filter fabric and drainage provisions are not contaminated.

The Contractor shall be responsible to ensure the permeability of the no fines concrete. The Engineer may request to Contractor to demonstrate the permeability of no fines concrete in place and any portion deemed to be of insufficient permeability shall be broken out and replaced at the Contractor's expense.

(vi) *Curing and surface protection*

All no-fines concrete shall be protected from the elements and loss of moisture. Protection against loss of moisture shall be accomplished in one or more of the following ways:

1) retaining formwork in place;
2) covering exposed surfaces with sacking or other approved absorbent material kept continuously wet; or
3) covering exposed surfaces with plastic sheeting.

No fines placed during cold weather shall be adequately protected against frost for at least 3 days.

g) Construction joints

(i) General

Concreting shall be carried out continuously up to the construction joints shown on the working drawings or as approved by the Engineer, except that if, because of an emergency, such as breakdown of the mixing plant or the occurrence of adverse

environmental conditions, concreting has to be interrupted, a construction joint shall be formed at the place of stoppage and in the manner which will least impair the durability, appearance, and proper functioning of the concrete. If directed by the Engineer, additional reinforcing steel dowels shall be placed across the emergency construction joint and the additional steel shall be furnished and placed at the Contractor's expense.

Unless otherwise shown on the drawings, the exact position of horizontal construction joints shall be marked on the formwork. The external face, for the specified cover depth, of fresh concrete at horizontal construction joints shall be wood floated sufficiently to thoroughly compact the surface and to form a neat regular straight line for aesthetic reasons. The remaining surface of the horizontal construction joint can be rough floated to thoroughly compact the surface prior to preparing the surfaces for structural bond.

Stub columns, stub walls, kickers and stays on footings shall be cast integrally with the footings and not afterwards, even where another class of concrete is being used. This concrete shall be well-compacted and no roughening of the cast surface by rakes or similar devices that disturb the surface while in the fresh phase shall be permitted.

(ii) Preparing the surfaces

When the concrete has set and while it is still green, the surface film and all loose material shall be removed, without disturbing the aggregate, by means of a water jet assisted by light brushing to expose the aggregate and leave a sound, irregular surface. Where this is not possible, the surface film shall be removed after the concrete has hardened, by mechanical means appropriate to the degree of hardness of the concrete so as to expose the aggregate and leave a sound, irregular surface. Controlled sand blasting or careful scabbling using light chipping hammers are favourable mechanical techniques. The Contractor shall where sand blasting and or scabbling techniques are used, prepare a trial section for approval to make sure the concrete joint is correctly formed. The Contractor shall ensure that the green concrete is not damaged or disturbed during the preparation of the joint and that any water proofing systems, for example waterstops, are not damaged. The resultant prepared concrete surfaces shall be entirely free of cracks, spalling, damage, laitance, loose debris, concrete slush and any other form of contamination.

Acid etching techniques shall not be permitted as this may damage the bond line and compromise water tightness of the structure. Surface retarding agents may be used only with the approval of the Engineer.

The roughened concrete surface shall be washed with clean water to remove all laitance, dirt and loose particles.

All exposed reinforcement shall be free from loose debris, concrete slush or any form of contamination that may affect its future bond to concrete.

(iii) Placing fresh concrete at construction joints

Where fresh concrete is placed the same day as that on which the construction joint was formed, the fresh concrete shall be cast directly against the face of the construction joint.

When concreting recommences a day or more after the construction joint has been formed, the following procedure shall be followed:

1. The construction joint shall be kept constantly wet for a period of at least 4 hours before concreting restarts, but, the surface of the concrete shall be in a saturated, surface- dry condition when concreting has to recommence;
2. Any dirt, excess water and loose particles shall be removed prior to reconcreting being started;
3. For horizontal construction joints a 150 to 250 mm thick concrete layer of the same grade of concrete made richer by reducing the coarse aggregate content by 25 % shall be placed on the joint plane immediately before normal concreting;
4. For vertical construction joints the fresh concrete shall be placed against a surface prepared in accordance with Clause A13.4.7.11g)(ii), and which is in a saturated, surface-dry; and
5. Where pumped concrete is utilised, the priming slush shall not be permitted to enter into any formwork or structural element to be cast.

Epoxy resins shall not be used to bond fresh concrete to hardened concrete. For specialist construction methods, for example precast segmental construction, the particular epoxy adhesive requirements shall be specified on the drawings.

(iv) Waterstops

Where required for water-tight structures or structural elements, waterstops for construction joints shall be as detailed on the drawings.

Waterstops shall be of plasticised virgin, non-biodegradable polyvinyl chloride (PVC) material and sealing systems shall be of modified, flexible Polyolefin material, of the type and details as specified on the drawings:

1. Flexible PVC waterstops shall comply with the requirements of CKS 389;
2. Modified, flexible Polyolefin sealing system shall have a minimum tape thickness of 2,0 mm and shall have resistance to diesel and petrol fuels and oils; or
3. Special Engineered waterstops shall be specified on the drawings.

Each piece of premoulded waterstop or sealing system shall be of maximum practical length in order to keep the number of end joints to a minimum. All joints in waterstops and sealing systems shall develop effective watertightness fully equal to that of the continuous waterstop material, shall permanently develop at least 50 % of the mechanical strength of the parent section, and shall permanently retain their flexibility. Precautions shall be taken so that the waterstops and sealing systems shall be neither displaced nor damaged by construction operations or other means. All surfaces of the waterstops shall be kept free from oil, grease, dried mortar, or any other foreign matter while the waterstop is being embedded in concrete. The Contractor shall ensure that all portions of the waterstop designed for embedment shall be tightly enclosed by dense concrete, particularly on the underside of horizontal waterstops.

h) Curing and surface protection

The protection of concrete before and during concrete placement, and hardened concrete susceptible to adverse environmental conditions is described in Clause A13.4.7.10. All classes of hardened concrete shall be cured so as to prevent loss of water and to achieve specified levels of curing efficiency. Curing shall commence immediately after the bleed water has left the surface and finishing operations are completed.

Where the surface of the concrete begins to dry before the selected curing method can be applied, the surface of the concrete shall be kept moist by a fine mist spray applied so as not to damage the surface.

When deemed necessary by the Engineer during periods of hot weather, water shall be continuously applied to concrete surfaces being cured by retaining formwork or by curing compound, until the Engineer determines that a cooling effect is no longer required or the end of the prescribed curing period has been reached.

Formwork shall be retained in position for the appropriate times given in Clause A13.2.7.3, and as soon as may be practicable, all exposed concrete surfaces shall be protected from loss of moisture by one or more of the following methods:

(i) Retaining formwork in place for the full curing period;
(ii) Ponding the exposed surfaces with water, except where atmospheric temperatures are low, i.e. less than 5°C;
(iii) Covering it with clean, non-marking sand or absorbent mats made from a moisture-retaining material, and keeping the covering constantly wet;
(iv) Constantly spraying the entire area of the exposed surfaces with water;
(v) Covering with a waterproof or plastic sheeting firmly anchored and sealed at the edges and joints immediately after wetting the surface;
(vi) Using an approved curing compound applied in accordance with the manufacturer's instructions, except that, where the surface has to be subsequently waterproofed, coated or covered with concrete, mortar or sprayed concrete, this method may not be used; or
(vii) Steam curing the concrete (precast units), using saturated steam with maximum temperature of 60°C and covering all exposed areas to prevent early drying.

The method of curing adopted shall be subject to the Engineer's approval and shall not cause staining, contamination, or marring of the surface of the concrete. Due care shall be exercised to ensure adherence to the recommended limits for thermal gradients in concrete.

The curing period, represented as either a prescribed minimum strength or curing efficiency, shall be stated on the drawings. Curing efficiency shall be measured in accordance with the water sorptivity test (refer Clause A13.4.7.9e)). The minimum curing efficiency required shall be the water sorptivity value determined from trial panels during the mix approval process as adjusted by the permissible deviation. When no such minimum strength or curing efficiency data is prescribed, the minimum curing period shall be as shown in Table A13.4.7-18.

Table A13.4.7-18: Minimum duration of curing

Minimum daily surface concrete temperature[3], t, in °C	**Minimum curing period[1], in days**			
	Rate of concrete compressive strength development[2], r = (Fcu at 3 days / Fcu at 28 days)			
	$r \geq 0{,}55$	$r \geq 0{,}50$	$r \geq 0{,}45$	$r \geq 0{,}25$
$t \geq 25$	5	7	10	15
$25 > t \geq 15$	6	8	11	16
$15 > t \geq 5$	7	10	15	21

Note: 1) Based on 70% of 28 day compressive cube or cylinder strength.

2) The rate of concrete compressive strength development is the ratio of the mean compressive strength after 3 days to the mean compressive strength after 28 days determined from initial tests or based on known performance of concrete from site records.
3) Where the ambient relative humidity is below 85 % this value may be increased as directed by the Engineer.

Typically extend curing period by 0,5 days (12 hours) for every 5 %, or part thereof, reduction in ambient relative humidity. When the ambient surface temperature of concrete falls below 5°C, the minimum curing periods shown in Table A13.4.7-18 shall be extended by the period during which the temperature of the concrete was below 5°C.

The concrete shall be protected by means of a fog spray to keep it wet constantly for the periods stated above or until a curing compound is applied. Wetting the concrete by spraying shall be by means of a fixed spraybar along the full length of the formwork. The spraybar shall be connected to a suitable high-pressure water supply. Wetting shall be discontinued when the ambient air temperature drops below 5°C, and care shall be taken by the Contractor to ensure that the water will not erode the surface of the fresh concrete.

When sliding formwork is used, the concrete shall be protected against the weather and rapid drying out by means of a 4,0 m wide skirt attached to the tail of the formwork and if vertical, below the lowest working walkway, both internal and external. The skirt shall consist of two layers of hessian in summer months but of one layer of canvas or other suitable material in winter. The skirt shall be weighted at the end to prevent it flapping around in windy conditions.

i) Pipes, ferrules and conduits

No pipes and conduits other than those shown on the drawings shall be embedded in the concrete without the Engineer's approval. Pipes and conduits shall be embedded in the structural element simultaneously with the casting of the element. The clear space between such pipes or between such pipes and any reinforcing steel shall be at least 30 mm or the maximum size of the aggregate plus 10 mm, whichever is the greater. The thickness of the concrete cover over pipes and fittings shall be specified on the drawings but shall be at least 40 mm.

The ends of ferrules used for bracing formwork shall be neatly finished off to the details shown on the drawings. Where no details are given on the drawings, ferrules shall be cut back to a depth of at least the specified cover, and the holes shall be filled in with mortar and finished off flush with the concrete surface.

j) Applied loading

(i) General

No load shall be applied to any part of a structure until the specified curing period has expired, the concrete has attained sufficient strength and, when applicable, sufficient prestressing has been completed, so that damage will not occur. The decision to permit applied loading to the structure shall rest with the Engineer. The Engineer's decision will be based on the type of load to be applied, the age of the concrete, the magnitude of stress induced and the propping of the structure.

(ii) Earth loads

Wherever possible the sequence of placing backfill around structures shall be such that overturning or sliding forces are minimised. When the placement of backfill will cause flexural stresses in the concrete, the placement shall not begin until the concrete has reached not less than 80 % of the characteristic strength or the curing period has expired, whichever is greater.

(iii) Construction loads

Light materials and equipment may be carried by hand onto deck elements only after the concrete has been in place at least 24 hours, providing curing is not interfered with and the concrete surface is not damaged. Loads in excess of the above, and those requiring mechanised handling and transport equipment, shall not be carried onto decks until the concrete has reached its specified characteristic 28 day strength. In addition these loads shall only be permitted once the prestressing has been satisfactorily completed and approved by the design Engineer and, where required, the deck propping system removed. At no stage shall bulk materials be stored on decks.

No loads from precast concrete or structural steel elements shall be placed on substructure elements until the concrete reaches the specified characteristic 28 day compressive strength.

Any layerworks constructed directly over structures shall be compacted only with static rollers. The Contractor shall ensure that vibratory settings on compacting equipment are not used within the specified minimum limit of the restricted fill and backfill, or where this is not indicated minimum 3,0 m from the structure.

(iv) Traffic loads

Traffic will not be permitted on concrete decks until all parts of the structure have attained the specified nominal 28 day concrete strength, at least 14 days after the last placement of deck concrete, completion and approval is issued by the Engineer of the post-tensioning, curing period and the minimum period for the removal of falsework and formwork.

k) Precast concrete

(i) Manufacturing

This Clause applies to all reinforced and prestressed concrete members other than precast concrete piles and pipes in so far as they are dealt with separately elsewhere in these specifications.

All precast members shall be manufactured in accordance with the requirements specified for cast in situ members in so far as these requirements are relevant, in addition to which the following shall apply:

1. The Contractor shall take all necessary safety and precautionary measures during the handling and erection of precast members and for ensuring the stability of members as positioned and prior to their being cast in or erected;
2. Where precast concrete members have been manufactured off site not under the direct control of the Engineer, the manufacturer shall keep and make available to the Engineer complete records of all the concrete mixes, strength-, durability- and cover-tests pertaining to the members cast. The Contractor shall notify the Engineer in advance of the dates on which members are to be cast to make arrangements for inspecting and testing the precast members;
3. For the purposes of identification, all members shall be marked with paint in neat lettering with the member number shown on the drawings or as agreed on and an identification number relating to the manufacturing records. Letters and markings shall be so positioned as not to be visible when the structural member is placed in its final position in the completed structure; and
4. All precast members which have been chipped, cracked, warped or otherwise damaged to the extent that such damage will, in the opinion of the Engineer, prejudice the appearance, durability, function or structural integrity of the members shall be rejected or, where so allowed, repaired to the satisfaction of the Engineer.

Where specified on the drawings and where instructed by the Engineer, the surfaces intended for structural bond shall be prepared and treated in accordance with Clause A13.4.7.12g)(ii) to ensure adequate composite action.

All precast members shall be cured as specified in Clause A13.4.7.12h).

(ii) Safety considerations

Construction activities that utilise precast concrete elements are generally known to be potentially hazardous operations and each operation will require particular precautionary measures taken by the Contractor to ensure compliance with the Occupational Health and Safety Act and applicable Construction Regulations, in addition to the limited safety considerations as addressed below.

1. Storage and stacking

   Precast elements shall be stored on suitably graded, engineered platforms with a typical bearing capacity of 500 kPa or as shown on the drawings. The graded platform shall ensure that the precast items are stable and structurally restrained against lateral- or torsional- instability during storage. The stacking of precast elements shall only be subject to the approval of a method statement by the Engineer. No torsional or flexural stresses shall be induced during storage and stacking that may crack or reduce the structural- and durability-performance of the precast element.

2. Temporary supports

   During storage and transportation operations, temporary supports shall be provided for precast elements. Temporary support shall consist of rubber mats or engineered bearings that provided adequate rotation capacity for the precast element. The position of temporary supports shall be minimum the design distance as indicated on the drawings from the edge of the member but a never a greater distance from the outside edge that results in a 98% of the design span length. The full width of the precast element shall be provided with temporary support.

3. Transportation

   The transportation method shall take account of the structural capacity of the precast element. No torsional or flexural stresses shall be induced during transportation that may crack or reduce the structural- and durability-performance of the precast element.

4. Placing and erection

Whenever precast elements are hoisted into place, the precast unit shall be stabilised, secured, inspected by the Contractor's competent person, approved and signed off as stable prior to the removal of lifting slings and equipment. Mobile cranes shall not be permitted to take up positions on existing bridge decks when lifting and placing precast beams or other precast elements.

l) Partial demolition and removal of existing structural concrete

(i) General

All plant, equipment, tools and devices used for the demolition of concrete members shall be based on proven and accepted technology within the industry. The plant, equipment, tools and accessories shall be inspected and maintained on a regular basis to ensure that they remain in good working order, function efficiently, and that safety is not compromised. All cutting and breaking tools shall be kept sharp to reduce the force required to break out concrete to a minimum.

The plant, equipment, tools and devices used for the demolition or removal process shall be of the accepted type and capacity for the relevant application. The suitability of the chosen method shall be demonstrated on a representative test section identified by the Engineer prior to the execution of any programmed work.

(ii) Demolition and removal of discrete concrete elements

The demolition of discrete structural elements shall employ techniques that do not damage adjacent structures or structural components, nor contaminate the surrounding environment.

The Contractor shall ensure that any nuisance associated with his work activity is minimised by implementing appropriate precautions and measures to the approval of the Engineer. Common nuisances associated with demolition and concrete removal include fumes, noise, dust, flying fragments, heat and vibration.

Concrete members that are to be demolished completely and removed, shall be broken up into suitably sized fragments to allow easy removal from site to an approved construction waste facility.

Recommended demolition techniques include the use of percussion breakers, chisels or other approved mechanical equipment, the use of thermal or hydraulic cutting techniques or by non-explosive chemical means, to ensure minimal damage, for example micro-cracking, to the existing concrete. Water jet removal of concrete is preferred wherever possible. Demolition by explosive means shall generally not be permitted.

(iii) Removal of concrete from structural elements

1. Cutting back concrete to a new finished surface

The concrete and reinforcement shall be cut back adequately to provide the prescribed concrete cover to the new finished surface as specified on the drawings or as directed by the Engineer. The technique used shall be suited to its intended purpose and shall not cause damage to the remaining concrete member.

Only techniques that do not damage the inherent structure, bond or strength of the remaining sound concrete shall be used. The thermal cutting technique shall not be used closer than 100 mm from the final surface as indicated on the drawings. The remaining concrete shall be removed using approved mechanical equipment or hydraulic techniques.

The fixed exposed contact surface shall be bounded by straight line edges cut at least 20 mm depth using a diamond cutting saw, angle grinder or other approved concrete cutting equipment.

2. Cutting back concrete to expose reinforcement

Where a concrete member has to be joined or extended or replaced by new concrete, the concrete shall be carefully cut or broken from the reinforcement bars to expose the bars to the dimensions and outline as shown on the drawings or as directed by the Engineer. Precautionary care shall be taken not to damage or reduce the strength of the exposed bars or concrete member thereby making them unfit for use. Where reinforcing or concrete is damaged, these shall be made good at the Contractor's expense. The remaining concrete contact surface shall be cut to a plane and even surface with exposed faces perpendicular to the horizontal face or side faces as applicable.

The bounding lines of the cut concrete shall be straight and neat cut to at least 20 mm deep using a diamond cutting saw, angle grinder or other approved concrete cutting equipment.

A13.4.8 WORKMANSHIP

A13.4.8.1 Tolerances

The tolerance shall be the maximum permissible deviations from the specified dimensions, properties, levels, alignment, positions, etc. shown on the drawings of the structures or structural members or described in Sections A13.1 to A13.7 after completion of concrete construction. In addition, the following tolerances and maximum permissible deviations are given below:

a) Concrete quality

(i) Compressive strength

1. Individual valid compressive strength test result:

Minus tolerance ..... 3 MPa less than specified characteristic compressive strength at 28 days.

Plus tolerance ..... unlimited

2. Arithmetic mean of any group of 3 to 29 successive valid compressive strength test results:

Minus tolerance ..... Tolerance value as stated in Table A13.4.8-1 greater than specified characteristic

compressive strength at 28 days.

Plus tolerance..... unlimited

Table A13.4.8-1: Allowable minimum tolerance for mean compressive strength tests

Minimum number of valid compressive strength tests	Tolerance (minimum)
3	+2,0 MPa
4	+3,0 MPa
5	+4,5 MPa
6	+5,0 MPa
10	+6,0 MPa
20	+7,0 MPa

(ii) Oxygen permeability

Minus tolerance (B_{ave}) for the arithmetic mean of 4 samples:

0,25 (log scale) less than specified nominal oxygen permeability at 28 days.

Plus tolerance unlimited

Assessment shall be in accordance with Clause A20.1.7.5 (Plan A) of Chapter 20.

The correlation coefficient (r^2) of the linear regression line for each sample shall be minimum 0,990.

(iii) Chloride conductivity

Plus tolerance (B_{ave}) for the arithmetic mean of 4 samples

0,20 mS/cm more than specified nominal chloride conductivity at 28 days.

Minus tolerance unlimited

Assessment shall be in accordance with Clause A20.1.7.5 (Plan A) of Chapter 20.

The porosity of samples determined in the chloride conductivity test shall be minimum 6 % for normal density concrete, or 3 % where chloride conductivity less than 0,40 mS/cm is recorded.

(iv) Water sorptivity and curing efficiency

Plus tolerance (B_{ave}) for the arithmetic mean of 4 samples

1,5 mm/(hour^{0,5}) more than the approved nominal water sorptivity at 28 days.

Minus tolerance unlimited

Assessment shall be in accordance with Clause A20.1.7.5 (Plan A) of Chapter 20.

The porosity of samples determined in the water sorptivity test in order to assess curing efficiency test shall be minimum 6 % for normal density concrete.

(v) Cover over reinforcing

(1) For visual inspection prior to casting of concrete, the tolerances shall be as given below.

(1.1) Minimum cover for formed surfaces and unformed finished surfaces:

- All elements..... -0 mm

(1.2) Maximum cover for formed surfaces and unformed finished surfaces to:

- Elements less than 500 mm thick .....+10 mm
- Elements greater than or equal to 500 mm thick.....+15 mm
- Elements cast against ground.....+25 mm

(2) For post-casting verification of cover, the tolerances shall be as given below.

(2.1) The mean cover determined per cover survey shall exceed the specified cover minus C_{max}, as specified or as shown in Table 13.4.8-2.

(2.2) The lot shall comply with the requirements specified for concrete cover if the mean cover for the lot is not less than the specified cover minus the C_{ave} tolerance specified in each case or as shown in Table A13.4.8-2.

Table A13.4.8-2: Values for assessment of cover

Specified cover (mm)	C_{max} (mm)	C_{ave} (mm)
75	15	5
60	12	5
50	10	5
40	8	5
35	7	5
30	6	5

A13.4.8.2 Criteria for compliance with the requirements

Routine inspection and acceptance control will be done by the Engineer as specified in Clause A20.1.7 of Chapter 20 and as specified in the Contract Documentation. For the purposes of determining compressive strength, the characteristic cylinder strength shall be determined using 100 mm diameter, 200 mm high cylinders prepared in accordance with SANS 3001-CO2-2 and tested in accordance with SANS 3001-CO2-3 at a sample age of 28 days or 150 mm cube samples prepared in accordance with SANS 3001-CO2-2 and tested in accordance with SANS 3001-CO2-3. The tensile splitting strength of hardened concrete shall be determined in accordance with SANS 3001-CO2-6. The flexural strength shall be determined from beam specimens prepared and tested at 28 days in accordance with SANS 3001-CO2-5.

The criteria for compliance with the requirements specified for 28-day characteristic compressive strength shall be as specified in Clause A20.1.7.5 of Chapter 20 for full acceptance and as specified in Clause A20.1.7.6 of Chapter 20 for conditional acceptance. For durability class concrete, compliance with the requirements specified for 28-day concrete durability index testing shall be as specified in Clause A20.1.7.5 of Chapter 20. For all reinforced, prestresssed and precast concrete, compliance with the requirements specified for post-casting cover depth verification shall be as specified in Clause A20.1.7.5 of Chapter 20. The resubmission of concrete lots on the basis of cores for full or conditional acceptance shall not be allowed, unless it forms part of the procedures as contemplated in Clause A13.4.8.3. If the Engineer is satisfied that the requirements of the Contractor's process control have been met, the Engineer may decide at his discretion to use the Contractor's test results in the evaluation of the concrete.

A13.4.8.3 Procedure in the event of non-compliance with the requirements

Any lot represented by test cylinders, cubes or flexural beams failing to comply with the criteria as specified in Chapter 20 for the characteristic strength shall be rejected. Any lot represented by concrete durability index testing and or cover depth verification failing to comply with the criteria specified above for minimum values shall be rejected.

The Engineer may at his discretion allow the following tests to be conducted in order to decide whether the concrete may be left in position at further reduced payment:

(i) The Engineer may allow the elements or units concerned to be cured for an additional period not exceeding 56 days. Thereafter the Contractor shall drill cores for compressive strength in accordance with SANS 3001-CO2-3, and the Engineer will evaluate these cores in accordance with SANS 10100-2. For durability concrete, the Contractor may drill cores for concrete durability index testing in accordance with SANS 3001-CO3-1 and tested for the relevant concrete durability index; or

(ii) Where the Engineer so directs, full-scale load tests shall be conducted in accordance with SANS 10100-2 to determine whether any particular structure or member can be left in position at further reduced payment as decided by the Engineer. The cost of such tests shall be for the Contractor's account regardless of the outcome of the tests. In all cases where concrete has been supplied which fails to comply with the strength or durability requirements, the Contractor shall immediately take the required remedial action by changing the mix proportions to obtain the required strength and durability properties.

A13.4.8.4 Tests ordered by the Engineer

Where the routine testing of concrete compressive strength samples, tensile splitting samples, flexural strength beams, energy absorption slabs and concrete durability test panels is not conducted on the site by the Engineer, he may order the Contractor to have the compressive strength samples, tensile splitting samples, flexural beams, energy absorption slabs and durability test panels, which have been made by the Engineer, tested at an approved testing laboratory, in which case payment will be made for such tests in accordance with the provisions of Clause A20.1.3.6 of Chapter 20.

B13.4 CONCRETE
PART B: LABOUR ENHANCEMENT

CONTENTS

B13.4.1 SCOPE

B13.4.2 DEFINITIONS

B13.4.3 GENERAL

B13.4.4 DESIGN BY CONTRACTOR / PERFORMANCE BASED SYSTEMS

B13.4.5 MATERIALS

B13.4.6 CONSTRUCTION EQUIPMENT

B13.4.7 EXECUTION OF THE WORKS

B13.4.8 WORKMANSHIP

B13.4.1 SCOPE

This Section covers the labour enhanced work in minor bridges, culverts and miscellaneous structures.

This Section covers the supply and storage or stockpile of all materials, manufacture, transport, placing, finishing, curing, protection and testing concrete in bridges, culverts and miscellaneous structures. The completed concrete elements shall conform to the lines, grades, and dimensions shown on the drawings and as specified in Section A13.2. The work includes elements of structures constructed by cast-in-place and precast methods using either plain (unreinforced), reinforced, or prestressed concrete or any combination thereof. This work is appropriately suited for labour enhanced construction activities.

B13.4.2 DEFINITIONS

The provisions of Part A shall apply.

B13.4.3 GENERAL

The provisions of Part A shall apply.

B13.4.4 DESIGN BY CONTRACTOR / PERFORMANCE BASED SYSTEMS

The provisions of Part A shall apply.

B13.4.5 MATERIALS

The provisions of Part A shall apply.

B13.4.6 CONSTRUCTION EQUIPMENT

The provisions of Part A shall apply.

B13.4.7 EXECUTION OF WORKS

The provisions of Part A shall apply with the following amendments:
Item C13.4.7.6, reference to Durable (Class D) concrete is not suitable for labour enhanced work

B13.4.7.1 Placing and compaction

Clause A13.4.7.11 provisions shall apply with the following amendment:
Clauses A13.4.7.11c) and e) are not be to be undertaken using labour enhanced construction methods.

B13.4.8 WORKMANSHIP

The provisions of Part A shall apply.

C13.4 CONCRETE

PART C: MEASUREMENT AND PAYMENT

(i) Preamble

The tendered rate for each item shall include full compensation for providing, maintaining and decommissioning upon completion, of all the plant, equipment, labour, tools, incidentals and supervision to carry out the activity or construct the works in the item, unless otherwise stated.

Any prime cost or provisional sums shall be paid in accordance with the provisions of the conditions of contract. The charge or mark-up tendered or allowed for is a percentage of the amount actually paid under the prime cost or provisional sum. This percentage shall cover all the Contractor's handling, supervision, profit and liability costs to provide the services in the prime cost or provisional sum item.

The requirements of Section C1.1 of Chapter 1 shall apply.

Where pay item descriptions include any wording in brackets it is an indication that contract specific information is to be inserted in the Pricing Schedule included in the Contract Documentation.

(ii) Notes on measurement and pay items

None.

(iii) Items that will not be measured separately

The following activities, whether required to complete the specified work or not, will not be measured and paid for separately and the Contractor shall include the cost thereof in other pay items as he deems appropriate:

1. No separate payment will be made for setting out the works.
2. No separate payment will be made for the protection or repair as required of any existing or new road furniture, structures, buildings, infrastructure or services damaged by the Contractor's activities.
3. No additional payment shall be made, nor shall any claim for additional payment be considered, for any specified work in confined or restricted areas. Any additional costs associated with working in confined or restricted areas shall be deemed to be included in the standard applicable pay items.
4. No separate payment will be made for the loading of any materials.
5. No separate payment will be made for the hauling of demolished concrete where the material is moved over a distance of less than, and up to 1,0 km and for labour enhanced construction, less than and up to 50 m.
6. No separate payment will be made for transporting materials from commercial sources irrespective of the haul distance.
7. No separate payment will be made for the removal or any surplus material imported to complete the works.
8. For all Works performed, precautionary measures required in terms of the Occupational Health and Safety Act (Act 85 of 1993) and the latest amendments thereof as well as the latest Construction Regulations shall be deemed included in the rates tendered for the relevant products.

(iv) Items to be measured and paid for using items specified elsewhere in the specifications

For activities in Table C13.4-1 pay items specified in other Chapters or Sections of the specifications, where they relate to work under this Section, will be listed in the Pricing Schedule.

Table C13.4-1: Payment items from other Chapters or Sections

Activity	Section 13.4 reference	Section item reference
Tests ordered by the Engineer	A13.4.8.4	C20.1.2 of Chapter 20 – All applicable items

(v) Items specifically for this Section of the specifications

Item		Description	Unit
C13.4.1		**Cast in situ concrete (Class of concrete and use or position in structure stated):**	
	C13.4.1.1	Strength concrete (class C):	
	(a)	Indicate part of structure, class code and 28 day characteristic cylinder strength/characteristic compressive cube strength and nominal aggregate size e.g. Blinding C12/15-20	cubic metre (m^3)
	(b)	Etc. For other parts of structure	cubic metre (m^3)
	C13.4.1.2	Durable concrete (class D):	
	(a)	Indicate part of structure, class code and 28 day characteristic cylinder strength/characteristic compressive cube strength, environmental exposure and service life and nominal aggregate size e.g. Deck slab D35/45-XS1(100)-20	cubic metre (m^3)
	(b)	Etc. For other parts of structure	cubic metre (m^3)

C13.4.1.3	Prescribed-composition concrete (class P):	
(a)	Indicate part of structure, class code and 28 day characteristic cylinder strength/characteristic compressive cube strength and nominal aggregate size e.g. Piers P32/40-20	cubic metre (m^3)
(b)	Etc. for other parts of structure	cubic metre (m^3)

Item	Description	Unit
C13.4.2	**Labour enhanced cast in situ concrete (class of concrete and use or position in structure stated)**	
C13.4.2.1	Commercially- Sourced concrete	cubic metre (m^3)
C13.4.2.2	Contractor-mixed concrete on site	cubic metre (m^3)

The unit of measurement for cast in situ concrete shall be the cubic metre of concrete in place. Quantities shall be calculated from the dimensions shown on the drawings or as authorised by the Engineer. No deduction in volume measured for payment shall be made for the volume of any reinforcing steel, inserts and pipes or conduits up to 150 mm in diameter embedded in the concrete, except for the volume of void formers, which shall be deducted.

The tendered rate shall include full compensation for procuring and furnishing all the materials, storing the materials, providing all plant, mixing, transporting, placing and compacting the concrete, forming the inserts, construction joints (except mandatory construction joints and contraction joints as measured), preparing the surfaces for structural bonding, repairing defective surfaces, and finishing the concrete surfaces as specified. Payment shall distinguish between the different classes and particular requirements of concrete.

The tendered rate for labour enhanced concrete shall include full compensation for the mix design, the supply of all materials, the production of the concrete, its transportation to the work site within the haul distance and all activities needed for placing, levelling, compacting, finishing, curing and protecting the concrete and the repair of defective surfaces

Note: ready-mix concrete shall be delivered to the work face by mixer-truck. Contractor-mixed concrete shall be transported to the work face by wheelbarrow up to the haul distance of 50 m. When the haulage exceeds 50 m, the concrete shall be transported by dumper for the full distance, paid as haul.

Item	Description	Unit
C13.4.3	**Extra over item C13.4.1 for the protection of concrete from adverse environmental conditions, if required:**	
C13.4.3.1	Strength concrete (class C):	
(a)	Indicate part of structure, class code and 28 day characteristic cylinder strength/characteristic compressive cube strength and nominal aggregate size e.g. Blinding C12/15-20	cubic metre (m^3)
(b)	Etc for other parts of structure	cubic metre (m^3)
C13.4.3.2	Durable concrete (class D):	
(a)	Indicate part of structure, class code and 28 day characteristic cylinder strength/characteristic compressive cube strength, environmental exposure and service life and nominal aggregate size e.g. Deck slab D35/45-XS1(100)-20	cubic metre (m^3)
(b)	Etc for other parts of structure	cubic metre (m^3)
C13.4.3.3	Prescribed-composition concrete (class P):	
(a)	Indicate part of structure, class code and 28 day characteristic cylinder strength/characteristic compressive cube strength and nominal aggregate size e.g. Piers P32/40-20	cubic metre (m^3)
(b)	Etc for other parts of structure	cubic metre (m^3)

Item	Description	Unit
C13.4.4	**Extra over item C13.4.2 for the protection of labour enhanced concrete from adverse environmental conditions**	
C13.4.4.1	(Class of concrete and use or position in structure stated)**:**	cubic metre (m^3)

The unit of measurement shall be the cubic metre of concrete placed in situ where any combination of means described in Clause A13.4.7.11 has been satisfactorily implemented in order to control the temperature of concrete within the specified limits and to adequately mitigate against adverse environmental conditions.

The tendered rate shall include full compensation for the design, supply, procurement and implementation of the required means of protection and environmental mitigation and applying it prior to casting and to the fresh concrete surface using approved method until the commencement of the curing period.

Partial payment shall be applied in the event that the Engineer allows conditional acceptance.

Item	Description	Unit
C13.4.5	**Curing and surface protection of cast in situ concrete, as and where specifically required:**	
C13.4.5.1	Indicate structural element and surface to be cured (Tenderer to specify method of curing):	square metre (m^2)
C13.4.5.2	Etc for other parts of structure (Tenderer to specify method of curing)	square metre (m^2))

Item	Description	Unit
C13.4.6	**Curing and surface protection of labour enhanced cast in situ concrete**	
C13.4.6.1	Structural element and surface to be stated (Tenderer to specify method of curing)	square metre (m^2)

The unit of measurement shall be the square metre of completed concrete element cured using an approved method as described in Clause A13.4.7.12 of these specifications, if and where specifically required on the drawings or as ordered by the Engineer.

The tendered rate shall include full compensation for providing the curing means and applying it to the fresh concrete surface using approved method(s) and, where applicable, in accordance with the product manufacturer's specified nominal rates of application satisfying ASTM C309 as amended in Clause A13.4.5.8.

Should no curing method be specified at the time of tender then it will be assumed that wet fine mist spraying curing is to be done. Where specified, curing shall be assessed by the sorptivity test. Partial payment shall be applied in the event that the Engineer allows conditional acceptance.

Item	Description	Unit
C13.4.7	**No-fines concrete (class NF):**	
C13.4.7.1	Cast in situ:	
(a)	Indicate class of no-fines concrete and portion of structure or use	cubic metre (m^3)
(b)	Etc for other classes of no-fines concrete and other portions of structures or uses	cubic metre (m^3)
C13.4.7.2	Precast:	
(a)	Indicate class of no-fines concrete and describe unit with reference to drawing:	number (No)
(b)	Etc for other classes of no-fines concrete and units of other types and sizes	number (No)

The unit of measurement shall be the number of complete units of each size and type in position in the works.

The tendered rate for each precast unit shall include full compensation for providing all materials, labour, plant and formwork required for the manufacturing of the unit, complete as shown on the drawings, and for curing, transporting, lifting and placing the unit in position.

Item	Description	Unit
C13.4.8	**Labour enhanced no fines concrete (Class NF)**	
C13.4.8.1	Cast in situ (class and portion of structure or use stated)	cubic metre (m^3)
C13.4.8.2	Precast	cubic metre (m^3)

The unit of measurement shall be the cubic metre of no-fines concrete in place. Quantities shall be calculated from the dimensions shown on the drawings or authorised by the Engineer.

The tendered rates shall include full compensation for procuring, furnishing and storing the materials, providing all plant, mixing, transporting, placing and working the concrete and for curing and protection of the surfaces described in Clause A13.4.7.11f) of the specification.

Item	Description	Unit
C13.4.9	**Manufacturing precast concrete members** (description of member with reference to drawing)	**number (No)**

Item	Description	Unit
C13.4.10	**Labour enhanced manufacture of precast concrete members** (Description of member with reference to drawing)	**number (No)**

The unit of measurement shall be the number of complete members or elements of each type and size in position in the works.

The tendered rate for each precast member shall include full compensation for all concrete work, protection from adverse environmental conditions, all formwork, curing and surface protection, safe guarding, and for all reinforcing steel and all the prestressing as required for manufacturing the member complete, excluding only prestressing in connection with in situ concrete cast subsequent to the placing of the precast members, for which prestressing separate payment is provided elsewhere in the schedule of quantities. Where required, the surfaces shall be prepared for structural bonding with subsequent concrete to the satisfaction of the Engineer.

Item	Description	Unit
C13.4.11	**Transporting and erecting precast concrete members** (description of member and approximate mass to be given)	**number (No)**

Item	Description	Unit
C13.4.12	**Labour enhanced transporting and erecting precast concrete members (**Description of member and approximate mass to be given)	**number (No)**

The unit of measurement shall be the number of precast concrete members of each type and size placed into position

The tendered rate for each precast member shall include full compensation for all work, costs, access and equipment required for transporting, stacking, lifting, erecting and installing the precast concrete member in its final position, complete as specified.

Item	Description	Unit
C13.4.13	**Complete demolition and disposal of existing structural concrete elements or parts existing structures:**	
C13.4.13.1	(Member Indicated)	cubic metre (m^3)
C13.4.13.2	etc. for other members	cubic metre (m^3)

The unit of measurement shall be the cubic metre of plain or reinforced concrete demolished for each member scheduled separately in the schedule of quantities. The quantity shall be measured in its original position and shape.

The tendered rate shall include full compensation for all labour, plant and equipment required to demolish the existing concrete, process the demolished product to ensure acceptance by the approved construction waste facility, and disposal of the product of the demolition at the construction waste facility with unlimited haul distance. The tendered rate shall also include full compensation for any necessary measures to ensure no debris falls into rivers and for any debris that has fallen into rivers to be recovered.

Item	Description	Unit
C13.4.14	**Controlled demolition of concrete from structural elements:**	
C13.4.14.1	(Member Indicated)	cubic metre (m^3)
C13.4.14.2	etc. for other members	cubic metre (m^3)

The unit of measurement shall be the cubic metre of plain or reinforced concrete removed under controlled conditions for each member or portion thereof scheduled separately in the schedule of quantities. The quantity shall be measured in its original position and shape and the modification required as shown on the drawings or approved by the Engineer.

The tendered rate shall include full compensation for all labour, material, screening of the structure for safety and environment protective measures, plant and equipment as well as for all work and incidentals required to partially demolish the concrete member. The tendered rate shall also include the processing of the demolished product to ensure acceptance by the approved construction waste facility, loading, lifting, transport and the disposal of the construction waste at the construction waste facility within a haul distance of 10 km. The tendered rate shall also include full compensation for any necessary measures to ensure no debris falls into rivers and for any debris that has fallen into rivers to be recovered.

D13.4 CONCRETE
PART D: GUARANTEES AND COMPLIANCE CERTIFICATES

CONTENTS

D13.4.1 SCOPE

D13.4.2 GENERAL

D13.4.3 PERFORMANCE GUARANTEE REQUIREMENTS

D13.4.4 FUNCTIONAL PERFORMANCE ASSESSMENTS

D13.4.5 VISUALLY ASSESSED PROPERTIES

D13.4.6 INSTRUMENTALLY ASSESSED PROPERTIES

D13.4.7 EVALUATION FOR ACCEPTANCE

D13.4.8 ADDITIONAL PROCEDURES TO BE ADOPTED IN THE EVENT OF FAILURE

D13.4.9 NOTIFICATION OF REMEDIAL WORK

D13.4.10 REMEDIAL WORK

D13.4.1 SCOPE

The scope of this Section covers the following:

- Product conformance specifications
- Performance specifications

D13.4.2 GENERAL

D13.4.2.1 Product Conformance Specifications

The Contractor shall within 28 days of entering into the contract with the Employer submit to the Engineer conformance documentation related to the specifications. All products used in the manufacture of concrete element shall be in compliance with the specifications continued in Section A13.4.

Compliance documentation shall be provided for the following;

a) Cement (Clause A13.4.5.1)
b) Supplementary cementitious materials (Clause A13.4.5.1)
c) Aggregates (Clause A13.4.5.2)
d) Water (Clause A13.4.5.3)
e) Admixtures (Clause A13.4.5.4)
f) Integral permeability reducing technology (Clause A13.4.5.5)
g) Fibres (Clause A13.4.5.6)
h) Pigments and integral colouring agents (Clause A13.4.5.7)
i) Curing compounds (Clause A13.4.5.8)
j) Commercially-sourced concrete (Clause A13.4.6.2)
k) Testing necessary to prove the satisfactory execution of the works (Clause A13.4.7)

D13.4.3 PERFORMANCE GUARANTEE REQUIREMENTS

D13.4.3.1 Performance specifications

Performance based specifications shall be contained in the Contract Documentation for the project.

13.5 PRESTRESSING

CONTENTS

PART A: SPECIFICATIONS

A13.5.1 SCOPE

A13.5.2 DEFINITIONS

A13.5.3 GENERAL

A13.5.4 DESIGN BY CONTRACTOR / PERFORMANCE BASED SYSTEMS

A13.5.5 MATERIALS

A13.5.6 CONSTRUCTION EQUIPMENT

A13.5.7 EXECUTION OF THE WORKS

A13.5.8 WORKMANSHIP

PART B: LABOUR ENHANCEMENT

PART C: MEASUREMENT AND PAYMENT

PART D: GUARANTEES AND COMPLIANCE CERTIFICATES

A13.5 PRESTRESSING

PART A: SPECIFICATIONS

A13.5.1 SCOPE

This Section covers the materials, equipment and work required for prestressing structural concrete members.

A13.5.2 DEFINITIONS

The following definitions shall apply to these specifications:

Anchorage - is the device comprising all the components and materials required for retaining the force in a tensioned tendon and to transmit this force to the concrete of the structure.

Anchorage reinforcement - is the spiral and other reinforcement which forms part of the anchorage and is required for strengthening the anchorage and/or assisting in transmitting the tendon force to the concrete.

Bursting reinforcement - is the reinforcing steel required in and adjacent to the anchorage zones to resist the tensile or splitting stresses induced in the concrete by the anchorage(s).

Cable - is the tendon, together with the anchorage, sheathing and all fittings.

Characteristic strength - characteristic strength of prestressing steel is the manufacturer's guaranteed tensile strength below which no more than 5 % of the test results in a statistical population shall fall.

Duct - is the void formed in the structural element to house the tendon(s) and may be formed by coring, or by using sheaths or by way of extractable cores.

Prestress - is the stress induced in concrete by tensioned tendons.

Prestressed concrete - is structural concrete in which effective internal stresses are induced by means of tensioned tendons.

Pre-tensioned concrete - is prestressed concrete where the tendon has been tensioned before the concrete is cast.

Post-tensioned concrete - is prestressed concrete where the tendon is tensioned after the concrete has hardened.

Pull-in - is the elastic shortening of the tendon caused by relative movement between the anchorage or coupler components on account of seating and gripping action during or immediately after transfer.

Release - is the specified elastic shortening of the tendon at the anchorage achieved before or during transfer.

Sheath - is the tube or casing enclosing the tendon and which temporarily or permanently allows a relative movement between the tendon and the surrounding concrete.

Tendon - is the prestressing steel consisting of the bar, wire or strand individually placed, or of bars, wires or strands placed in a duct, all of which are tensioned to impart prestress to a concrete member.

Tensioning - is the action of inducing and regulating the force in a tendon by means of tensioning and measuring equipment.

Transfer:

- Transfer in the case of post-tensioned concrete is the action of transferring the tensioning force from the tensioning equipment (jack) to the anchorage.
- Transfer in the case of pre-tensioned concrete is the action of transferring the force in the tensioned tendon(s) to the concrete.

Bond breaker - is the coating or sheath placed on a tendon to prevent it from bonding to the surrounding concrete.

Coupler - is the device comprising all components required to join up two tendons.

Deflector - is the device used to deflect a tendon alignment within a structural element.

Transmission length - is the tendon length required to transmit via bond stresses the full force in the tendon to the concrete.

A13.5.3 GENERAL

A13.5.4 DESIGN BY CONTRACTOR / PERFORMANCE BASED SYSTEMS

A13.5.4.1 Method Statements

The method statements and typical drawings submitted by the Contractor with his tender submission, describing key facets such as method, key plant, materials, personnel and programme constraints of the envisaged construction process, shall form the basis for the detailed method statements required for the works to be executed on the project.

These method statements shall be prepared and submitted to the Engineer for approval for each facet of the work at the start of construction, within time scales specified. The onus lies with the Contractor to ensure that the information is gathered and associated activities are completed expeditiously so as to avoid any delays in the commencement, continuation and completion of the required works. Unless otherwise specified or provided for in the Contract Documentation no permanent works shall be commenced until the Engineer's approval has been obtained. Due allowance shall be made for obtaining alternative materials, resubmissions and redesigns, all to the required/approved standards, methods and practices in attending to these requirements. Particular attention shall be paid to the early submission of materials-, concrete- and grout mix designs where parameters at various ages may be specified. No consideration for extension of the contract period will be entertained for delays incurred in meeting these requirements.

Trials, if applicable, shall be conducted and based on outcomes thereof, may require that changes be made to the relevant method statements. Once approved in writing by the Engineer, these shall become the method statements in accordance whereby the relevant portion of the works shall henceforth be executed. Notwithstanding, the Engineer may require revision from time to time if circumstances during construction arise which warrants change.

The Contractor shall, however, remain responsible for all work-methods, materials, plant and equipment used, notwithstanding acceptance by the Engineer.

A13.5.4.2 Hold points and approvals

The Contractor shall comply with the specified hold points relating to approvals required from the Engineer. A hold point is a stage of the work, where the Engineer's approval is required, before commencement or continuance of that particular activity by the Contractor, is permitted. Project specific requirements will be included in the Contract Documentation or agreed upon between the Engineer and the Contractor.

A13.5.4.3 Technical data

The following technical data for pre-tensioned and post-tensioned structural members required for the contract shall be furnished on the drawings. Where this information is not provided, the Contractor will request the information.

a) Tendon alignment

A diagram showing the alignment of each tendon or group of tendons in both the horizontal and vertical planes, together with the horizontal and vertical coordinates, and curve equations of the centroid of the tendon(s), as may be relevant.

b) Tendon system

The design is based on the system shown on the drawings, but the Contractor may use any suitable system which will meet all the specified requirements, subject to approval by the Engineer.

c) Tensioning the tendons

Full particulars regarding the partial tensioning of the tendons, the stage during which the tendons shall be tensioned, and the sequence of tensioning to be followed.

d) Tensioning force

The maximum tensioning force and the effective force at the live anchorages, after transfer, as well as the corresponding stress level in the prestressing steel, for each tendon or group of tendons. The forces will be given in MN units, and the stress levels will be expressed as a percentage of the characteristic strength.

e) Extension

The extension per tendon or group of tendons under the maximum tensioning force, together with the modulus of elasticity (E) on which it has been based. The release to be attained at each live anchorage as well as the pull-in for which provision has been made.

The Contractor shall show on his drawings the expected extension based on the actual modulus of elasticity of the strand as well as the expected wedge pull-in and any provision for shimming.

f) Prestressing losses in tendons

The losses allowed for in the design from the causes listed below will be given as follows:

(i) Friction loss

The formula used for determining the tendon/duct friction loss together with the values adopted for the friction coefficient (μ) caused by curvature, and the wobble factor (k) caused by unintentional variation from the specified alignment.

(ii) Elastic deformation of concrete

The elastic factor, which, when multiplied by the compressive stress in the concrete adjacent to the tendon, will give the loss caused by the deformation of the concrete.

(iii) Creep of the concrete

The creep factor, which, when multiplied by the compressive stress in the concrete adjacent to the tendon, will typically give the loss caused by the creep of the concrete.

(iv) Shrinkage of the concrete

The stress loss in MPa caused by the shrinkage of the concrete.

(v) Relaxation of prestressing steel

The stress loss in MPa at a stress level of 70 % of the characteristic strength of the prestressing steel caused by the relaxation of the prestressing steel.

g) Anchorages

The positions where loop or fan-type dead-end anchorage may be used.

h) Bursting reinforcement

The bursting reinforcement for the prestressing system on which the design is based.

i) Precamber

The precamber at intervals not exceeding 0,25 times the span length.

j) Compressive strength of the concrete during transfer

The compressive strength to be attained by the concrete in the relevant member before transfer may take place.

A13.5.4.4 Prestressing systems

The use of all prestressing systems shall be subject to approval by the Engineer. Tenderers are advised to obtain approval for the prestressing system they intend using, prior to submitting their tenders.

Within one month of the tender having been awarded, or within a period agreed on with the Engineer, the Contractor shall submit full details regarding the prestressing system(s), materials and equipment he intends using, as well as regarding the methods he proposes to adopt in the prestressing and related operations.

The Engineer, at his own discretion, may call for further information in the form of detailed drawings, proof of successful previous use, performance certificates from an approved independent testing authority, and calculations substantiating the adequacy of the system. The Contractor shall furnish such information within 2 weeks of being called upon to do so or within a period agreed to with the Engineer. If, after investigating all the information, the Engineer is not satisfied that the prestressing of the structural member can be carried out satisfactorily with the prestressing system offered by the Contractor, the Engineer reserves to himself the right to order the Contractor to use any system which is suited to the work and which is readily available to the Contractor.

Only minor alterations to the concrete dimensions shown on the drawings will be considered in order to accommodate the prestressing system finally selected. Major alterations occasioned by the prestressing system offered by the Contractor and which is at variance with the tendon system specified in Clause A13.5.4.3b) shall be treated as alternative designs and shall be dealt with as specified in the General Conditions of Contract.

A13.5.4.5 Drawings prepared by the Contractor

All drawings prepared by the Contractor and submitted to the Engineer for consideration shall comply with the requirements of A1.2.4 of Chapter 1.

The Contractor shall submit to the Engineer at least 2 months before he intends commencing with the manufacturing of concrete element to be prestressed, drawings detailing the layout and alignment for the individual tendons, the cable supports, modifications to the bursting and other reinforcement, anchorage recesses, tensioning sequence, tensioning loads and extensions, as well as requirements for controlling the tensioning operations. For the prestressing system finally selected, the technical data which are at variance with the information given on the drawings shall be shown on the drawings. Each tendon shall be separately numbered for identification.

The drawings shall also show the anchorage reinforcement required for the prestressing anchorages and couplers, as well as any modifications that may be required to the bursting reinforcement. The cost of supplying and fixing the anchorage reinforcement shall be included in the rate for anchorages and couplers.

Where required, the Contractor shall submit calculations in respect of the variation of the tendon force along the length of the tendon, the expected extension and the bursting forces.

After approval by the Engineer of the drawings and calculations submitted by the Contractor, no departure shall be permitted from the forces, stresses and extensions shown thereon, without authorisation by the Engineer.

The manufacturing of concrete elements to be prestressed shall not commence before the relevant drawings have been accepted by the Engineer.

The Contractor shall make full allowance in his tendered rates for all costs in connection with the furnishing of information, making calculations, and preparing and submitting the drawings. However, no allowance need be made for the cost of checking, undertaken by the Engineer, of drawings and calculations for work which does not qualify as an alternative design.

Alternative designs shall comply with the requirements of the General Conditions of Contract and the relevant provisions of this Section.

A13.5.5 MATERIALS

A13.5.5.1 General

All materials and prestressing systems used in the prestressing of structural concrete members shall be subject to approval by the Engineer.

A13.5.5.2 Prestressing steel

a) General

The type of prestressing steel shall be designated in accordance with the requirements of Clauses A13.5.5.2b) and c).

The Contractor shall keep proper records of all material analyses and test certificates for the batches of prestressing steel used in the works. Where required by the Engineer, the Contractor shall produce certificates from recognised testing authorities certifying compliance of the prestressing steel with the specified requirements.

Where prestressing steel is available in weld-free lengths (production lengths) and lengths containing welds (standard lengths), the batches delivered at the site shall be clearly labelled for identifications purposes.

In no circumstances shall prestressing steel after manufacture be subjected to heat treatment other than as provided for in these specifications.

b) Bars

Cold-worked high-tensile alloy steel bars for prestressed concrete shall comply at least with the requirements of BS 4486.

The type of prestressing steel shall be indicated in accordance with the requirements of Clause 4.2 of BS 4486, e g BS 4486-RR-32-1230 for 32 mm diameter ribbed bar with a nominal tensile strength of 1 230 MPa.

c) Wires and seven-wire steel strand

Steel wire and seven-wire steel strand for prestressed concrete shall comply at least with the requirements of BS 5896.

The type of prestressing steel shall be indicated in accordance with the requirements of Clauses 14 and 20 of BS 5896 for wire and strands respectively, e.g.:

(i) BS 5896/2 wire 1770-7-PE-relax 1 for a 7,0 mm nominal diameter straightened smooth wire of class 1 relaxation with a nominal tensile strength of 1 770 MPa; and
(ii) BS 5896/3 superstrand 1860-12,9-relax 2 for a 12,9 mm nominal diameter seven-wire superstrand of class 2 relaxation with a nominal tensile strength of 1 860 MPa.

d) Straightness

Prestressing bars delivered at the site shall be straight. Only small adjustments for straightness may be made, which shall be done by hand on the site at a temperature above 5°C and under the supervision of the Engineer. Where heating of the bars is required, this shall be by means of steam or hot water. Bars bent in the threaded portion shall not be used.

Prestressing wire and strand shall be supplied in coils with a sufficiently large diameter to ensure that the wire and strand will pay off straight.

e) Surface condition

Prestressing steel shall be clean, free from faults or defects, and without any harmful films and matter which may impair adhesion to the grout or concrete. A film of rust is not necessarily harmful and may improve the bond. It may, however, increase the friction between the tendon and duct.

The depth of imperfections or pits on the surface of prestressing steel shall not exceed 0,1 mm for wire with a diameter up to and including 8,0 mm, or 0,2 mm for bars or wire with a diameter exceeding 8,0 mm.

Tendons may be cleaned by wire brushing or by passing through a pressure box containing carborundum powder. Solvent solutions shall not be used for cleaning without the approval of the Engineer.

Prestressing steel shall be delivered at the site suitably protected against damage and corrosion. Such protection or the use of a corrosion inhibitor where allowed by the Engineer, shall not have any deleterious effect on the steel or concrete or impair the bond between the two.

f) Galvanising

Galvanised prestressing steel shall not be used unless specified. In no circumstances shall prestressing steel be subjected to galvanising after manufacture.

g) Welds

Prestressing steel used in structural prestressed concrete shall be weld-free. Where the steel is supplied in standard lengths, the welds shall be cut out and delivered to the Engineer.

A13.5.5.3 Anchorages and couplers

Anchorages and couplers to be used in prestressed concrete shall comply with the requirements of BS EN 13391 and shall be of a proved and approved type, constructed from durable material completely free from imperfections and shall not damage, distort or kink the prestressing steel in a manner as will result in ultimate tensile strength reduction. They shall resist, without failure and/or excessive deformation or relaxation of the force in the tendons, the full ultimate tensile strength of the tendons. The characteristic value for anchorages and couplers, determined in

accordance with BS EN 13391, shall not be less than 90 %.

The anchorages shall effectively distribute the force in the tendon to the structural member, and the resulting local stresses and strains in the member shall be so limited as to prevent damage. Unless otherwise approved by the Engineer, all anchorages and couplers shall be provided with anchorage reinforcement.

Wedges and the insides of barrels or cones shall be clean to allow the free movement and seating of the wedges inside the taper.

The threads of bars, nuts, anchorages and couplers shall be suitably protected against damage and corrosion. The protection shall be removed at the last moment and the threads properly lubricated before use.

A13.5.5.4 Sheaths

Sheaths shall be grout-tight and of such material and configuration that bond forces can be transferred from the grout to the surrounding concrete. The properties of the sheath material shall be such that no corrosion attack of the prestressing steel will be induced. The sheath shall be sufficiently flexible to accept the required curvature without kinking, and strong enough to retain its cross-section and alignment and to resist damage on account of handling, transporting, tying and contact with vibrators during concreting. Unless otherwise approved by the Engineer, the thickness of the metal of steel sheaths shall not be less than 0,4 mm.

Metal sheathing shall be delivered at the site suitably protected against damage and corrosion. At the time of incorporation into the structural member, the sheathing shall be free from loose mill scale, loose rust, lubricants and harmful matter.

Galvanized sheathing shall not be used unless specified.

Plastic sheaths shall be formed using HDPE corrugated piping in accordance with 'Corrugated Plastic Ducts for Internal Bonded Post-tensioning', Bulletin No. 7, International Federation for Structural Concrete (fib), January 2000.

Unless otherwise specified, the internal diameter of the sheath shall be at least 10 mm greater than the diameter of the tendon. For vertical tendons and where tendons are to be drawn into cast-in sheaths, the cross-sectional duct area shall be at least three times the cross-sectional area of the tendon.

A13.5.5.5 Cable supports

Supports of reinforcing steel or structural steel suitably braced to prevent buckling under load shall be used to support the cables. The cable saddles shall be rigid and secured in position by welding or by equivalent mechanical means to resist both gravitational and buoyancy forces.

Normal web reinforcement shall not be utilised to support cables.

Saddles for external cables shall be of special design and material to ensure low friction and to prevent the tendon or parts thereof from grooving the surface. The saddle plates shall be curved to the requisite radius to prevent the tendon or part thereof from bearing on the end of the plate.

A13.5.5.6 Tendon spacers

Tendon spacers used inside the ducts to separate individual bars, wires or strands of the tendon shall be of a proved and approved type and manufactured from material which will not induce corrosion of the prestressing steel.

A13.5.5.7 Grout

a) Materials

In addition to the requirements of Clause A13.4.5.3, water shall not contain more than 500 mg of Cl ions per litre of water.

Only CEM I or CEM II/A, with a strength class of 42.5 N or greater, which complies with the requirements of SANS 50197 shall be used. The temperature of the cement shall be less than 40°C, and the cement shall be stored in accordance with the requirements of Clause A13.4.5.10b).

Fine aggregate shall consist of siliceous granules, finely ground limestone or very fine sand. The aggregate used shall pass through a 0,600 mm sieve. The use of fine aggregate shall be subject to the approval of the Engineer and shall be restricted to grout for ducts with a diameter exceeding 150 mm. The aggregate content in the grout shall not exceed 30 % of the mass of the cement.

The use of admixtures shall be subject to tests having shown that their use improves the properties of the grout, e g by increasing workability, reducing bleeding, entraining air, or expanding the grout. Admixtures shall be free from any product liable to damage the steel or the grout itself, such as halides, nitrates, sulphides, sulfates, etc. The quantity of admixture to be used shall be in accordance with the manufacturer's instructions.

b) Properties of the grout

The mixed grout shall have the following properties:

(i) The Cl ions content shall not exceed 750 mg per litre.
(ii) The viscosity of the grout measured in accordance with Clause A13.5.5.9(d) for horizontal cables shall be 500 to 2 500 cP and for vertical cables 400 to 1 500 cP. The viscosity of the grout, 20 minutes after mixing, shall not exceed 2 500 cP and 1 500 cP for horizontal and vertical cables respectively.
(iii) Bleeding at 20°C measured in accordance with Clause A13.5.5.9d) shall not exceed 2 % by volume 3 hours after the grout has been mixed, and the maximum bleeding shall not exceed 4 %. In addition, the separated (bleed) water must be reabsorbed after 24 hours.
(iv) The cube compressive strength of 100 mm cubes made of the grout and cured in a moist atmosphere for the first 24 hours and then in water at 20°C shall exceed 20 MPa at 7 days.

A13.5.5.8 Protecting agents for unbonded tendons

The material used for permanent protection of unbonded tendons shall have the following properties:

a) It shall remain free from cracks and shall not become brittle or fluid within the temperature range of -20°C to 70°C.
b) It shall be chemically stable for the entire life of the structure.

c) It shall be non-reactive with the surrounding materials, i e concrete, tendons, wrapping or sheathing.
d) It shall be non-corrosive or corrosion-inhibiting.
e) It shall be impervious to moisture.
f) It shall be sufficiently tough to withstand the abrasion caused when a tendon, precoated with the material, is drawn into the sheath.
g) It shall have no appreciable shrinkage or excessive volume increase.
h) It shall have a suitable viscosity at ambient temperature or require only moderate preheating to permit injection.

A13.5.5.9 Testing

a) General

Where so directed by the Engineer, the Contractor shall make arrangements for samples of the materials he intends to use in the works to be tested by an independent testing authority. The cost of testing prestressing steel, anchorage assemblies and couplings shall be paid for as specified in Section C20.1 of Chapter 20 on condition that the product complies with the requirements. Control tests on the viscosity and bleeding of grout will be regarded as part of the Contractor's obligations under Chapter 1 for process control and will not be paid for separately.

Material represented by samples which do not comply with the specified requirements, shall be removed and replaced with suitable material.

b) Anchorages and couplers

Anchorages and couplers shall be tested in accordance with the requirements of Clause A13.5.5.3. The anchorages and couplers shall be assembled in accordance with their practical application on the site where all the components necessary for anchoring shall be used, but excluding the ducts.

c) Prestressing steel

Prestressing steel shall be tested in accordance with the requirements of Clause A13.5.5.2. Should any test piece fail to comply with the requirements specified for the prestressing steel, the material represented by that sample shall not be used without further testing and shall be replaced with materials conforming to the specifications, if further testing confirms that they do not comply with the specifications.

d) Grout

The fluidity of grout shall be measured with a flow cone, immersion apparatus or viscometer. The instrument shall be accurately calibrated in a laboratory so that the specified viscosity of the grout can be controlled satisfactorily.

The procedure for conducting the flow-cone test for measuring the fluidity of grout shall be as follows:

Unless otherwise approved, the flow cone shall be as shown in Figure A13.5-1.

Immediately after the grout has been mixed, the pre-wetted flow cone, which is held firmly with its top rim in a level position, shall be filled with grout to the level indicated by the pre-set pointer, whilst the bottom orifice is held closed with a finger.

As soon as the required volume of grout, (± 1 750 ml), is reached, the finger shall be released to allow the grout to flow out freely through the bottom orifice. A stop watch shall be used to determine the flow time for emptying the cone, to the nearest second.

The readings obtained during grouting shall be compared with the times determined in the laboratory for grouts of the specified viscosities.

The bleeding of grout shall be measured in a metal or glass container with an internal diameter of approximately 100 mm and a height of approximately 120 mm. The grout and water levels in the container shall be controlled with a metal bridge into which two adjustable studs A and B are secured. See Figure A13.5-2 for details of the apparatus.

The procedure for determining the bleeding of grout shall be as follows:

Studs A and B in the metal bridge shall be adjusted and locked so that the distance from the lower tips of the studs to the bottom of the container will be approximately 100 mm and 107 mm respectively. The volumes VA and VB for the container at the respective levels of the stud settings shall then be determined to the nearest millilitre.

The container shall be filled with freshly mixed grout to a level where the grout will just touch the tip of stud A which points downwards. The bridge shall then be removed and the container tightly sealed to prevent evaporation. The container shall then be stored at 20°C and kept free from vibrations for the entire duration of the test.

Three hours after the grout has been mixed, the container shall be opened and the free (bleed) water poured off. The bridge shall be placed over the container with the tip of stud B pointing downwards and water poured onto the grout with a measuring apparatus until the water level touches the tip of stud B. The volume of water added shall be determined to the nearest millilitre and designated as ΔV.

The percentage of bleeding shall be calculated from the formula: $[1 - (V_B - \Delta V) / V_A] \times 100$

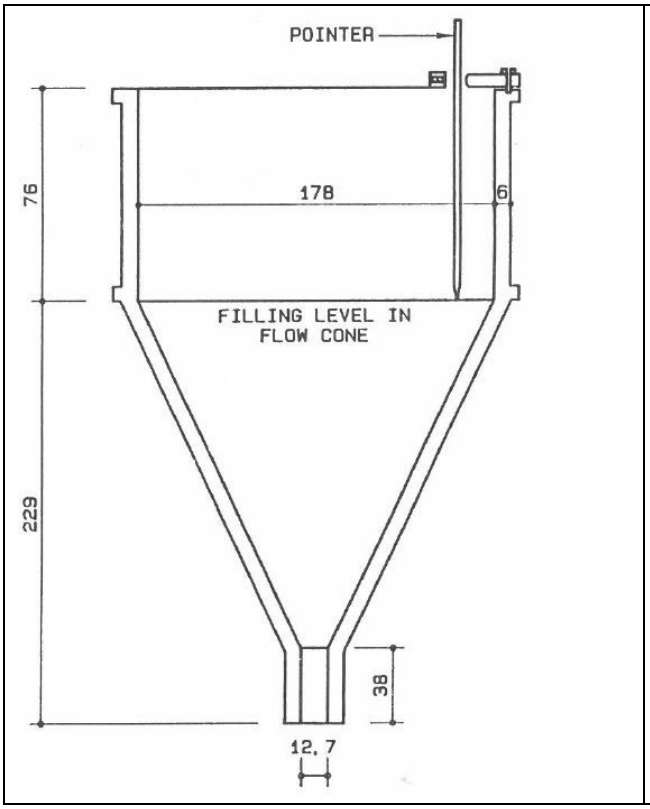

Figure 13.5-1: Flow Cone

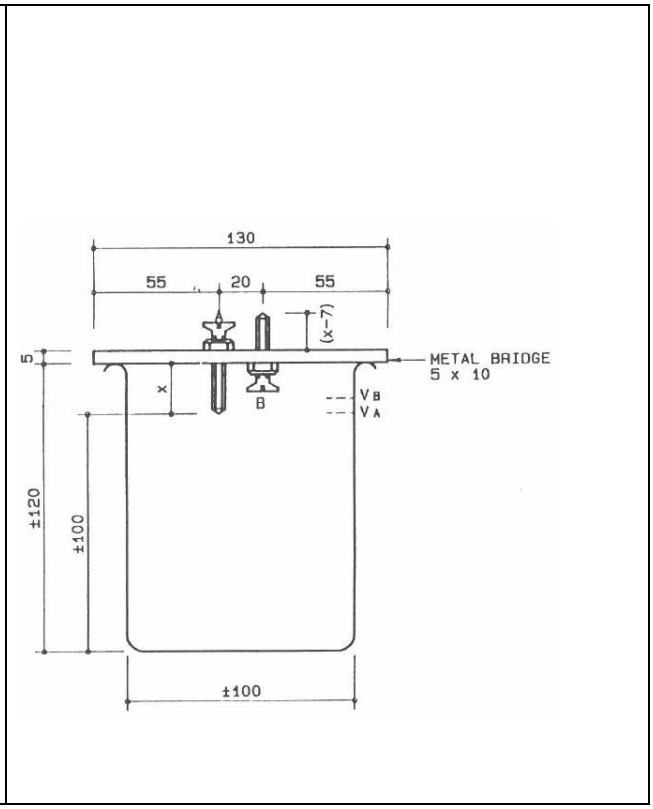

Figure 13.5-2: Metal or Glass Container

A13.5.6 CONSTRUCTION EQUIPMENT

A13.5.6.1 General

All equipment used shall be in a good working order, and properly maintained and suitable for its indicated use.

A13.5.6.2 Tensioning and measuring equipment

Tensioning and measuring equipment shall be such that the tendon force can be established to an accuracy of ± 2 % during any stage of the tensioning operation.

Unless otherwise authorised by the Engineer, the tensioning equipment shall be power driven and capable of gradually applying a controlled total force without inducing dangerous secondary stresses in the tendon, anchorage or concrete.

The force in the tendon during tensioning shall be measured by a direct-reading dynamometer (load cell type) or obtained direct from pressure gauges fitted in the hydraulic system to determine the pressure in the jacks.

Pressure gauges shall have concentric scale dials which comply with the requirements of BS EN 837-1. The dials shall not be less than 150 mm in diameter and the gauges shall be used within the range of 50 – 90 % of their full capacity at maximum service pressure.

When pressure gauges not using glycerine are used, a snubber or similar device shall be fitted to protect the gauge against any sudden release of pressure. Provision shall also be made for T-connections for the attachment, when required, of supplementary control gauges.

Only self-sealing connections shall be used in the hydraulic circuit. Where the pressure input pipe is connected to the jack, a pipe rupture valve shall be installed in the circuit.

Tensioning equipment shall be calibrated before the tensioning operation and thereafter at frequent intervals, as directed by the Engineer, with a master gauge or proving ring, and the Engineer shall be furnished with a calibration chart. The load-measuring devices shall be calibrated to an accuracy of ± 2 %.

The extension of tendons shall be measured to an accuracy of ± 2 % or ± 2,0 mm, whichever is the more accurate, and pull-in and release to an accuracy of ± 2,0 mm.

A13.5.6.3 Grouting equipment

a) Mixer

Mechanically operated mixers only, of a type capable of producing high local turbulences while imparting only a slow motion to the body of the grout shall be used.

The mixer shall be equipped with a screen with openings not exceeding 1,0 mm and shall be capable of consistently producing grout with a colloidal consistency.

b) Agitator

Where the capacity of the mixer is insufficient to fill the duct completely with grout, an agitator shall be used.

Mechanical agitators only shall be used, which are capable of maintaining the colloidal condition of the grout fill during the storing and injection processes. The grout shall be delivered at the structure from the agitator, and the system shall make provision for recirculating the grout from the pump back to the agitator.

c) Injection equipment

The pump shall be of the positive displacement type (piston, screw or similar type), capable of exerting a constant pressure of at least 10 bars on completely grouted cables and shall incorporate a safety device for preventing the build-up of pressure above 20 bars. The pump shall be fitted with a pressure gauge and a valve which can be locked-off without loss of pressure in the cable.

The pump shall be capable of delivering grout at a speed as will produce a speed of the grout in the cable of between 6,0 and 12 m per min.

All connections in the pipes and between the pipe and the cable shall be airtight. Only bayonet, threaded, or similar types of connectors shall be used.

A13.5.7 EXECUTION OF THE WORKS

A13.5.7.1 Precasting

a) Casting yard on the site

Subject to approval by the Engineer, precast work may be done at any location selected by the Contractor.

Before the casting yard is established, the Contractor shall submit plans to the Engineer which demarcate the site and detail the layout of the works, together with a flow diagram of the construction stages and storage.

b) Manufacture off the site

The Contractor shall notify the Engineer in advance of the dates when tensioning of tendons, casting of members and transfer, will be undertaken.

Within 7 days of transfer, the Contractor shall submit to the Engineer a certificate giving the tendon force(s) and extension(s) attained as well as records of the cube crushing strength and age of concrete at transfer.

Test results relating to all aspects of the work shall be sent to the Engineer immediately after becoming available.

Where the Engineer requires tests to be conducted on completed members, no member to which the tests relate shall be dispatched to the site until the tests have been satisfactorily completed and the members accepted by the Engineer.

c) Manufacture

Before work is commenced, details of the manufacture, curing and phasing of the work shall be submitted to the Engineer for approval. After approval no changes shall be made to the methods or systems without approval by the Engineer.

The Contractor shall ensure that the specified precamber is incorporated in the formwork. The magnitude of the precamber shown on the drawings shall be subject to variation depending on the Contractor's construction programme, and the Contractor shall, before manufacture, ascertain in writing from the Engineer, the increase or decrease in precamber. This procedure shall also apply to the cases where no precamber has been specified.

Lifting and supporting the precast members shall be made only at the points marked and provided on the members.

Precast members which have not been fully tensioned or fully stage-tensioned or which have ungrouted tensioned tendons shall not be handled without authorisation by the Engineer.

Where members with ungrouted tensioned tendons are handled, control shall be exercised to guard against possible slip of the tendon at the anchorage.

Prestressed precast concrete members shall also comply with the requirements of Clause A13.4.7.11k).

A13.5.7.2 Pre-tensioning

During the period between tensioning and transfer, the force in the tendon shall be fully maintained by some positive means. At transfer, detensioning shall take place slowly to minimise any shock which could adversely affect the transmission length of the tendon.

In the long-line method of pre-tensioning, sufficient locator plates shall be distributed through-out the length of the bed to ensure that the straight tendons are maintained in their proper position during concreting. Where a number of units are manufactured in line, they shall be free to slide in the direction of their length so as to permit transfer of the tendon force to the concrete along the entire line.

In the individual-mould system, the moulds shall be sufficiently rigid to provide the reaction to the tendon force without distortion.

Where possible, the mechanism for holding down or holding up deflected tendons shall ensure that the part in contact with the tendon will be free to move in the line of the tendon so that friction losses are eliminated. If, however, a system is used which develops a frictional force, this force shall be determined by test and due allowance made therefor.

For single tendons, the deflector in contact with the tendon shall have a radius of not less than 5 times the tendon diameter for wire, or 10 times the tendon diameter for a strand, and the total angle of deflection shall not exceed 15°.

Transfer of the tendon force to the concrete shall be effected in conjunction with the release of hold-down and hold-up forces in accordance with an approved method.

Transfer shall not be effected until compressive-strength tests on the concrete show that the concrete of the particular member has attained a compressive strength of at least the compressive strength shown on the drawings. The transmission length is affected by the concrete strength, and the necessary modification for the concrete strength at transfer shall be made in conjunction with the Engineer.

The tendons shall be cut off flush with the end of the member and the exposed ends covered with a heavy coat of approved bituminous material or epoxy resin or as instructed by the Engineer. The cutting of the prestressing steel shall be performed with a high-speed abrasive cutting wheel. Flame cutting will not be permitted.

A13.5.7.3 Post-tensioning

a) Storage, handling and protection

During storage, transit, construction and after installation, the sheaths, prestressing steel, anchorages and couplers shall be protected against corrosion, damage or permanent deformation. The manner and extent of protection required will depend on the environmental factors and the length of time before permanent corrosion protection is applied, and shall be to the satisfaction of the Engineer. Under severe corrosive conditions in coastal, damp and wet areas and under aggressive conditions the materials shall be stored in weatherproof sheds. All materials shall be stored clear of the ground and while in storage shall not be exposed to the weather.

When prestressing steel has been stored for a prolonged period and there is evidence of its deterioration, the Contractor may be called on to prove by tests that the quality of the steel has not been significantly impaired and that the prestressing steel still complies with the provisions of these specifications.

Suitable protection shall be provided to the threaded ends of bars.

After fabrication, the cable ends shall be covered with protective wrapping to prevent the ingress of moisture into the duct.

When the tendon is to be left untensioned for a prolonged period after installation, precautions shall be taken to protect the tendon against corrosion. Corrosion inhibitors, soluble oils or similar materials used as lubrication or to provide temporary protection shall be such that they can be completely removed before permanent protection is affected.

b) Fabrication

All cutting of prestressing steel shall be performed with a high-speed abrasive cutting wheel or by a method approved by the Engineer. Flame cutting will not be permitted.

Care shall be taken to prevent the prestressing steel or anchorages from coming into contact with splashes from flame-cutting or welding processes in the vicinity.

Where possible, all bars, wires or strands tensioned in one operation shall be taken from the same parcel of prestressing steel. The tendon or cable shall be labelled to show the tendon or cable number, as well as identify from which parcel the steel has been taken.

Where bars, wires or strands in a tendon are not tensioned simultaneously, tendon spacers shall be used in accordance with the recommendations for the prestressing system or, in the absence thereof, as directed by the Engineer.

Cables shall be fitted at both ends with pipes with a diameter of at least 10 mm for the injection of grout or protection agents. The ends of the injection pipes shall be fitted with a clamp, valve or device capable of withstanding a pressure of at least 15 bars without loss of grout or protection agent.

Vent pipes with a diameter of at least 25 mm shall be provided in the duct at every high point, low point, change of sheath cross-section and at such intermediate positions as may be shown on the drawings or required by the Engineer. The vent pipes shall extend to at least 500 mm above the concrete and shall comply with the requirements for injection pipes.

Connections to, and joints in sheaths shall be made grout-tight by using special sheathing couplings and taping. With bonded cables, the length of taping shall not exceed six sheath diameters. Where oversleeves are used, equal overlaps shall be provided over each length of sheathing. Joints in adjacent sheaths shall be spaced at least 300 mm apart.

c) Installation

The installation of tendons shall not commence until the requirements of Clause A13.5.4.5 have been complied with.

The cable, sheath or extractable core shall be accurately installed to the specified alignment and securely held in position both vertically and horizontally at intervals appropriate to its rigidity and so as not to be displaced during concreting, either by the weight of the concrete or by buoyancy. The spacing of the cable supports shall furthermore ensure that the tendon can be installed to a smooth alignment without kinks and within the tolerance specified in Clause A13.5.8.1. Cable sheaths shall be supported and held in position by means of separate reinforcing steel supports with a diameter of not less than 16 mm. The transverse bars must be welded to the vertical bars or must rest on lugs welded to the vertical bars. The spacing of the vertical supports shall not exceed 1,0 m.

Extractable cores shall not be coated with release agent unless approved by the Engineer.

Unless otherwise shown on the drawings, the alignment of the tendon within a distance of 1,0 m from the live anchorage and/or coupler shall be straight. The tendon axis shall be set perpendicular to the bearing surface of its anchorage and firmly secured in position so as not to move during concreting. External anchorages shall be seated on a thin mortar bedding to bear evenly on the concrete bearing surface, and the tendon axis shall be perpendicular to the bearing surface of the anchorage.

Unless otherwise shown on the drawings, the minimum concrete cover over the outside surface of the sheath or cable support shall comply with the requirements of Clause A13.3.7.4, except that, for sheaths, the cover shall not be less than 50 mm.

The spacing of cables will depend on the size of the cable and shall be such that the concrete can be properly placed and compacted.

Immediately before concreting, the Contractor shall inspect the sheaths for grout-tightness and shall seal all damaged and suspect sections.

External tendons shall be installed to the same standards and accuracy specified herein for internal tendons. The tendons shall be temporarily supported at regular intervals along the straight length between saddles. The supports shall consist of rigidly constructed frames secured to the concrete face.

d) Concrete strength

Full tensioning of all or some of the tendons shall not commence until the compressive-strength of the concrete is 35 MPa or the strength shown on the drawings, whichever is the greater. Irrespective of concrete strength, full tensioning shall not commence within 7 days after completion of the last concrete pour affected by the prestressing.

The 7-day period may be reduced for certain forms of construction such as Incremental Launching, Balanced Cantilever or Precast Segmental Construction. The Contractor shall submit a request to reduce the 7-day period to the Engineer for approval at least 28 days before construction of that part of the works commences. The request shall include a method statement that demonstrates that the concrete compressive strength and tensile strength has reached the required strengths prior to prestressing.

The compressive strength of the concrete shall be determined from cubes manufactured and tested in accordance with the relevant SANS 3001-CO1 and CO2 test methods, which have been cured under the same conditions as the structural member which is to be prestressed. The number of concrete cubes required for this purpose shall be as agreed on with the Engineer.

Where initially all or some of the tendons are to be partially tensioned, tensioning shall not commence before the concrete has attained the compressive strength indicated on the drawings.

e) Tensioning

(i) Preparation

Within 2 hours of the concrete having been placed, the Contractor shall demonstrate that sheaths are free from obstructions, that extractable cores can be removed and, where the design permits, that all tendons are free to move in the ducts. All water in the ducts shall then be expelled with compressed air and the cables sealed until tensioning takes place.

Before tensioning is commenced, the side forms and other restraining elements shall be released or removed to give the structural member the freedom to deform under the induced force.

(ii) Tensioning sequence

The sequence of tensioning to be followed shall be as shown on the drawings and/or on drawings prepared by the Contractor in terms of Clause A13.5.4.5. The Contractor shall make allowance in his tendered rates for all incidentals which he may have to incur as a result of having to tension fully only some of the tendons at any one stage or instant.

Where partial tensioning of tendons is required, the work shall be executed in accordance with the details on the drawings or as specified. The Contractor shall, in his tendered rates, make provision for all incidentals he may have to incur as a result of having to tension partially only some of or all the tendons at any one stage or instant.

Where the elastic shortening in the falsework prior to prestressing exceeds the uplift in the deck caused by prestressing, the falsework shall be lowered to prevent unintended loads and cracking. The procedure for stressing part of the prestressing, then lowering the falsework, followed by completion of the stressing, shall be submitted to the Engineer for approval in terms of Clause A13.2.7.3d).

(iii) Assembling the equipment, and safety precautions

The tensioning and measuring equipment shall be assembled for tensioning in exactly the same way as they are combined for calibration.

The Contractor shall take all the necessary safety precautions to prevent accidents caused by the malfunctioning or failure of any part of the equipment or material and shall accept full responsibility for injury sustained by persons or damage to property resulting therefrom.

(iv) Friction

The Engineer may require the Contractor to perform friction tests on designated tendons and to revise the relevant theoretical extensions to compensate for the discrepancy between the values adopted in the design and the test results. Payment for these tests shall be made under Section C20.1 of Chapter 20.

Where applicable, allowance shall be made in the tensioning force to compensate for friction loss in the jack and in the anchorage.

(v) Tensioning

Tensioning shall be carried out under the supervision of a technician skilled in the use of the prestressing system and equipment and the methods of tensioning to be adopted.

Tensioning shall not be commenced before the Engineer has been advised of each tensioning operation and has given his approval for the work to be started.

The technician and operators shall be supplied with a schedule listing the sequence of tensioning the various tendons and a tensioning record sheet showing the theoretical gauge readings, jacking forces, extensions, release and pull-in for each tensioning operation. The record sheet shall furthermore provide room for entering the corresponding information recorded and observations made during tensioning. A graph of the tensioning force and/or gauge reading versus theoretical extensions shall, where required, be appended to the record sheet and the actual extensions measured for each load increment shall be plotted on the graph. Copies of the completed record sheets and graphs shall be submitted to the Engineer within 24 hours of each tensioning operation having been completed.

The Contractor shall note that the extensions shall be regarded as an indirect measurement of the tensioning force and shall serve as a control on the tensioning force applied.

The protruding ends of all bars, wires and strands shall be clearly marked for the accurate measurement of extension, release and pull-in.

Before tensioning is commenced on external tendons, a small load shall be applied to each tendon, commencing with the uppermost tendon. The force shall be sufficient to take up all slack and prevent entanglement of the tendons.

The jacking force shall be increased to approximately 5 to 10 % of the final jacking force to take up the tendon slack and to determine the zero position for measuring the extension and to check the gripping devices and the position and alignment of the jacks. The load shall then be increased gradually to the full specified tensioning force while intermediate gauge readings and extensions are recorded at regular intervals.

The final stage of tensioning shall be deemed to have been satisfactorily accomplished when all the following requirements have been complied with:

1. The tendons have been tensioned to the required force.
2. The measured extension on individual tendons is within ± 6 % of the theoretical extensions.
3. The average variation between the measured and theoretical extensions of all the tendons in a structural member is less than ± 3 %.
4. The release and/or pull-in is within ± 2,0 mm of the theoretical values.

Where the above conditions are not met individually and collectively, the Contractor shall immediately advise the Engineer and obtain a ruling as to the procedure to be followed.

In the event of the tendon friction being too high, the Contractor may, subject to approval by the Engineer, inject an approved lubricant into the sheath after first having detensioned the tendon.

The cost of the remedial and corrective measures and of the release and retensioning of tendons, which have been occasioned by failure of the operations to meet the above requirements shall be for the Contractor's account.

After the tensioning has been accepted by the Engineer, the Contractor may cut off the tendons behind the anchorage as described in Clause A13.5.7.3b).

f) Permanent protection and bonding of tendons

(i) General

After tensioning, all tendons shall receive permanent protection against mechanical damage and corrosion.

Internal tendons shall be protected and bonded to the structural member by cement grout or, when permitted by the Engineer, by sand-cement grout. Where bond is not important, protection may be effected by the use of bitumen, petroleum-based compounds, epoxy resins, plastics and similar products, all complying with the requirements of Clause A13.5.5.8 and subject to approval.

Tendons located outside the structural section (i.e. external tendons) shall be encased with a dense concrete, dense mortar or material sufficiently stable and hard, all subject to approval. The encasement shall be of the thickness shown on the drawings. Where bonding of the tendon to the structural concrete is required, this shall be achieved by bonding the concrete encasement to the structure with reinforcing steel as detailed on the drawings.

Protection and bonding of the tendons shall be effected within 7 days of the final tensioning of the tendons, or as specified on the drawings, but shall not take place without the prior approval of the Engineer having been obtained.

After the permanent protection or bonding has been completed the anchorages shall be encased in concrete or grout which shall be bonded to the old concrete with epoxy resin designed for this purpose, or shall be completely coated with a corrosion-resistant material. The protection provided shall in all cases prevent the ingress of water or aggressive agents.

(ii) Preparation of ducts

Before permanent protection and/or bonding of tendons is effected, the following precautions shall be taken:

1. The cables shall be checked for blockages by water or compressed air, being injected.
2. Unlined ducts which are to be filled with grout shall be flushed with water to wet the concrete.
3. Temporary protection or lubricants which are incompatible with the permanent protection or bonding, shall be removed by flushing the duct with water or an inert solution, or by any suitable approved method.
4. On completion of the above, any excess fluid shall be expelled from the ducts by means of compressed air or shall be displaced by the protecting agent or grout, as may be relevant.

Any blockages, leakages or factors which in any way may affect the permanent protection or bonding shall immediately be reported to the Engineer.

(iii) Mixing

1. Protecting agents

The mixing of protecting agents shall be strictly in accordance with the manufacturer's instructions.

2. Grout

The aggregate, if used, and the cement shall be measured by mass, and the water by mass or by volume.

The water: cement ratio by mass shall be as low as possible within the range between 0,36 to 0,45, and shall be consistent with the fluidity requirements of Clause A13.5.5.7b).

Where an admixture is used, it shall be dissolved in a part of the mixing water before it is added to the grout.

Mixing shall be commenced by two-thirds of the cement being added to the greater part of the mixing water, and, if used, an additive predissolved in part of the mixing water, and finally the remainder of the cement. Mixing shall continue for not longer than 4 minutes after which the grout shall be continually agitated at slow speed throughout the injection operation.

Where aggregate is used in the grout mix, the word "cement" in the preceding paragraph shall be replaced by the term "cement/aggregate component".

(iv) Injection

1. General

The injection of permanent protecting agents or grout shall not commence before approval has been granted that the work may start.

Before injection commences all air shall be expelled from the injection equipment and hoses and all connections checked for airtightness.

Injection shall take place from the anchorage or coupler, whichever is situated at the lower end of the cable.

Grout injection shall proceed without any interruption until the cable has been completely filled and closed off.

2. Protecting agents

The injection of protecting agents shall be strictly in accordance with the instructions, and with the equipment specified by the manufacturer.

3. Grout

Immediately after mixing, and also during injection, the fluidity of the grout shall be tested at regular intervals in accordance with Clause A13.5.5.9.

Injection shall be continuous at a rate of 6,0 m to 12 m per minute. As soon as grout with the original consistency flows from the intermediate vent pipes they shall be successively closed. Injection shall continue until the grout flowing from the vent at the free end is of the same consistency as that of the injected grout. At this stage the vent shall be closed and the final pressure or a pressure of 5 bars, whichever is the greater, shall have been maintained on the grout column for 5 minutes before the valve at the injection end is closed.

All vents shall be kept closed and supported vertically until the grout has finally settled. On vertical cables, a riser pipe with funnel shall be fitted to the top anchor to ensure that the separated water migrate upwards and will not remain in the cable.

If an expanding agent is used in the grout mix, the air vents shall be re-opened after grouting to release any separated water, and shall then again be closed.

Unless a retarder is used in the grout mix, the grout not used within 60 minutes of mixing shall be discarded.

During the course of grouting 100 mm cubes shall be made for testing in accordance with Clause A13.5.5.9. Whilst the grout is being poured into the cube mould, the sides of the mould shall be slightly tapped to permit any entrapped air to escape.

All excess grout including expelled, spilt or waste grout shall be collected and disposed of in an approved manner. No grout shall be allowed to flow over formed concrete surfaces in order to avoid permanent marking. Precautions shall be taken not to discharge the escaping grout onto railway lines, public roads, rivers or private property.

If a blockage occurs during the course of grouting, the grouting shall be stopped before the maximum grouting pressure is reached. The duct shall then be flushed out immediately and the blockage cleared.

Grouting shall not be carried out during very cold weather when the ambient air temperature drops below 5°C. Care shall be taken that the ducts are completely free from frost or ice before grouting commences after frosty weather.

A13.5.7.4 Loss of prestress

Any structural member which has lost all or part of its prestress through the failure or malfunctioning of any part of the prestressing component may be rejected by the Engineer and shall be removed from the works unless approved remedial measures have been successfully carried out on the member. No payment will be made in respect of such remedial work or loss suffered by the Contractor in this regard.

A13.5.7.5 Safety

Stressing operations shall be carried out under the direction of a competent person. Workers involved in prestressing shall be instructed in, and follow safe work procedures. Appropriate eye protection shall be worn by all workers involved in grouting, stressing and cable trimming operations.

During prestressing operations, workers shall be protected by guards or other suitable devices at the tensioning ends and anchoring points to contain the flying strands and the strand wedges in the event of strand failure.

Welding, flame-torching or other similar operations shall not be permitted in the vicinity of prestressing strands unless proper care is taken to protect the strands from sparks or other heat sources, and from stray electric currents.

Visual or audible signaling devices shall be provided and used in the area of tensioning operations to warn workers approaching the area. Workers not directly involved in tensioning or de-tensioning operations shall be kept clear of the danger area and shall remain clear until operations are completed and the visual or audible signals are turned off or removed.

Strand elongation and strand deflection shall be measured by a means which does not expose the workers to the risk of injury.

A13.5.8 WORKMANSHIP

The Contractor shall ensure that prestressing is done in accordance with the specifications and instructions of an ECSA Registered Professional Engineer, and a copy of such information shall be available in the safety file on site while the work is being done.

A13.5.8.1 Tolerances

Sheaths for prestressing tendons shall be placed and maintained in position within the following tolerances:

In the direction of the width of the member:

- For members of up to 200 mm in width .....± 10 mm
- For members exceeding 200 mm in width.....± 20 mm

In the direction of the depth of the member:

- For members of up to 200 mm in depth ..... ± 0,025 x depth
- For members exceeding 200 mm in depth ..... ± 0,010 x depth within the tolerance range of ± 5,0 mm to ± 25 mm.

B13.5 PRESTRESSING
PART B: LABOUR ENHANCEMENT

CONTENTS

B13.5.1 SCOPE

B13.5.2 DEFINITIONS

B13.5.3 GENERAL

B13.5.4 DESIGN BY CONTRACTOR / PERFORMANCE BASED SYSTEMS

B13.5.5 MATERIALS

B13.5.6 CONSTRUCTION EQUIPMENT

B13.5.7 EXECUTION OF THE WORKS

B13.5.8 WORKMANSHIP

B13.5.1 SCOPE

This Section covers the materials, equipment and work required for prestressing structural concrete members. Due to the specialised skills level that is required for this activity, it is deemed not suitable for labour enhanced construction methods.

B13.5.2 DEFINITIONS

The provisions of Part A shall apply with no additional requirements.

B13.5.3 GENERAL

The provisions of Part A shall apply with no additional requirements.

B13.5.4 DESIGN BY CONTRACTOR / PERFORMANCE BASED SYSTEMS

The provisions of Part A shall apply with no additional requirements.

B13.5.5 MATERIALS

The provisions of Part A shall apply with no additional requirements.

B13.5.6 CONSTRUCTION EQUIPMENT

The provisions of Part A shall apply with no additional requirements.

B13.5.7 EXECUTION OF THE WORKS

The provisions of Part A shall apply with no additional requirements.

B13.5.8 WORKMANSHIP

The provisions of Part A shall apply with no additional requirements.

C13.5 PRESTRESSING

PART C: MEASUREMENT AND PAYMENT

(i) Preamble

The tendered rate for each item shall include full compensation for providing, maintaining and decommissioning upon completion, of all the plant, equipment, labour, tools, incidentals and supervision to carry out the activity or construct the works in the item, unless otherwise stated.

Any prime cost or provisional sums shall be paid in accordance with the provisions of the conditions of contract. The charge or mark-up tendered or allowed for is a percentage of the amount actually paid under the prime cost or provisional sum. This percentage shall cover all the Contractor's handling, supervision, profit and liability costs to provide the services in the prime cost or provisional sum item.

The requirements of Section C1.1 of Chapter 1 shall apply.

Where pay item descriptions include any wording in brackets it is an indication that contract specific information is to be inserted in the Pricing Schedule included in the Contract Documentation.

(ii) Notes on measurement and pay items

None.

(iii) Items that will not be measured separately

The following activities, whether required to complete the specified work or not, will not be measured and paid for separately and the Contractor shall include the cost thereof in other pay items as he deems appropriate:

1. No separate payment will be made for setting out the works.
2. No separate payment will be made for the protection or repair as required of any existing or new road furniture, structures, buildings, infrastructure or services damaged by the Contractor's activities.
3. No additional payment shall be made, nor shall any claim for additional payment be considered, for any specified work in confined or restricted areas. Any additional costs associated with working in confined or restricted areas shall be deemed to be included in the standard applicable pay items.
4. No separate payment will be made for the loading of any materials.
5. No separate payment will be made for the hauling of any materials where the material is moved over a distance of less than, and up to 1,0 km and for labour enhanced construction, less than and up to 50 m.
6. No separate payment will be made for transporting materials from commercial sources irrespective of the haul distance.
7. No separate payment will be made for the removal or any surplus material imported to complete the works.
8. For all Works performed, precautionary measures required in terms of the Occupational Health and Safety Act (Act 85 of 1993) and the latest amendments thereof as well as the latest Construction Regulations shall be deemed included in the rates tendered for the relevant products.

(iv) Items to be measured and paid for using items specified elsewhere in the specifications

Not applicable to this Section.

(v) Items specifically for this Section of the specifications

Item	Description	Unit
C13.5.1	**Prestressing tendons:**	
C13.5.1.1	Longitudinal tendons	meganewton-metre (MN-m)
C13.5.1.2	Transverse tendons	meganewton-metre (MN-m)
C13.5.1.3	Vertical tendons	meganewton-metre (MN-m)

The unit of measurement shall be the meganewton-metre which is calculated as the product of the nominal tensile strength in megapascals of the prestressing steel, the cross-sectional area of the tendon in square metres and the length of the tendon in metres between the faces of the anchorages, as shown on the drawings. In the case of fan and loop anchorages the "length of the tendon" shall include the length of tendon forming the loop or fan.

Where the Contractor provides an alternative prestressing system where the quantities exceed that of those shown on the drawings, the quantities shown on the drawings shall be used for measurement.

The tendered rates shall include full compensation for preparing and submitting the drawings, supplying, storing, handling and protecting all materials (excluding anchorages and couplers), fabricating, supporting and installing the cables; lubricating, permanently protecting and bonding the tendons, for the using of all the equipment, as well as for all work and incidentals required for completing the work as specified.

Item	Description	Unit
C13.5.2	**Anchorages and couplers:**	
C13.5.2.1	Anchorage at jacking end	meganewton (MN)
C13.5.2.2	Anchorage at dead end	meganewton (MN)

C13.5.2.3	Coupler at jacking end	meganewton (MN))
C13.5.2.4	Coupler at dead end	meganewton (MN))

The unit of measurement shall be the meganewton which is calculated as the product of the nominal tensile strength in mega pascals of the prestressing steel and the cross-sectional area of the tendon in square metres, effectively anchored or coupled.

The tendered rates shall include full compensation for supplying, storing, handling, fabricating and protecting the complete anchorage or coupler assembly, anchorage reinforcing, constructing the recesses for the anchorage or coupler, tensioning, anchoring and/or coupling, trimming the tendon ends, using all the equipment, as well as for all work and incidentals required for completing the work as specified.

The coupler shall include the complete assembly consisting of the anchorage built into the first-stage construction and the part coupled to it.

The tendered rate for loop or fan anchorages shall exclude the cost of the length of tendon forming the loop or fan.

Item	Description	Unit
C13.5.3	**Extra over item C13.5.2 for partially tensioning the tendons**	meganewton (MN)

The unit of measurement shall be the meganewton, which is calculated as for item C13.5.2.

The tendered rate shall include full compensation for the use of all equipment, as well as for all work and incidentals required for tensioning and anchoring the tendons to the specified partial force.

D13.5 PRESTRESSING
PART D: GUARANTEES AND COMPLIANCE CERTIFICATES

CONTENTS

D13.5.1 SCOPE

D13.5.2 GENERAL

D13.5.3 PERFORMANCE GUARANTEE REQUIREMENTS

D13.5.4 FUNCTIONAL PERFORMANCE ASSESSMENTS

D13.5.5 VISUALLY ASSESSED PROPERTIES

D13.5.6 INSTRUMENTALLY ASSESSED PROPERTIES

D13.5.7 EVALUATION FOR ACCEPTANCE

D13.5.8 ADDITIONAL PROCEDURES TO BE ADOPTED IN THE EVENT OF FAILURE

D13.5.9 NOTIFICATION OF REMEDIAL WORK

D13.5.10 REMEDIAL WORK

D13.5.1 SCOPE

The scope of this Section covers the following:

- Product conformance specifications
- Warranties for product or element design and installation of proprietary systems
- Performance specifications

Note that the requirements for performance specifications are not limited to that given in Part C only but includes all of the requirements in the Contract Documentation.

D13.5.2 GENERAL

D13.5.2.1 Product conformance specifications

The Contractor shall, within 28 days of entering into the contract with the Employer, submit to the Engineer conformance documentation related to the specifications.

Conformance documentation shall be provided for:

a) Prestressing strand: each parcel or cheese

D13.5.3 PERFORMANCE GUARANTEE REQUIREMENTS

D13.5.3.1 Warranties for product or element design and installation of proprietary systems

No additional requirements.

D13.5.3.2 Performance specifications

The Contractor shall, within 28 days of entering into the contract with the Employer, submit to the Engineer conformance documentation related to the specifications.

Performance specifications shall be provided for the following:

Prestressing system:

a) Proven track record;
b) Compliance with an internationally recognised standard such as EN 13391.

13.6 BEARINGS

CONTENTS

PART A: SPECIFICATIONS

A13.6.1 SCOPE

A13.6.2 DEFINITIONS

A13.6.3 GENERAL

A13.6.4 DESIGN BY CONTRACTOR / PERFORMANCE BASED SYSTEMS

A13.6.5 MATERIALS

A13.6.6 CONSTRUCTION EQUIPMENT

A13.6.7 EXECUTION OF THE WORKS

A13.6.8 WORKMANSHIP

PART B: LABOUR ENHANCEMENT

PART C: MEASUREMENT AND PAYMENT

PART D: GUARANTEES AND COMPLIANCE CERTIFICATES

A13.6 BEARINGS

PART A: SPECIFICATIONS

A13.6.1 SCOPE

This Section covers various items of work associated with the construction, supply and installation of bearings for structures. All bearings shall be designed, manufactured and installed in accordance with European Standard EN 1337: “Structural Bearings.”

A13.6.2 DEFINITIONS

The following definitions shall apply to this Section:

Polytetrafluoroethylene chemical compounds used for sliding surfaces of Bearings **(PTFE).**

The Hardness of rubber used in Bearing is defined as **International Rubber Hardness Degree (IRHD)**.

Elastomer - natural or synthetic rubber which has both viscosity and elasticity.

Large Elastomeric Bearings - these are bearings which can be subjected to a maximum vertical load of 3000 kN at ultimate limit state

Micaceous Iron Oxide (MIO) points are used as part of the paint systems for Bearings

Shear Modulus (G) is the ratio of shear stress to shear strain

Polychloroprene Rubber (CR) and **Natural Rubbers (NR)** are used in bearings.

A13.6.3 GENERAL

The bearings in this Section include simple bearing strips of roofing felt and rubber, elastomeric bearings reinforced with steel plates and precision manufactured steel pot type, spherical, uplift and line rocker proprietary bearings.

A13.6.4 DESIGN BY CONTRACTOR / PERFORMANCE BASED SYSTEMS

A13.6.4.1 Design of elastomeric bearings

All bearings shall be designed to the European Standard EN 1337: Part 3 for Elastomeric Bearings.

a) Technical data

The following technical data for the elastomeric bearings will be specified on the drawings, and shall also be indicated on drawings prepared by the Contractor for submission to the Engineer related to the specific type of bearing proposed:

(i) Design loads and deformations

The critical design-load combinations and co-existing rotations and horizontal displacements for each bearing or each group of identical bearings.

b) Size and construction of bearing

The size and construction of a bearing shall be designated by
a x b x n(t) or D
Where
b = length of bearing in the transverse direction, in mm.

a = width of bearing in the span direction, in mm.

t = thickness of individual elastomer layers, in mm.

n = number of elastomer layers.

D = diameter of bearing.

The steel plates shall be encased in a 5,0 mm thick elastomer layer.

c) Hardness and type of elastomer

The IRHD hardness and type of elastomer, i.e. natural or synthetic rubber, from which the specified bearings are to be manufactured.

d) Identification

Each bearing shall be identified by a unique number

e) Alternative bearings

Where alternative bearings are offered by the Contractor, these shall be designed in accordance with the requirements of EN 1337 for the loadings and deformations shown on the drawings.

Where a bearing consisting of a type of rubber is offered, which differs from that which is specified, the bearing shall be redesigned to make provision for the variation in hardness and/or type of rubber.

A13.6.4.2 Design of proprietary bearings

a) Drawings and approval

All proprietary bearings shall be designed to the European Standard EN 1337: “Structural Bearings”.

Prior to manufacturing the bearings, the Contractor or his nominee shall submit the following information to the Engineer for consideration.

(i) The manufacturer's specification containing detailed information on the design standards, materials, manufacture and technical data.
(ii) Drawings complying with the provision in Chapter 1 showing the bearing construction and installation details.
(iii) Friction properties based on actual tests conducted on the relevant materials.

All bearings used in the permanent Works shall be subject to the approval of the Engineer and subject to a performance guarantee.

b) Technical data

The following technical data for the proprietary bearings will be supplied on the drawings, and shall also be supplied on the drawings prepared by the Contractor for submission to the Engineer.

c) Design loads and movement

The maximum and minimum vertical loads and co-existing horizontal loads both at serviceability and ultimate limit state as well as the maximum horizontal load and co-existing vertical load.

The maximum values in each direction of the reversible and irreversible movements and the rotation about each axis.

d) Mechanical fit

Mechanical fit on unidirectional and fixed bearings expressed as the maximum permissible slack (play) shall be smaller or equal to 1mm between the shear transfer members of the bearing which are required to resist the applied horizontal loads.

e) Identification

Identification of each bearing by a unique number, data on the degree of freedom of movement (fixed, multi-directional or unidirectional bearings) and the type of bearing (spherical, elastomer-pot, etc.) shall appear on each bearing. However, the direction of movement of the bearing must correspond to the direction on the drawings.

f) Design

The bearings shall be designed to accept the specified load combinations in conjunction with the maximum eccentricity and rotation, without overstressing any part in terms of working load requirements or exceeding the requirements for the serviceability limit.

Unless otherwise specified in the Contract Documentation or on the Drawings, the following shall be complied with:

(i) The maximum average stress on the projected area of the PTFE shall not exceed 45 MPa under ultimate effects and 30 MPa under the permanent design load effect for the serviceability limit state. The maximum peak stress on the projected area of the PTFE shall not exceed 55 MPa under all the design load effects and permanent design load effects for the serviceability limit state.

(ii) The maximum average contact stress and maximum edge stress on the concrete or mortar bedding shall not exceed 20 MPa and 25 MPa respectively.
(iii) The initial peak static coefficient of friction shall not exceed 0,06 and the final static coefficient of friction shall not exceed 0,04.

(iv) The max stress in the elastomer shall not exceed 25 MPa for the maximum serviceability limit state.

(v) The bearing shall be of such overall dimensions as to fit into the space allowed for its installation. Major alterations to the contiguous members will not be considered.

(vi) Movements shall be considered at the ultimate limit state for all proprietary bearings.

A13.6.5 MATERIALS

A13.6.5.1 Bearings in structures

a) General

Unless otherwise specified, all the materials used for manufacturing the bearings shall comply with the requirements of EN 1337: Structural bearings.

b) Roofing felt

Roofing felt shall be 3-ply and comply with the requirements of SANS 92 for type 1 roofing felt.

c) Elastomer

(i) General

The elastomer used in the manufacture of Elastomeric Bearings should be specified in the project documentation as either natural rubber (NR) or chloroprene rubber (CR) as the raw polymer. Blending with up to 5 % of another polymer, which may be added to aid processing, is permitted. No reclaimed or ground vulcanized rubber shall be used.

NOTE: Natural rubber bearings can be protected by a cover of polychloroprene, both parts vulcanized simultaneously.

(ii) Physical and mechanical properties of elastomer

The physical and mechanical properties of the elastomer shall comply with the requirements given in Table A13.6.5-1, depending upon the raw polymer used. In case of a natural rubber bearing having a polychloroprene cover, the natural rubber does not have to be tested for ozone resistance.

The polychloroprene compound for the cover shall meet the requirements for polychloroprene and the core shall meet the requirements for NR, except for ozone resistance.

The frequency of the tests given in Clause 8 of EN 1337 – 3.

The specifications are given for moulded test pieces or samples taken from complete finished bearings. In this case they shall be taken from the top and bottom surfaces or first internal layer, and from the internal layer at the centre of the bearing.

Table A13.6.5-1: Physical and mechanical properties of elastomer

Characteristics	Requirements	Test methods
Shore Hardness (IRHD) Shear Modules (MPa) (G)	**60 ± 5** **0.9**	
Tensile strength (MPa) Moulded Test Piece Test Piece from bearing **Minimum Elongation at break (%)** Moulded Test Piece Test Piece from bearing	 **≥ 16** **≥ 14** **425** **375**	 ISO 37 Type 2
Minimum Tear Resistance (kN/m) CR NR	 **≥ 10** **≥ 8**	 ISO 34-1 Trouser (Method A)
Compression Set (%) 24h ; 70 ºC	CR ≥ 15 NR ≥ 30	ISO 815 Ø29 x 12,5 mm Spacer: 9,38 – 25 %
Accelerated Aging (Maximum change from unaged value) - Hardness (IRHD) NR 7 d, 70 ºC CR 3 d, 100 ºC - Tensile strength (%) NR 7 d, 70 ºC CR 3 d, 100 ºC - Elongation at break (%) NR 7 d, 70 ºC CR 3 d, 100 ºC	 - 5 + 10 ± 5 ± 15 ± 15 ± 25 ± 25	ISO 48 ISO188
Ozone Resistance Elongation : 30 % - 96 h 40ºC ± 2ºC NR 25 pphm CR 100 pphm)	No Cracks	ISO 1431-1

d) Stainless steel sliding plates

The texture of the sliding surface of stainless steel plate used in conjunction with PTFE to form low-friction sliding surfaces shall be equal to or better than 0,20 micrometer Ra in accordance with the requirements of BS 1134.

e) Stainless steel plates in elastomeric bearings

All plates in elastomeric bearings shall be manufactured from 3CR12 stainless steel and corners shall be rounded to a 10 mm radius or 10 mm bevel. The plates shall be sand blasted to SA 2 to ISO 8501 to ensure adhesion of the elastomer layers.

The minimum plate thickness shall be 2,0 mm.

f) Stainless steel dowels and bolts

Stainless steel used for the manufacture of dowels and anchor bolts shall comply with the requirements of BS 970: part 4 for steel 316S16.

g) Proprietary mortars

Mortar beddings for seating the bearings shall be composed of an approved sand and either cement or epoxy resin of an approved proprietary mortar. The mortar beddings shall obtain full strength before the bearings are loaded. The mortar shall comply with the following strength requirements:

(i) Sand-cement mortar

The 7-day compressive strength of 100 mm cubes made from the mortar and cured in a moist atmosphere for the first 24 hours and afterwards in water at 22°C to 25°C and shall be not less than 2,0 times the average contact stress under the bearing or 15 MPa whichever is the greater. The samples shall be prepared in accordance with SANS 5861-3 and tested in accordance with SANS 5863.

(ii) Sand-epoxy resin mortar

The cured compressive cube strength of the mortar shall be not less than 2 times the average contact stress under the bearing, or 20 MPa, whichever is the greater. The 100 mm cube samples shall be prepared in accordance with SANS 5861-3 and tested in accordance with SANS 5863.

(iii) Mortar Thickness under bearings

Mortars shall have a maximum thickness of 20 mm unless otherwise specified on the drawings.

A13.6.6 CONSTRUCTION EQUIPMENT

The Contractor shall before construction commences, provide comprehensive details of all plant and equipment which shall be appropriate for lifting, placing and installation of bearings.

A13.6.7 EXECUTION OF THE WORKS

A13.6.7.1 Concrete hinges

Concrete hinges shall be constructed in accordance with the details shown on the drawings.

Construction joints shall not be formed in the throat area. Where a joint is necessary, it shall be formed as a recess below the throat, level with the top reinforcement mat. The width of the recess shall be slightly greater than that of the throat.

Care shall be taken to eliminate the formation of shrinkage cracks within the throat.

During construction, adequate bracing and support shall be provided to the satisfaction of the Engineer to prevent rotation in the throat from the time of casting to completion of the structure incorporating the hinge. During the course of construction the hinge shall not be subjected to conditions which will induce tensile stresses in the throat area.

Upon completion of the structural members incorporating the hinge, the space around the throat shall be filled and sealed with an approved compressible material.

A13.6.7.2 Roofing felt

Roofing felt used as bearing strips shall consist of at least 3 layers of 3 ply roofing felt.

Where lubricated linings are specified, the roofing felt shall be saturated with used motor oil and then liberally dusted with graphite powder before it is laid on the bearing surface.

A13.6.7.3 Proprietary bearings

a) General

This section covers custom-built bearings and bearings manufactured under license, except elastomeric bearings. Combined bearings, consisting of an assembly of an elastomeric bearing in conjunction with a low-friction sliding or mechanical component shall fall under this Clause.

Bearings shall be fitted with adaptor plates to facilitate removal for maintenance and replacement. Only where specifically stated on the drawings or Contract Documentation may adaptor plates be omitted.

The Contractor shall base his tender on any bearing which complies with the specified requirements, provided that the efficacy of the bearing has been verified by tests and successful previous use. Evidence hereof as well as information on the durability and suitability of the bearings for the specified use shall be submitted to the Engineer for consideration together with a performance guarantee.

Details of the product guarantee shall be submitted with the tender and shall be in accordance with the requirements as set out in Chapter 1.

b) Manufacture

Unless otherwise specified in the Contract Documentation or on the Drawings, the following requirements shall be complied with:

(i) The IRHD of the elastomer disc in the pot type of bearing shall be 50 ± 5 or 55 ± 5. The elastomer shall be protected along the edge of the disc by either a metal sealing ring or a capping ring moulded integrally with the disc along the perimeter.

(ii) The thickness of the elastomer disc shall not be less than 0,066 times its diameter.

(iii) The PTFE shall be not less than 3,0 mm thick and shall be recessed into the supporting base to a depth of 0,5 times the thickness of the PTFE plus or minus ± 0,2 mm.

(iv) The minimum dimension of individual PTFE areas shall not be less than 50 mm and their spacing shall be such as to ensure the equal distribution of stress throughout the contiguous members.

(v) The thickness of the stainless-steel sliding plate shall be not less than 1,25 mm. The plate shall be either recessed into or bonded to the base and, in addition, riveted or bolted to the base. The edges of the plate shall be sealed to prevent the ingress of moisture between the plate and the base.

(vi) The slack (play) between the shear transfer members of unidirectional and fixed bearings shall not exceed 2,0 mm, unless otherwise specified.

(vii) Only silicone grease of an approved type shall be used as lubricant between the sliding surfaces.

(viii) The bearing shall be provided with tight- fitting seals to prevent the ingress of dust or deleterious matter onto the moving parts. The

seals shall be of an approved type and shall be sufficiently durable to last for longer than 50 years.

(ix) The assembled bearing shall be supplied with welded or bolted lugs or straps, temporarily securing the moving parts firmly in position to ensure that no undesirable relative movement occurs before or during construction.

(x) The bearing shall be recessed into adaptor plates or bolted to flat plates where no recess is provided. All horizontal loads shall be taken on the recessed flanges or holding down bolts on the adaptor plates

(xi) Anchor and holding-down bolts shall be of the material specified on the Drawings.

(xii) Corrosion protection of the exposed steel surfaces, with the exception of the stainless-steel sliding plate, shall be as follows:

1. Preparation of the surfaces by abrasive blasting to a finish equal to the Sa 3 finish of BS EN ISO 8501-01 medium profile.
2. Sprayed metal coating of the surface with zinc in accordance with the requirements of BS EN 22063, to a thickness of not less than 100 microns.
3. Coating of the zinc-sprayed surfaces shall be within 4 hours with a sealer compatible with the zinc and the subsequent coat of paint.
4. Application of a Zinc Rich Epoxy primer to 50 – 70 microns dft
5. Application of 2 coats of an Epoxy MIO undercoat to 100 microns mdft each.
6. Application of a final coat of a 2 component acrylic polyurethane of 50 microns mdft and of a dark grey colour.
7. Minimum total dry-film thickness 325 microns excluding sprayed metal coating.

Surfaces in contact with concrete shall receive only the treatment described in 1 and 2 above. Hot dip galvanizing may be permitted by the Engineer to replace the Zinc metal spraying in 1 and 2 above, however the manufacturer shall allow for machining the surfaces as required. Special care shall be taken to prevent flaking of the galvanized surfaces.

c) Dowels and guides

Where dowels and guides are used in conjunction with bearings they shall not complicate or prevent the removal of the bearings.

d) Storage and handling

The bearings shall at all times be stored under cover and clear of the ground, away from sunlight, heat, oils and chemicals deleterious to the bearings. The bearings shall not be stacked in a manner or on a surface which will cause distortion of the bearings.

The bearings shall be handled with care to ensure that they are not subjected to impact loads or any other conditions which may be harmful.

e) Installation

The Contractor shall submit to the Engineer for his approval a detailed method statement including all materials and details for the installation of Bridge Bearings.

The concrete surfaces of elements required to receive bearings shall comply with the requirements of Clause A13.2.2.2c). Plastering of the surface will not under any circumstances be permitted.

Before the mortar bedding is constructed, the concrete surface shall be chipped back to expose the aggregate and leave a sound irregular surface. Bonding of the mortar bedding to the concrete surface shall be in accordance with the manufacturer's recommendations and the Engineer's instructions.

Unless otherwise shown on the drawings, the bearings shall be installed on a horizontal plane and shall be in full contact with the concrete and bedding surfaces. In order to ensure full contact between the concrete and the bedding surfaces, the Contractor shall provide a method statement for the system of grouting to be used.

The Contractor shall test the method statement using a mock-up of the bearing installation. After approval by the Engineer, the Contractor shall use the same team who did the mock up test to install the bearings.

To accommodate soffit irregularities and camber in the case of precast members, the member shall be lowered onto an epoxy mortar layer on top of the bearing. The member shall then be propped until the mortar layer has hardened into a wedge.

The bearings shall be accurately installed to the specified level, alignment and orientation, all within the construction tolerances set out in Clause A13.6.8.1a) and the details shown on the drawings.

Where the bearing has long sliding plates, the latter shall be rigidly supported to prevent their being distorted under the weight of the wet concrete and the construction loads.

Before the bearing is incorporated into the structure, it shall be cleaned to remove all deleterious substances and adhering matter, after which it shall be wrapped in polyethylene sheeting and so sealed as to prevent the ingress of mortar and/or slush onto the bearing during the course of construction.

After installation, the polyethylene wrapping shall be removed, the bearing and the space around the bearing thoroughly cleaned and the lugs removed as prescribed by the Engineer.

On completion of installation of proprietary bearings, the Contractor shall submit to the Engineer a certificate from the manufacturer or supplier of the bearings certifying acceptance of the installation in accordance with EN 1337. The issuing of such a certificate shall not relieve the Contractor of his responsibility under this contract. Payment for the inspection of the bearings by the manufacturer or supplier and the issuing of the certificate will be made under Section C20.1 of Chapter 20.

A13.6.8 WORKMANSHIP

A13.6.8.1 Tolerances

The tolerances given below shall be the maximum permissible deviations from the specified dimensions, levels, alignment, positions, etc., shown on the drawings of the structures or structural members.

a) Bearings

Bearings for structures shall be installed to within 5,0 mm of the position shown on the drawings and to within 2,0 mm of the required level.

Horizontal surfaces of Bearing Plinths shall comply with the tolerances as set out in EN 1337-3 Section 7.1.

Dimensional tolerances for elastomeric bearings shall comply with the requirements of EN 1337-3 Section 6.

A13.6.8.2 Inspection and testing

a) Elastomeric bearings

(i) When requested by the Engineer, the Contractor shall submit test certificates from an approved, independent testing authority to show that the respective materials comply with the specified requirements, or a certificate from the patent holder or designer certifying that the manufactured item complies in all respects with the relevant product specifications. All these tests shall be carried out in accordance with the requirements of EN 1337-3 Section 8.

(ii) On completion of the manufacture of the bearings, the Contractor shall submit bearings selected by the Engineer, or specially manufactured bearings to serve as samples as authorised by the Engineer, to an independent testing authority for testing.

The testing facilities of the manufacturer or supplier may be used if so approved and on condition that the tests are conducted in the presence of the Engineer.

The Engineer will determine which tests are to be conducted, and the tests shall comply with the appropriate requirements of Clause A20.1.5.6a) of Chapter 20. Payment will be made under Section C20.1 of Chapter 20 for these tests, for bearings damaged, and for sample bearings.

Copies of test results and certificates for the abovementioned tests shall be submitted by the Contractor to the Engineer in good time to enable the Engineer to assess the information before the bearings are installed.

(iii) Before the bearings are dispatched to the site of the works, each bearing, with the exception of large bearings as defined in Clause A13.6.2, shall be subjected simultaneously to a vertical load equal to 150 % of the maximum design load, and to a shear distortion equal to 150 % of the maximum design value. The bearings shall be visually inspected for defects by the Engineer or his nominee and shall not at any stage under this test show any cracks visible to the naked eye or any other defects. The cost of this testing shall be included in the rate tendered for under Section C20.1 of Chapter 20.

The Engineer may instruct that 1 or more bearings of each consignment shall be cut open with a view to a visual assessment of the bonding and the thickness of the elastomeric layers. Payment for these bearings shall be paid for under payment item C13.6.1.

Large bearings shall also be tested by cutting them into halves or quarters in accordance with EN 1337-3. The test results shall then be factored to ensure that the loads obtained meet the requirements of the design.

(b) Proprietary bearings

The Engineer may require tests to be conducted to verify compliance of the bearing with the EN 1337 specifications and/or its satisfactory performance under the design loads. Payment for this testing will be made under Section C20.1 of Chapter 20.

Test certificates of all the tests conducted shall be submitted to the Engineer.

The Contractor shall give the Engineer at least 14 days' notice prior to final assembly of the bearings to enable the Engineer to inspect the bearings at the factory.

Under no circumstances shall bearings be taken apart and reassembled on the site, except where it is an unavoidable feature of the installation procedure, in which case the dismantling, installation and reassembly shall be under the supervision of qualified personnel.

Rehabilitation, modification and repair work to bearings shall be carried out only in the factory or in an Engineering works approved by the Engineer.

B13.6 BEARINGS
PART B: LABOUR ENHANCEMENT

CONTENTS

B13.6.1 SCOPE

B13.6.2 DEFINITIONS

B13.6.3 GENERAL

B13.6.4 DESIGN BY CONTRACTOR / PERFORMANCE BASED SYSTEMS

B13.6.5 MATERIALS

B13.6.6 CONSTRUCTION EQUIPMENT

B13.6.7 EXECUTION OF THE WORKS

B13.6.8 WORKMANSHIP

B13.6.1 SCOPE

This Section covers various items of work associated with the construction, supply and installation of bearings for structures. This Section is of a specialist nature and is not suitable for labour enhanced work.

B13.6.2 DEFINITIONS

The provisions of Part A shall apply with no additional requirements.

B13.6.3 GENERAL

The provisions of Part A shall apply with no additional requirements.

B13.6.4 DESIGN BY CONTRACTOR / PERFORMANCE BASED SYSTEMS

The provisions of Part A shall apply with no additional requirements.

B13.6.5 MATERIALS

The provisions of Part A shall apply with no additional requirements.

B13.6.6 CONSTRUCTION EQUIPMENT

The provisions of Part A shall apply with no additional requirements.

B13.6.7 EXECUTION OF THE WORKS

The provisions of Part A shall apply with no additional requirements.

B13.6.8 WORKMANSHIP

The provisions of Part A shall apply with no additional requirements.

C13.6 BEARINGS

PART C: MEASUREMENT AND PAYMENT

(i) Preamble

The tendered rate for each item shall include full compensation for providing, maintaining and decommissioning upon completion, of all the plant, equipment, labour, tools, incidentals and supervision to carry out the activity or construct the works in the item, unless otherwise stated.

Any prime cost or provisional sums shall be paid in accordance with the provisions of the conditions of contract. The charge or mark-up tendered or allowed for is a percentage of the amount actually paid under the prime cost or provisional sum. This percentage shall cover all the Contractor's handling, supervision, profit and liability costs to provide the services in the prime cost or provisional sum item.

The requirements of Section C1.1 of Chapter 1 shall apply.

Where pay item descriptions include any wording in brackets it is an indication that contract specific information is to be inserted in the Pricing Schedule included in the Contract Documentation.

(ii) Notes on measurement and pay items

None.

(iii) Items that will not be measured separately

The following activities, whether required to complete the specified work or not, will not be measured and paid for separately and the Contractor shall include the cost thereof in other pay items as he deems appropriate:

1. No separate payment will be made for setting out the works.
2. No separate payment will be made for the protection or repair as required of any existing or new road furniture, structures, buildings, infrastructure or services damaged by the Contractor's activities.
3. No additional payment shall be made, nor shall any claim for additional payment be considered, for any specified work in confined or restricted areas. Any additional costs associated with working in confined or restricted areas shall be deemed to be included in the standard applicable pay items.
4. No separate payment will be made for the loading of any materials.
5. No separate payment will be made for the hauling of any materials where the material is moved over a distance of less than, and up to 1,0 km and for labour enhanced construction, less than and up to 50 m.
6. No separate payment will be made for transporting materials from commercial sources irrespective of the haul distance.
7. No separate payment will be made for the removal or any surplus material imported to complete the works.
8. For all Works performed, precautionary measures required in terms of the Occupational Health and Safety Act (Act 85 of 1993) and the latest amendments thereof as well as the latest Construction Regulations shall be deemed included in the rates tendered for the relevant products.

(iv) Items to be measured and paid for using items specified elsewhere in the specifications

Not applicable to this Section.

(v) Items specifically for this Section of the specifications

Item	Description	Unit
C13.6.1	**Bearings:**	
C13.6.1.1	Bearings (description of each type and class)	number (No)
C13.6.1.2	Provision of Engineering drawings of proprietary bearings and certification after installation, by an ECSA Registered Professional Engineer or Technologist.	lump sum

The unit of measurement shall be the number of complete bearings of each type and class installed.

The tendered rate shall include full compensation for supplying all the materials, including anchor bolts and/or dowels, constructing the bedding, manufacturing the bearings, transporting, handling and storing, and all labour, equipment and incidentals required for installing the bearings complete as detailed. The tendered rate shall also include for the provision of Engineering drawings and certification after installation by an ECSA Registered Professional Engineer or Technologist. Payment shall only be made for the Engineering drawings after the submission of the construction record drawings of the bearings. Payment shall be made in 2 stages 50 % on submission and approval of the Bearings and 50 % on the submission of the record drawings of Bearings.

Item	Description	Unit
C13.6.2	**Concrete Hinges**	
C13.6.2.1	(Description of hinge measured per metre)	metre (m)
C13.6.2.2	(Description of hinge measured by number)	number (No)

The unit of measurement shall be either the metre of complete hinge of each type manufactured and installed or the number of complete hinges of each type manufactured and installed.

The tendered rates shall include full compensation for supplying all materials, including formwork, manufacturing the hinges, transporting, handling and storing, sealing the hinges, and all labour, equipment and incidentals required for installing the hinges complete as detailed.

Item	Description	Unit
C13.6.3	**Bearing strips** (description of the material and number of Layers)	**square metre (m^2)**

The unit of measurement shall be the square metre of bearing area lined with the specified material irrespective of the number of layers placed

The tendered rate shall include full compensation for supplying all the materials, transporting, handling and storing, and all labour and incidentals required for installing the bearing strips complete as detailed.

Item	Description	Unit
C13.6.4	**Dowels or guides** (description of each type)	**number (No)**

The unit of measurement shall be the number of dowels/guides of each type installed.

The tendered rate shall include full compensation for supplying all materials, including anchor bolts, manufacturing the dowels/guides transporting, handling and storing, and all labour, equipment and incidentals required for installing the dowels/guides complete as detailed.

Item	Description	Unit
C13.6.5	**Specialist proprietary bearings:**	
C13.6.5.1	Prime cost sum allowed for purchasing and taking delivery of bearing	prime cost sum
C13.6.5.2	Percentage on prime cost sum for charges and profit	percentage (%)

Payment for purchasing and taking delivery of proprietary bearings, complete with anchor bolts and/or dowels, shall be in accordance with the provisions of the general conditions of contract.

Item	Description	Unit
C13.6.6	**Installing the proprietary bearings** (description of each type, and state class)	**number (No)**

The unit of measurement shall be the number of complete bearings of each type and class installed.

The tendered rate shall include full compensation for supplying all the materials not covered under item C13.6.5, constructing the bedding, transporting, handling and storing, and all labour, equipment and incidentals required for installing the bearings complete as detailed.

The tendered rate shall be final and binding, irrespective of the type or make of bearing finally installed.

D13.6 BEARINGS
PART D: GUARANTEES AND COMPLIANCE CERTIFICATES

CONTENTS

D13.6.1 SCOPE

D13.6.2 GENERAL

D13.6.3 PERFORMANCE GUARANTEE REQUIREMENTS

D13.6.4 FUNCTIONAL PERFORMANCE ASSESSMENTS

D13.6.5 VISUALLY ASSESSED PROPERTIES

D13.6.6 INSTRUMENTALLY ASSESSED PROPERTIES

D13.6.7 EVALUATION FOR ACCEPTANCE

D13.6.8 ADDITIONAL PROCEDURES TO BE ADOPTED IN THE EVENT OF FAILURE

D13.6.9 NOTIFICATION OF REMEDIAL WORK

D13.6.10 REMEDIAL WORK

D13.6.1 SCOPE

The scope of this Section covers the following:

- Product conformance specifications
- Warranties for product or element design and installation of proprietary systems
- Performance specifications

D13.6.2 GENERAL

D13.6.2.1 Product conformance specifications

The Contractor shall within 28 days before manufacture of the Bearings submit to the Engineer conformance documentation related to the specifications. All products used in the manufacture and installation of Bridge bearings shall be in compliance with the specifications contained in Section A13.6 and EN 1337.

Compliance documentation shall be provided for:

a) Carbon Steel
b) Stainless Steel
c) Natural Rubber (NR)
d) Synthetic Rubber (Polychloroprene) (SR)
e) PTFE
f) Epoxy Adhesives
g) Epoxy Mortars

D13.6.3 PERFORMANCE GUARANTEE REQUIREMENTS

D13.6.3.1 Warranties for product or element design and installation of proprietary systems

The design and installation of proprietary bearings shall require a warranty of 25 years to be supplied by the Contractor. The format of this warranty shall be as per Form D13.6.2 hereafter. A full set of drawings of the proprietary bearings shall be submitted together with certificates of all tests carried out in accordance with the requirements of EN 1337.Certification of the installation by a suitably experienced ECSA Registered Professional Engineer or Technologist is also required together with the warranty submitted with the taking over certificate.

D13.63.2 Performance specifications

Performance based specifications shall be contained in the Contract Documentation for the project.

Form D13.6.2

WARRANTY FOR DESIGN, MANUFACTURE AND INSTALLATION OF PROPRIETARY BRIDGE BEARINGS ON (CONTRACT NUMBER AND DESCRIPTION)	
DESCRIPTION	**DETAILS**
Bridge Number	
Name and Address of Contractor	
Name of Contact Person	
Name and Address of Manufacturer	
Name of Contact Person	
Name and Address of Installer	
Name of Contact Person	
Date of Manufacture	
Date of Installation	
Duration of Warranty	
Start date of Warranty	
End date of Warranty	

The Contractor, Manufacturer and Installer hereby warrant that the above bearings will perform satisfactorily in terms of workmanship and durability, and that the bearings have been installed in accordance with the patent holders requirements and as set out in the specifications and on the drawings for each particular bearing.

This warranty is for 25 years from the completion date of the Main Contract for the project.

In the event that the performance of the bearings is not in accordance with this warranty due to materials or workmanship defects, the Contractor undertakes to rectify the bearings within 90 days of receiving the instruction to do so by the Employer.

The bearings shall be completely replaced including, supply and installation including all other costs associated thereto (i.e. Traffic Accommodation, jacking, closure of the road and bridge as agreed to by the Employer) to the satisfaction of the Engineer.

SIGNED ON BEHALF OF CONTRACTOR: _____

SIGNED ON THIS THE _____ DAY OF _____ IN THE YEAR _____

on behalf of: _____

Address: _____

_____

_____

Telephone No: _____

SIGNED ON BEHALF OF MANUFACTURER: _____

SIGNED ON THIS THE _____ DAY OF _____ IN THE YEAR _____

on behalf of: _____

Address: _____

_____

_____

Telephone No: _____

SIGNED ON BEHALF OF INSTALLER: _____

SIGNED ON THIS THE _____ DAY OF _____ IN THE YEAR _____

on behalf of: _____

Address: _____

_____

_____

Telephone No: _____

WITNESS:

Signature: _____

Name: _____

Address: _____

_____

_____

Telephone No: _____

13.7 JOINTS

CONTENTS

PART A: SPECIFICATIONS

A13.7.1. SCOPE

A13.7.2 DEFINITIONS

A13.7.3 GENERAL

A13.7.4 DESIGN BY CONTRACTOR / PERFORMANCE BASED SYSTEMS

A13.7.5 MATERIALS

A13.7.6 CONSTRUCTION EQUIPMENT

A13.7.7 EXECUTION OF THE WORKS

A13.7.8 WORKMANSHIP

PART B: LABOUR ENHANCEMENT

PART C: MEASUREMENT AND PAYMENT

PART D: GUARANTEES AND COMPLIANCE CERTIFICATES

A13.7 JOINTS

PART A: SPECIFICATIONS

A13.7.1 SCOPE

This Section covers the supply and installation of all permanent joints which will permit relative movement between contiguous structural members.

A13.7.2 DEFINITIONS

The following definitions shall apply to this Section.

Joint Termination - shall consist of the end treatment of a joint at a barrier, wall, soffit, parapet or sidewalk kerb.

Thermoplastic sealants - thermoplastic material has a high concentration of polymers with amorphous structures and excellent elasticity. These sealants can be either hot poured or cold applied.

International Rubber Hardness Degree - refer to Clause A13.6.2. The hardness of rubber used in joint glands is defined as international Rubber Hardness Degree IRHD

Polyethelene Tape - polyethelenes are types of polymers which are thermoplastic in nature

Agrément South Africa - an objective, independent agency which evaluates the fitness-for-purpose of non-standard construction products.

A13.7.3 GENERAL

This Section covers all types of joints in structures including horizontal and vertical joints in walls and slabs and bridge deck expansion joints. Cover plates at the termination of bridge joints shall always be provided.

Proprietary bridge joints shall have Agrément South Africa certification. The certification shall include the Roadway / Footwalk / Barrier interface as part of the complete Joint System.

Joint terminations in Roadway Joints shall always be constructed as part of all expansion joints in the roadway.

A13.7.3.1 Method Statements

The method statements and typical drawings submitted by the Contractor with his tender submission, describing key facets such as method, key plant, materials, personnel and programme constraints of the envisaged construction process, shall form the basis for the detailed method statements required for the works to be executed on the project.

These method statements shall be prepared and submitted to the Engineer for approval for each facet of the work at the start of construction, within time scales specified. The onus lies with the Contractor to ensure that the information is gathered and associated activities are completed expeditiously so as to avoid any delays in the commencement, continuation and completion of the required works. Unless otherwise specified or provided for in the Contract Documentation no permanent works shall be commenced until the Engineer's approval has been obtained. Due allowance shall be made for obtaining alternative materials, resubmissions and redesigns, all to the required/approved standards, methods and

practices in attending to these requirements. Particular attention shall be paid to the early submission of materials-, concrete- and grout mix designs where parameters at various ages may be specified. No consideration for extension of the contract period will be entertained for delays incurred in meeting these requirements.

Trials, if applicable, shall be conducted and based on outcomes thereof, may require that changes be made to the relevant method statements. Once approved in writing by the Engineer, these shall become the method statements in accordance whereby the relevant portion of the works shall henceforth be executed. Notwithstanding, the Engineer may require revision from time to time if circumstances during construction arise which warrants change.

The Contractor shall, however, remain responsible for all work-methods, materials, plant and equipment used, notwithstanding acceptance by the Engineer.

A13.7.3.2 Hold points and approvals

The Contractor shall comply with the specified hold points relating to approvals required from the Engineer. A hold point is a stage of the work, where the Engineer's approval is required, before commencement or continuance of that particular activity by the Contractor, is permitted. Project specific requirements will be included in the Contract Documentation or agreed upon between the Engineer and the Contractor.

A13.7.4 DESIGN BY CONTRACTOR / PERFORMANCE BASED SYSTEMS

A13.7.4.1 Design and manufacture of proprietary joints

The expansion joint shall be designed to withstand the movements, displacements and rotations specified on the design drawings in conjunction with the loads described in the code of practice adopted for the design of the structure without exceeding in any member the requirement for serviceability limit state. Any strengthening of the supporting member required to resist forces imparted by the joint to the structure shall be for the Contractor's account.

The specified movements, displacements and rotations shall be withstood without the efficacy or riding quality of the road being impaired.

The joint shall be vibration free, resistant to mechanical wear and other forms of abrasion, and shall resist corrosion. ▮ shall have good riding quality characteristics, shall be highly skid resistant, and silent, also of watertight construction or have provision for the disposal of water, debris or grit collecting in the joint. The construction of the joint shall facilitate easy inspection, maintenance and repair.

Corrosion protection of all the steel surfaces, with the exception of the stainless-steel section, shall be as follows:

a) Preparation of the surfaces by abrasive blasting to a finish equal to the Sa 3 finish of BS EN ISO 8501-01 medium profile.

b) Sprayed metal coating of the surface with zinc in accordance with the requirements of BS EN 22063, to a thickness of not less than 100 microns. Steel sections may also be hot dipped galvanized in accordance with the requirements of SANS 1391 part 1 for Zn 150 coverage.

c) Coating of the zinc-sprayed or galvanized surfaces shall be within 4 hours with a sealer compatible with the zinc and the subsequent coat of paint.

d) Application of a Zinc Rich Epoxy primer to 50 – 70 microns dft

e) Application of 2 coats of an Epoxy MIO undercoat to 100 microns mdft each.

f) Application of a final coat of a 2 component acrylic polyurethane of 50 microns mdft and of a dark grey colour.

g) Minimum total dry-film thickness 325 microns excluding sprayed metal coating.

h) All proprietary joints shall have a joint termination into the barrier, parapet or sidewalk kerb which shall be turned up to an adequate height such that it shall sustain the water tests as specified elsewhere herein.

i) Cover plates in bariers, parapets and sidewalk kerbs shall be manufactured from nonmetallic materials as specified on the drawings.

j) All fixing systems of the nonmetallic cover plates to the concrete surfaces shall be stainless steel.

Prior to manufacture of the joints, the Contractor shall submit for approval detail drawings in accordance with the requirements of chapter 1 for each expansion joint. The design drawings shall be signed off by an ECSA Registered Professional Engineer or Technologist before manufacture and shall also be handled in with the record drawings of the structure.

The expansion joints delivered at the site shall be suitably marked to show clearly the sequence and position of installation.

A13.7.5 MATERIALS

A13.7.5.1 Joints in structures

a) General

All materials used in forming, constructing and sealing permanent joints as well as all proprietary or custom-built expansion-joint assemblies shall be subject to the approval of the Engineer.

b) Joint filler

Joint filler shall consist of sheets or strips of the following materials complying with the requirements of the relevant specifications listed:

Bitumen-impregnated fibreboard and bitumen - impregnated corkboard – US Federal Specification HH- F-341F or AASHTO Specification M213.

Resin-impregnated corkboard U S Federal Specification HH-F-341F.

Flexible foams of expanded polyethylene, polyurethane, PVC or polypropylene AASHTO Specification.

Rigid foams of expanded polyethylene, polyurethane or polystyrene BS 4840 or BS 3837.

Other joint filler materials may be used if approved by the Engineer after he has been furnished with full specifications and information by the Contractor.

c) Sealants

Thermoplastic hot-poured sealants shall comply with the requirements of US Federal Specification SS-S-1401B, BS 2499 or AASHTO Specification M173. The sealants shall be of the rubberised bituminous type containing a minimum of 20 % natural or synthetic rubber.

Thermoplastic cold-applied sealants shall comply with the requirements of US Federal Specification SS-2-200E(2). The sealant shall be of the rubberised bituminous type containing a minimum of 20 % natural or synthetic rubber.

Thermosetting chemically curing sealants shall comply with the requirements of ASTM C.920 or BS 4254.

The final IRHD hardness of the sealant shall be 20 ± 5.

Silicone sealants shall comply with the requirements of Clause A6.1.5.7c) of Chapter 6.

d) Waterstops

Waterstops shall be of natural rubber or flexible PVC and of the type specified or shown on the drawings.

Natural-rubber waterstops shall comply with the requirements of CKS 388.

Flexible PVC rubber waterstops shall comply with the requirements of CKS 389.

e) Accessory material

(i) Primers

Where a primer is to be used in conjunction with the sealant, it shall be of the prescribed proprietary material.

(ii) Bond breakers

Polyethylene tape, coated paper, metal foil or similar material may be used where bond breakers are required.

(iii) Backup material

Backup material shall consist of a compressible material of correct width and shape to ensure that, after installation, it will be in approximately 50 % compression and the sealant can be formed to the specified depth.

Backup materials shall be compatible with the sealant used. Material containing bitumen or volatiles shall not be used with thermosetting chemically curing sealants.

f) Joint terminations

Joint terminations shall be constructed of the same materials as the roadway joint and form a watertight monolithic system at the interface with the barrier, wall, parapet and sidewall kerbs.

g) Cover plates

Cover plates at the termination of bridge deck joints shall be manufactured from fibre reinforced approved UV resistant nonmetallic materials. Cover plates shall have a minimum thickness of 6,0 mm and specifications and drawings of cover plates shall be submitted to the Engineer for approval. Anchor bolts and washers shall be of stainless steel grade x10CvNi18-8Co.05-0.155=0.015 which complies with the requirements of BS EN 10088 part 1.

A13.7.6 CONSTRUCTION EQUIPMENT

The Contractor shall before construction commences, provide comprehensive details of all plant and equipment which is appropriate for lifting, placing and installation of bridge deck expansion joints.

A13.7.7 EXECUTION OF THE WORKS

A13.7.7.1 Filled and unfilled joints

a) General

Wherever polystyrene or similar material susceptible to damage is used for forming joints, it shall be lined with a hard surface on the side to be concreted. The hard surface shall be sufficiently resilient to ensure that the joint and surfaces can be formed free from defects.

b) Filled joints

Filled joints shall be accurately formed to the dimensions shown and with the filler material specified on the drawings. The filler shall be secured in position not to displace during concreting or thereafter if the filler is to remain permanently in the joint.

Where the removal of the filler is required, it shall be done prior to the installation of the proprietary joint.

c) Unfilled joints

Unfilled joints shall be accurately formed to the dimensions given on the drawings, and all external corners chamfered or rounded for at least 5,0 mm. The concrete face against which the fresh concrete is placed shall be treated in good time with an approved bond breaker.

d) Concrete nosings forming the edges of expansion joints shall be constructed as follows:

After the concrete in the structural member has hardened sufficiently, the protruding ends of the reinforcing steel shall be bent flat onto the

concrete surface of the formed recess.

Before the asphalt surfacing is laid, the recess shall be filled with well-compacted crusher run, sand or weak mortar. The Contractor shall ensure that the concrete surfaces of the recess and the reinforcing steel are not contaminated with bituminous agents. The asphalt surfacing shall then be laid continuously over the joint.

The asphalt surfacing shall be parallel cut with a diamond saw blade to correspond to the width of the nosing and all material shall be removed from the nosing recess. The concrete surfaces of the recess shall then be roughened to expose the aggregate and leave sound, irregular surfaces. The reinforcing steel shall then be bent, fixed and placed as shown on the drawings.

The prepared concrete surfaces of the recesses shall be treated as specified in Clause A13.4.7.11g)(ii), immediately before the concrete nosings are cast. Opposite concrete nosings separated by a joint filler strip as specified, shall be cast simultaneously in accordance with Clause A13.4.7.11g)(iii) and compacted by vibrator. The nosing shall be screeded flush with the asphalt surfacing and be given a class U2 surface finish.

Curing shall be in accordance with method (6) of Clause A13.4.7.11h).

The exposed corners of the nosings shall be ground to a 10 mm chamfer.

After the joint has been sealed, the wearing surface of the nosings shall be treated with a bituminous primer to the satisfaction of the Engineer.

Unless otherwise specified, traffic shall not be permitted to pass over the joint before the concrete in the nosing has aged for at least 10 days.

Unless otherwise indicated on the drawings, the concrete used in the construction of the nosings shall be class C32/40 with a 13 mm aggregate and shall have a slump of not less than 50 mm and not exceeding 75 mm.

Concrete nosings shall be constructed under the direct supervision of experienced and skilled personnel.

A13.7.7.2 Asphaltic plug proprietary type expansion joint systems

Asphaltic Plug proprietary type expansion joint systems, shall be constructed in accordance with the details on the drawings and the specifications and instructions of the licensees which are to be submitted to the Engineer.

A13.7.7.3 Sealing the joints

a) General

Sealed joints shall be made watertight over the full length of the joint, including the full height of the kerbing, unless otherwise prescribed in the Contract Documentation.

Unless a waterstop is equipped with an effective watertight interlocking system for joining sections, all joints in waterstops shall be bonded or fused to have a tensile strength of at least 50% of that of the unjointed material. At intersections and abrupt changes of direction, waterstops shall be jointed with prefabricated junction pieces.

Restrictions on joint width and on the temperature at the time of installing the sealant or seal will be shown on the drawings. In the absence of such restrictions on the drawings, and unless otherwise specified, installation shall be carried out only within the temperature range between 5° C and 30°C.

b) Preparing the joints

Where required joints shall be sawn at a suitable time so as to avoid edge spalling or ravelling.

After the temporary filler material has been removed or the excess concrete has been broken out, the inside faces of the joint shall be wire-brushed or sand-blasted to remove all laitance and contaminants. The joint shall then be cleaned and blown out with compressed air to remove all traces of dust. Solvents shall not be used for removing contaminants from the concrete and porous surfaces.

The Contractor shall ensure that primers are applied only to surfaces which are absolutely dry. The primer shall be applied strictly in accordance with the manufacturer's instructions. Unless otherwise specified, the primer shall be applied within the temperature range of 10°C and 40°C and the sealant shall be applied after the curing period of the primer and within the period when the primer remains active.

c) Sealants

Sealants shall be applied strictly in accordance with the manufacturer's instructions by a person skilled in the use of the particular type of sealant. Trapping of air and the forming of voids in the sealant shall be avoided. The sealant shall be finished to a neat appearance to the specified depth.

Thermoplastic hot-poured sealants shall not be poured into the joints when the temperature of the joint is below 10°C. The safe heating temperature shall not exceed the specified pouring temperature by more than 10°C.

Two-part thermosetting chemically curing sealants shall not be applied after expiry of the specified pot-life period which commences once the base and activator of the sealant have been combined.

d) Waterstops

Waterstops shall be securely and accurately located in position so that they will not be displaced or deformed during construction.

A13.7.7.4 Proprietary expansion joints

a) General

The use of all types of proprietary expansion joint shall be subject to approval of the Engineer.

b) Dimensions

The Contractor shall note the overall dimensions of the expansion joints and the limiting dimensions of that portion of the concrete structure which is to accommodate the joints. No alterations to the concrete which will be visible in the final structure or major re-arrangement of the prestressing anchorages, will be permitted in order to accommodate joints of excessive size.

All joints to be installed skew shall be accurately dimensioned to ensure compliance with the requirements of Clause A13.7.7.4c).

Unless otherwise specified, proprietary expansion joints shall include the complete expansion-joint assembly, traversing the entire roadway, kerbs, sidewalks and median, and shall include the joint terminations and barrier, parapet and sidewalk kerb nonmetallic cover plates as well as the drainage system to drain the expansion joint

c) Installing the expansion joints

All deck expansion joints shall be installed by approved specialist subcontractors only. Installed deck expansion joints shall have the following guarantees which shall be applicable from the date of the taking over certificate for the periods as prescribed hereunder.

Proprietary joints - 25 years

Asphalt plug type joints - 15 years

Elastomeric glands - 15 years

The guarantee provided shall include the nosings and the joint Roadway / Footwalk / Barrier interface and all components which make up the joint system

Proprietary deck expansion joints will only be considered for use if the manufacturer has obtained Agrément South Africa certification.

No expansion joint or part thereof shall be installed prior to the construction of the final surfacing, unless otherwise approved.

The joint manufacturer and installer shall take full account of the reinforcement in the structural element into which the joint system is to be installed. No indiscriminate cutting of existing reinforcement in joint recesses shall be permitted.

- The expansion joint shall form an even surface with the road surface on either side or the deviation across and along the expansion joint shall comply with the requirements of Chapter 5 for surface regularity measured by ordinary straight-edge.

On completion of the installation of proprietary expansion joints, the Contractor shall submit to the Engineer a certificate from the manufacturer or supplier of the joints, certifying acceptance of the installation. Notwithstanding the issuing of such certificate, it shall not relieve the Contractor of his responsibility under the contract. Payment for the inspection of the joints and the issuing of the certificate by the manufacturer or supplier will be made under Section C20.1 of Chapter 20.

A13.7.8 WORKMANSHIP

A13.7.8.1 Tolerances

The joint assemblies shall be constructed within a tolerance of ± 5,0 mm for all dimensions. The alignment shall not deviate from the true alignment by more than 10 mm in any place, nor shall other alignment deviate by more than 5,0 mm from the true alignment over a length of 5,0 m.

A13.7.8.2 Inspection and testing

When ordered by the Engineer, the Contractor shall submit test certificates issued by an approved, independent testing authority to confirm that the respective materials in joint systems comply with the specified requirements, or a certificate by the patent holder or designer certifying that the manufactured item complies in all respects with relevant product specifications.

A13.7.8.3 Water testing of joints

The water shall be ponded and maintained to a minimum depth 150 mm above the top of the joints at the lowest kerb or a minimum of 100 mm elsewhere for a period of one hour each.

The testing should follow the installation of various sections of joints to take advantage of the existing traffic accommodation and each test shall cover the length of each joint installed. (Generally, the half width of the bridge).

The Engineer has the right to order any additional water tests to prove the joint should this be required at his sole direction.

B13.7 JOINTS
PART B: LABOUR ENHANCEMENT

CONTENTS

B13.7.1 SCOPE

B13.7.2 DEFINITIONS

B13.7.3 GENERAL

B13.7.4 DESIGN BY CONTRACTOR / PERFORMANCE BASED SYSTEMS

B13.7.5 MATERIALS

B13.7.6 CONSTRUCTION EQUIPMENT

B13.7.7 EXECUTION OF THE WORKS

B13.7.8 WORKMANSHIP

B13.7.1 SCOPE

This Section covers the supply and installation of all permanent joints which will permit relative movement between contiguous structural members. Complex joints are deemed to be of a specialist nature and hence not suitable for labour enhanced work.

B13.7.2 DEFINITIONS

The provisions of Part A shall apply with no additional requirements.

B13.7.3 GENERAL

The provisions of Part A shall apply with no additional requirements.

B13.7.4 DESIGN BY CONTRACTOR / PERFORMANCE BASED SYSTEMS

The provisions of Part A shall apply with no additional requirements.

B13.7.5 MATERIALS

The provisions of Part A shall apply with no additional requirements.

B13.7.6 CONSTRUCTION EQUIPMENT

The provisions of Part A shall apply with no additional requirements.

B13.7.7 EXECUTION OF THE WORKS

The provisions of Part A shall apply with no additional requirements.

B13.7.8 WORKMANSHIP

The provisions of Part A shall apply with no additional requirements.

C13.7 JOINTS

PART C: MEASUREMENT AND PAYMENT

(i) Preamble

The tendered rate for each item shall include full compensation for providing, maintaining and decommissioning upon completion, of all the plant, equipment, labour, tools, incidentals and supervision to carry out the activity or construct the works in the item, unless otherwise stated.

Any prime cost or provisional sums shall be paid in accordance with the provisions of the conditions of contract. The charge or mark-up tendered or allowed for is a percentage of the amount actually paid under the prime cost or provisional sum. This percentage shall cover all the Contractor's handling, supervision, profit and liability costs to provide the services in the prime cost or provisional sum item.

The requirements of Section C1.1 of Chapter 1 shall apply.

Where pay item descriptions include any wording in brackets it is an indication that contract specific information is to be inserted in the Pricing Schedule included in the Contract Documentation.

(ii) Notes on measurement and pay items

None.

(iii) Items that will not be measured separately

The following activities, whether required to complete the specified work or not, will not be measured and paid for separately and the Contractor shall include the cost thereof in other pay items as he deems appropriate:

1. No separate payment will be made for setting out the works.
2. No separate payment will be made for the protection or repair as required of any existing or new road furniture, structures, buildings, infrastructure or services damaged by the Contractor's activities.
3. No additional payment shall be made, nor shall any claim for additional payment be considered, for any specified work in confined or restricted areas. Any additional costs associated with working in confined or restricted areas shall be deemed to be included in the standard applicable pay items.
4. No separate payment will be made for the loading of any materials.
5. No separate payment will be made for the hauling of any materials where the material is moved over a distance of less than, and up to 1,0 km and for labour enhanced construction, less than and up to 50 m.
6. No separate payment will be made for transporting materials from commercial sources irrespective of the haul distance.
7. No separate payment will be made for the removal or any surplus material imported to complete the works.
8. For all Works performed, precautionary measures required in terms of the Occupational Health and Safety Act (Act 85 of 1993) and the latest amendments thereof as well as the latest Construction Regulations shall be deemed included in the rates tendered for the relevant products.

(iv) Items to be measured and paid for using items specified elsewhere in the specifications

For activities in Table C13.7-1 pay items specified in other Chapters or Sections of the specifications, where they relate to work under this Section, will be listed in the Pricing Schedule.

Table C13.7-1: Payment items from other Chapters or Sections

Activity	Section 13.7 reference	Section item reference
Filled joints	C13.7.21 and C13.7.2.2	C13.2.1, C13.2.2, C13.2.3 and C13.2.4 - All applicable items
Unfilled joints	C13.7.3.1 and C13.7.3.2	C13.2.1, C13.2.2, C13.2.3 and C13.2.4 - All applicable items
Expansion joints	C13.7.10.1 and C13.7.10.2	C13.2.6 - All applicable items

(v) Items specifically for this Section of the specifications

Item	Description	Unit
C13.7.1	**Expansion joints:**	
C13.7.1.1	(Description of joint measured per metre)	metre (m)
C13.7.1.2	(Description of joint measured by number)	number (No)

The unit of measurement shall be either the metre of complete joint between the kerbs of each type supplied and installed or the number of complete joints of each type supplied and installed excluding the non-metallic coverplates.

The tendered rates shall include full compensation for supplying all materials, transporting, handling and storing, and all labour, equipment, shaping the recesses, and incidentals required for installing the expansion joint complete in accordance with instructions (see notes 1 and 2 below). The joint measured shall be the complete joint shown on the drawings excluding the joint termination details, recesses and cover plates at the barriers, parapets and sidewalks.

The tendered rates shall include full compensation for supplying all the materials, manufacturing the expansion joint, transporting, handling and storing, and all labour, equipment, shaping the recesses, and incidentals required for installing the expansion joint complete in accordance with instructions (see notes 1 and 2 below).

The tendered rate for items C13.7.1.1 and C13.7.1.2 shall also include for water test required to prove the joint. The tendered rate shall include full compensation for providing the pond of water and maintaining its depth of 150 mm for the full one hour period and clearing away the ponding materials on completion.

Item	Description	Unit
C13.7.2	**Filled joints:**	
C13.7.2.1	(Description of joint and thickness of joint filler for joints measured per square metre)	square metre (m²)
C13.7.2.2	(Description of joint and thickness of joint filler for joints measured per metre)	metre (m)

The unit of measurement shall be the square metre of filled joint calculated from the surface area of the joint. Where the filled joint is 150 mm or less in depth, the unit of measurement shall be the metre of filled joints measured along the joint centre line. Concrete surfaces formed prior to the construction of the final surface for completing the filled joint shall be measured under item C13.2.1, C13.2.2, C13.2.3 or C13.2.4, as may be applicable.

The tendered rates shall include full compensation for supplying and installing the joint filler and all materials not covered under item C13.7.4, and for all labour and incidentals required for completing the filled joint as prescribed.

The tendered rate for items C13.7.2.1 and C13.7.2.2 shall also include for water test required to test the joint. The tendered rate shall include full compensation for providing the pond of water and maintaining its depth of 150 mm for the full one hour period and clearing away the ponding materials on completion.

Item	Description	Unit
C13.7.3	**Unfilled joints:**	
C13.7.3.1	(Description of joint for joints measured per square metre)	square metre (m²)
C13.7.3.2	(Description of joint for joints measured per linear metre)	metre (m)

The unit of measurement shall be the square metre of unfilled joint, calculated in accordance with the joint area. Where, however, the depth of the joint is 150 mm or less, the unit of measurement shall be the metre of unfilled Joint measured long the joint centre line. Concrete areas formed before the final surface is constructed to complete the unfilled joint, shall be measured under items C13.2.1, C13.2.2, C13.2.3 or C13.2.4, as may be applicable.

The tendered rates shall include full compensation for providing and applying the bond breaker and also for the labour and incidentals required for completing the unfilled joint as prescribed.

Item	Description	Unit
C13.7.4	**Sealing joints with:**	
C13.7.4.1	Sealant (description of joint, sealant and size)	metre (m)
C13.7.4.2	Waterstop (description of joint, waterstop and size)	metre (m)

The unit of measurement shall be the metre of sealant, seal or waterstop of each type installed.

The tendered rates shall include full compensation for supplying all materials, forming or cutting the concrete to the required shape and size, all labour, equipment and incidentals required for sealing the joint complete in accordance with the prescriptions, and for all waste materials (see note 2 below).

Item	Description	Unit
C13.7.5	**Supply and installation of Agrément South Africa certified proprietary expansion joints**	
C13.7.5.1	Claw and other modular joints in nosings	
(a)	Type of joint and movement range specified	metre (m)
(b)	Type of joint and movement range specified	metre (m)
C13.7.5.2	Asphaltic plug type joints	
(a)	150 x 50 mm	metre (m)
(b)	300 x 50 mm	metre (m)
(c)	400 x 75 mm	metre (m)

(d)	500 x 75 mm	metre (m)
(e)	500 x 100 mm	metre (m)
(f)	(other dimensions as specified)	metre (m)
(g)	Extra over for variation in joint depth of asphaltic joints	litre (lit)
C13.7.5.3	Provision of Engineering Drawings of proprietary joints and certification after installation by an ECSA registered professional Engineer of technologist	lump sum

The unit of measurement shall be the metre of complete joint inclusive of concrete or elastomeric nosings between the kerbs of each type installed excluding the joint terminations and nonmetallic coverplates.

The tendered rates shall include full compensation for supplying all materials, transporting, handling and storing, and all labour, equipment, shaping the recesses, and incidentals required for installing the expansion joint complete in accordance with instructions (see notes 1 and 2 below). The joint measured shall be the complete joint shown on the drawings excluding the joint termination details, recesses and cover plates at the barriers, parapets and sidewalks. Payment for the Engineering drawings shall only be made after the submission of the construction record drawings of the joints.

The tendered rate for all the sub items shall also include for water test required to prove the joint. The tendered rate shall include full compensation for providing the pond of water and maintaining its depth of 150mm for the full one hour period and clearing away the ponding materials on completion.

The tendered rate shall be final and binding, irrespective of the type or make of joint finally installed.

Item	Description	Unit
C13.7.6	**Joint terminations in:**	
C13.7.6.1	Barriers and Parapets (type of joint indicated)	number (No)
C13.7.6.2	Sidewalks (type of joint indicated)	number (No)

The unit of measurement shall be the number of each type of joint termination installed.

The tendered rate shall include full compensation for all supplying materials transporting, handling and storing, and all labour, plant and equipment to form the recesses and install the joint terminations as specified and indicated on the drawings.

Item	Description	Unit
C13.7.7	**Cover plates (non-metallic) in barriers, parapets and sidewalks where specified on the drawings in:**	
C13.7.7.1	Barriers and Parapets (type of joint indicated)	number (No)
C13.7.7.2	Sidewalks (type of joint indicated)	number (No)

The unit of measurement shall be the number of each type and size of cover plates installed.

The tendered rate shall include full compensation for the supply and installation of the cover plate and box outs as detailed on the drawings. The tendered rate shall also include for all stainless steel bolts and fixing anchors' and incidentals as specified.

Item	Description	Unit
C13.7.8	**Additional water tests for joints ordered by the Engineer**	number (No)

The unit of measurement shall be the number of additional water tests for proving the expansion joints, as ordered by the Engineer.

The tendered rate shall include full compensation for providing the pond of water and maintaining its minimum depth of 150mm for the full one hour period, and clearing away the ponding materials on completion.

Item	Description	Unit
C13.7.9	**Specialist proprietary expansion joints:**	
C13.7.9.1	Prime cost sum allowed for purchasing and taking delivery of expansion joints	prime cost sum
C13.7.9.2	Percentage on prime cost sum for charges and profit	percent (%)

Payment for purchasing and taking delivery of proprietary expansion joints shall be in accordance with the provisions of the general conditions of contract (see note 2 below).

Item	Description	Unit
C13.7.10	**Installation of specialist proprietary expansion joints:**	
C13.7.10.1	(Description of joint measured per metre)	metre (m)
C13.7.10.2	(Description of joint measured by number)	number (No)

Notes:

(1) The cost of forming the open joint(s) shall not be included in the rates tendered for items C13.7.5 and C13.7.10 as payment for this work shall be made under item C13.2.6.

(2) Separate payment shall not be made for supplying and/or installing the seal in proprietary expansion joints or the seal between concrete or synthetic nosings.

(3) Measurement of and payment for concrete sidewalks (including kerbing and copings) shall be made in accordance with Clauses the measurement and payment items for formwork, steel reinforcement and concrete.

D13.7 JOINTS
PART D: GUARANTEES AND COMPLIANCE CERTIFICATES

CONTENTS

D13.7.1 SCOPE

D13.7.2 GENERAL

D13.7.3 PERFORMANCE GUARANTEE REQUIREMENTS

D13.7.4 FUNCTIONAL PERFORMANCE ASSESSMENTS

D13.7.5 VISUALLY ASSESSED PROPERTIES

D13.7.6 INSTRUMENTALLY ASSESSED PROPERTIES

D13.7.7 EVALUATION FOR ACCEPTANCE

D13.7.8 ADDITIONAL PROCEDURES TO BE ADOPTED IN THE EVENT OF FAILURE

D13.7.9 NOTIFICATION OF REMEDIAL WORK

D13.7.10 REMEDIAL WORK

D13.7.1 SCOPE

The scope of this Section covers the following:

- Product conformance specifications
- Warranties for product or element design and installation of proprietary systems
- Performance specifications

D13.7.2 GENERAL

D13.7.2.1 Product conformance specifications

The Contractor shall within 28 days of entering into the contract with the Employer submit to the Engineer conformance documentation related to the specifications. All products used in the manufacture and installation of Bridge joints shall be in compliance with the specifications contained in Section A13.7.

Compliance documentation shall be provided for:

a) Carbon Steel
b) Stainless Steel
c) Elastomeric Glands
d) Asphaltic Plug joint material.
e) All sealants
f) Epoxy Adhesives
g) Epoxy Mortars

D13.7.3 PERFORMANCE GUARANTEE REQUIREMENTS

D13.7.3.1 Warranties for product or element design and installation of proprietary systems

The design and installation of proprietary bearings shall require a warranty of 25 years to be supplied by the Contractor. The format of this warranty shall be as per Form D13.7.2 hereafter. A full set of drawings of the proprietary joints shall be submitted together with certificates of all tests carried out in accordance with the manufacturers or Agrément requirements. Certification of the installation by a suitably experienced ECSA Registered Professional Engineer or Technologist is also required together with the warranty.

The following periods are prescribed for bridge deck expansion joints as follows:

Proprietary Joints - 25 years

Asphaltic Plug Type Joint - 15 years

Elastomeric Glands - 15 years.

D13.7.3.2 Performance specifications

Performance based specifications shall be contained in the Contract Documentation for the project.

FORM D13.7.2

WARRANTY FOR DESIGN, MANUFACTURE AND INSTALLATION OF PROPRIETARY BRIDGE DECKS EXPANSION JOINTS ON (CONTRACT NUMBER AND DESCRIPTION)	
DESCRIPTION	**DETAILS**
Bridge Number and Type of Joint	
Name and Address of Contractor	
Name of Contact Person	
Name and Address of Manufacturer	
Name of Contact Person	
Name and Address of Installer	
Name of Contact Person	
Date of Manufacture	
Date of Installation	
Duration of Warranty	
Start date of Warranty	
End date of Warranty	

The Contractor, Manufacturer and Installer hereby warrant that the above joints will perform satisfactorily in terms of workmanship and durability, and that the joints have been installed in accordance with the patent holder's requirements and as set out in the specifications and on the drawings for each particular joints.

This warranty is for 25* or 15* years from the completion date of the Main Contract for the project. (*Delete whichever is not applicable).

In the event that the performance of the joints is not in accordance with this warranty due to materials or workmanship defects, the Contractor undertakes to rectify the joints within 90 days of receiving the instruction to do so by the Employer.

The joints shall be completely replaced including, supply and installation including all other costs associated thereto (i.e. Traffic Accommodation, Closure of the road and bridge as agreed to by the Employer) to the satisfaction of the Engineer.

SIGNED ON BEHALF OF MAIN CONTRACTOR: _____

SIGNED ON THIS THE _____ DAY OF _____ IN THE YEAR _____

on behalf of: _____

Address: _____

_____

_____

Telephone No: _____

SIGNED ON BEHALF OF MANUFACTURER: _____

SIGNED ON THIS THE _____ DAY OF _____ IN THE YEAR _____

on behalf of: _____

Address: _____

_____

_____

Telephone No: _____

SIGNED ON BEHALF OF INSTALLER: _____

SIGNED ON THIS THE _____ DAY OF _____ IN THE YEAR _____

on behalf of: _____

Address: _____

_____

_____

Telephone No: _____

WITNESS:

Signature: _____

Name: _____

Address: _____

_____

_____

Telephone No: _____

13.8 ANCILLARY STRUCTURAL ELEMENTS

CONTENTS

PART A: SPECIFICATIONS

A13.8.1. SCOPE

A13.8.2 DEFINITIONS

A13.8.3 GENERAL

A13.8.4 DESIGN BY CONTRACTOR / PERFORMANCE BASED SYSTEMS

A13.8.5 MATERIALS

A13.8.6 CONSTRUCTION EQUIPMENT

A13.8.7 EXECUTION OF THE WORKS

A13.8.8 WORKMANSHIP

PART B: LABOUR ENHANCEMENT

PART C: MEASUREMENT AND PAYMENT

PART D: GUARANTEES AND COMPLIANCE CERTIFICATES

A13.8 ANCILLARY STRUCTURAL ELEMENTS

PART A: SPECIFICATIONS

A13.8.1 SCOPE

This Section covers:

a) The construction of barriers, parapets, railings and sidewalks on structures.

b) The construction and installation of drainage works such as weep holes, drainage pipes and gulley's, no-fines concrete blocks, filter lining and concrete channels; and.

c) The installation of bolt groups for electrification brackets.

d) The installation of service ducts

A13.8.2 DEFINITIONS

Concrete Barriers - a barrier is a concrete element which separates lanes of traffic (or pedestrians) in the same or opposing directions.

Parapets - a parapet is an element constructed on sides of bridges and other structures to prevent traffic from falling off where there is a vertical drop.

Railings - railings manufactured from various materials are constructed along footwalks to prevent pedestrians from falling off where there is a drop.

Transition Blocks - transition blocks are concrete members constructed between elements of different cross sections such as barriers, end blocks, parapets, kerbs and channels etc.

Synthetic Fibre - is a geotextile fabric with a specific tensile strength and flow rate through the fabric to allow water to permeate through it but to retain fine materials.

Copings - copings are concrete elements which are constructed on retaining walls, decks and footwalks as a finish to these members. Railings in concrete or steel are cast into copings.

A13.8.3 GENERAL

The ancillary items for structures covered in this section consist of concrete elements constructed on site or elements which are precast concrete, steel or other materials used for the construction or manufacture of the elements which are specified in this Chapter. All cast in situ elements and manufactured items shall be constructed or manufactured as indicated on the drawings from materials as specified in of these specifications or in other Chapter the relevant SANS, BS and EN specifications.

A13.8.4 DESIGN BY CONTRACTOR / PERFORMANCE BASED SYSTEMS

Where alternative designs or materials are proposed by the Contractor to be used in certain elements of the structure these designs or the proposed materials shall be submitted to the Engineer for approval 28 days before the manufacture or supply of such elements.

A13.8.5 MATERIALS

A13.8.5.1 Barriers, parapets, railings and sidewalks for structures.

a) Concrete

All concrete work shall be carried out in accordance with the requirements of Sections A13.2, A13.3 and A13.4.

b) Structural steel

Structural steel work shall comply with the provisions of Section A13.7.

c) Mortar

Mortar shall comply with the requirements of Clause A13.6.5.1g).

d) Painting

Painting shall comply with the requirement of Section A13.12.

A13.8.6 CONSTRUCTION EQUIPMENT

The Contractor shall before construction commences, provide comprehensive details of all plant and equipment, which shall be appropriate for the intended use.

A13.8.7 EXECUTION OF THE WORKS

A13.8.7.1 Barriers, parapets, railings and sidewalks

a) Concrete barriers and parapets

Vehicle containment Concrete barriers and parapets on Bridges and on top of retaining walls shall always be cast in situ as shown on the drawings.

Concrete barriers and parapets on bridges shall be constructed after the removal of the false work and the completion of the prestressing, but not before the bridge deck has been accurately measured so as to determine the final lines and levels. Service ducts in barriers, parapets and end blocks shall be fixed and cast in accordance with the requirements of Clause A13.4.7.11k)(i) and the details shown on the drawings. Precast alternatives for parapets shall not be permitted.

“Precast Barrier in medians and adjacent to retaining walls in cutting may be permitted if indicated on the drawings. Precast Concrete Median Barriers which are integrated into an in-situ reinforced concrete framework are permitted where the difference in height between the top of the precast units on each side are less than 125 mm. For higher differences in height a precast barrier may be permitted on the lower and higher side when the higher barrier is constructed into a reinforced concrete retaining wall. When retaining walls are constructed in the median or adjacent to fills the In-situ reinforced concrete Barriers and Parapets shall always be constructed on the top of retaining walls or be supported on their own cast reinforced concrete foundations.”

The pipes and fittings to be used for the construction of the ducting shall be rigid PVC pipes and fittings with flexible rubber joints which comply with the requirements of SANS 967. Duct ends shall be provided with end caps to prevent dirt, concrete, etc., from entering the ducts. Two strands of 2,5 mm diameter galvanized steel wire shall be threaded through each duct. The strands shall extend 2,0 m beyond each end and be wedged firmly into position with the wooden stoppers. Inspection eyes for the ducts shall be constructed in accordance with the details shown on the drawings.

No separate payment will be made for service ducts in barriers, parapets and end blocks and the rates tendered for the barriers, parapets and end blocks shall include full compensation for the provision and installation of service ducts complete with stoppers, draw wires and Inspections eyes.

b) Steel railings

All steelwork shall be manufactured in accordance with the requirements of Section A13.9.

A mortar bed, not less than 10 mm in thickness, shall be provided below all steel base plates over the full dimensions of the plate. The sides of the beds shall be neatly chamfered at 45°. All open spaces between the bolt and the sides of the holes in the base plate shall be grout filled.

Steelwork which is to be cast or grouted into concrete shall be completely painted to a depth of 75 mm in the concrete or grout, and shall be cleaned of all loose rust, mill scale, oil or other material which may impair the bond between the concrete and steel.

All steelwork shall be painted in the shop and on site in accordance with the provisions Section A13.11. Surfaces which will be inaccessible after erection of the units shall be painted before erection commences. If called for on the drawings or in the schedule of quantities, steelwork shall be galvanised and painted. Galvanising shall be done after fabrication, in accordance with SANS 32 and or SANS 121.

c) Concrete railings

All concrete work to manufacture or construct concrete railings shall be carried out in accordance with Sections A13.2, A13.3 and A13.4.

The vertical posts and horizontal railing shall be cast on site or manufactured as detailed on the drawings and cast into the kerbs or footwalks of

the structure. Special attention shall be given to the top railing being erected to the line and level of the footwalks and railings as indicated on the drawings. All the posts supporting the railings shall be vertical.

d) Numbers for structures

(i) Number plates

Number plates shall be fixed in the positions and according to the method of fixing shown on the drawings. Number plates shall be cast from nonmetallic materials. The minimum overall thickness shall be 11 mm and a background plate with a minimum thickness of 8,0 mm. The letter thickness shall not be less than 3,0 mm. Laminated PVC or other laminated materials shall not be permitted.

(ii) Painted numbers

The surface onto which the numbers are to be painted shall be prepared in accordance with the requirements of Section A13.12. The background shall be of at least two coats of the prescribed paint. The letters and figures shall be in accordance with the details given on the drawings and shall be written at the prescribed positions with a template.

(iii) Numbers shaped in concrete

Bridge numbers shall be placed and shaped in accordance with the requirements shown on the drawings. The minimum concrete cover over the steel reinforcement behind the numbers shall not be less than the prescribed cover for the structural member in question.

e) Concrete sidewalks

After completion of the prestressing and the removal of the formwork, the sidewalks and kerbing shall be constructed, but not before the bridge deck has been accurately surveyed to establish final lines and levels after the falsework has been removed.

The previously cast bridge deck area shall be prepared as specified in Section A13.4 to receive the sidewalk concrete.

Forms shall be accurately set to the final lines and levels and shall be firmly held in position during the placing of the concrete. Stops at the ends of sections shall be accurately placed to ensure that joints between adjacent sections will be truly perpendicular to the surface of the concrete and at right angles to the edge of the road or to the skew angle of the deck at the expansion joint. All finishing chamfers shall be firmly installed on formwork within final tolerance for completed concrete.

After removal of the forms, the exposed surfaces of the kerbs and copings shall be rubbed and finished in accordance with the requirements of Clauses A13.2.7.4c) and (iii) and A13.2.7.2b). All edges shall be rounded to a radius of 20 mm unless otherwise shown on the drawings

f) Service Ducts in Sidewalks and Structures

When required, the Contractor shall construct service ducts for the easy installation and maintenance of existing, new and future services.

Service ducts shall be normal duty uPVC pipes in accordance with SANS 791. All pipes shall be joined with water tight couplings made of the same material as the pipe. The couplings shall be adequate at expansions joints to provide for deck movements as detailed on the drawings.

All ducts shall be suitably fixed at 500 mm centres to prevent horizontal and vertical movement.

Duct ends shall be provided with suitable end caps to prevent material from entering the ducts.

Two stands 2,5 mm diameter galvanised steel wire shall be threaded through each duct and shall extend 3,0 m beyond each end.

g) Concrete surface finish requirements

All formed concrete surfaces shall have a class F3 surface finish as specified in Clause A13.2.7.2b) and all unformed concrete surfaces shall have a class U3 surface finish in accordance with Clause A13.2.7.2c).

h) Transition blocks

Transition blocks shall be constructed in accordance with the details shown on the drawings.

A13.8.7.2 Drainage for structures

a) Weep holes, drainage pipes and channels

Weep holes shall not be placed within 40 mm of any reinforcement and shall be carefully cleaned and kept clean.

Drainage pipes shall be of the material prescribed on the drawings, and the interior surface shall, on completion, be smooth and clean.

Perforated drainage pipes for drainage behind retaining walls and abutments shall comply with the requirements of Clause A3.1.5.2a) of Chapter 3.

Cast in situ concrete channels shall be provided next to the kerbing if shown on the drawings and according to the details provided. Concrete work shall be carried out in accordance with the provisions of Section A13.4 and channels shall be given a class U2 surface finish as specified in Clause A13.2.7.2c). The channels shall be bonded to the bridge deck concrete in accordance with the provisions of Clause A13.4.7.11g).

b) No-fines concrete blocks

Blocks shall be of the class of prescribed no-fines concrete and to the required dimensions and shall be placed in advance of backfilling.

No-fines concrete shall comply with the requirements of Clause A13.4.7.11f).

c) Synthetic filter fabric

Synthetic-fibre filter fabric shall be of the type and grade shown on the drawings or specified in the Contract Documentation. Filter fabric shall be placed as shown on the drawings and shall be protected against sunlight and mechanical damage during storage and installation.

The fabric shall comply with the requirements of geotextiles as per Section A12.11 of Chapter 12.

d) Crushed stone in drainage strips behind walls

The crushed stone used in drainage strips shall comply with the requirements for 19 mm nominal size stone as specified in table 9 of SANS 1083. The crushed stone shall be wrapped in synthetic-fibre geotextile and placed in accordance with the details shown on the drawings or as instructed by the Engineer.

A13.8.7.3 Bolt groups for electrification brackets

If specified the Contractor shall supply and install bolt groups in bridge decks for the electrification brackets of railway owners. The bolt groups shall consist of stainless-steel sockets complete with stainless-steel bolts and mild-steel plates. The sockets, bolts and plates shall be manufactured in accordance with the details shown on the drawings. The Contractor shall install the sockets in bridge decks in the positions and in the manner shown on the drawings.

On completion of the deck, the Contractor shall ensure that the threads of the bolts and sockets are clean and that the bolts can be secured in the sockets. The brackets shall be as specified by the applicable Railway Authorities.

A13.8.8 WORKMANSHIP

A13.8.8.1 Tolerances

The tolerances given below shall be the maximum permissible deviations from the specified dimensions, levels, alignment, positions, etc., shown on the drawings of the structures or structural members.

a) Chamfers

Fillets used for forming chamfers shall be within a tolerance of 1,0 mm in cross-sectional dimensions, and the actual chamfer on the concrete shall not vary by more than 3,0 mm from the specified dimensions.

b) Barriers, parapets, railings, footwalks and kerbs.

The members shall be constructed within a tolerance ± 5,0 mm for all dimensions. The vertical and horizontal alignment shall not deviate from the true alignment by more than 10 mm in any location, nor shall the alignment deviate by more than 5,0 mm from the true alignment over any length of 5,0 m.

c) Service ducts

Service ducts shall be placed horizontally and vertically to a tolerance of 10 mm.

d) Brackets

Brackets shall be fixed to a horizontal tolerance of 20 mm.

e) Copings

Coping shall be constructed to an alignment tolerance of ± 10 mm and for level tolerance of ± 5,0 mm.

B13.8 ANCILLARY STRUCTURAL ELEMENTS
PART B: LABOUR ENHANCEMENT

CONTENTS

B13.8.1 SCOPE

B13.8.2 DEFINITIONS

B13.8.3 GENERAL

B13.8.4 DESIGN BY CONTRACTOR / PERFORMANCE BASED SYSTEMS

B13.8.5 MATERIALS

B13.8.6 CONSTRUCTION EQUIPMENT

B13.8.7 EXECUTION OF THE WORKS

B13.8.8 WORKMANSHIP

B13.8.1 SCOPE

This Section covers:

a) The construction of barriers, parapets, railings and sidewalks on structures.

b) The construction and installation of drainage works such as weep holes, drainage pipes and gulley's, no-fines concrete blocks, filter lining and concrete channels; and.

c) The installation of bolt groups for electrification brackets.

d) The installation of service ducts

Part A is suitable for labour enhanced work.

B13.8.2 DEFINITIONS

The provisions contained in Part A shall apply.

B13.8.3 GENERAL

The provisions contained in Part A shall apply.

B13.8.4 DESIGN BY CONTRACTOR / PERFORMANCE BASED SYSTEMS

The provisions contained in Part A shall apply.

B13.8.5 MATERIALS

The provisions contained in Part A shall apply.

B13.8.6 CONSTRUCTION EQUIPMENT

The provisions contained in Part A shall apply.

B13.8.7 EXECUTION OF THE WORKS

The provisions contained in Part A shall apply.

B13.8.8 WORKMANSHIP

The provisions contained in Part A shall apply.

C13.8 ANCILLARY STRUCTURAL ELEMENTS

PART C: MEASUREMENT AND PAYMENT

(i) Preamble

The tendered rate for each item shall include full compensation for providing, maintaining and decommissioning upon completion, of all the plant, equipment, labour, tools, incidentals and supervision to carry out the activity or construct the works in the item, unless otherwise stated.

Any prime cost or provisional sums shall be paid in accordance with the provisions of the conditions of contract. The charge or mark-up tendered or allowed for is a percentage of the amount actually paid under the prime cost or provisional sum. This percentage shall cover all the Contractor's handling, supervision, profit and liability costs to provide the services in the prime cost or provisional sum item.

The requirements of Section C1.1 of Chapter 1 shall apply.

Where pay item descriptions include any wording in brackets it is an indication that contract specific information is to be inserted in the Pricing Schedule included in the Contract Documentation.

(ii) Notes on measurement and pay items

None.

(iii) Items that will not be measured separately

The following activities, whether required to complete the specified work or not, will not be measured and paid for separately and the Contractor shall include the cost thereof in other pay items as he deems appropriate:

1. No separate payment will be made for setting out the works.
2. No separate payment will be made for the protection or repair as required of any existing or new road furniture, structures, buildings, infrastructure or services damaged by the Contractor's activities.
3. No additional payment shall be made, nor shall any claim for additional payment be considered, for any specified work in confined or restricted areas. Any additional costs associated with working in confined or restricted areas shall be deemed to be included in the standard applicable pay items.
4. No separate payment will be made for the loading of any materials.
5. No separate payment will be made for the hauling of any materials where the material is moved over a distance of less than, and up to 1,0 km and for labour enhanced construction, less than and up to 50 m.
6. No separate payment will be made for transporting materials from commercial sources irrespective of the haul distance.
7. No separate payment will be made for the removal or any surplus material imported to complete the works.
8. For all Works performed, precautionary measures required in terms of the Occupational Health and Safety Act (Act 85 of 1993) and the latest amendments thereof as well as the latest Construction Regulations shall be deemed included in the rates tendered for the relevant products.

(iv) Items to be measured and paid for using items specified elsewhere in the specifications

For activities in Table C13.8-1 pay items specified in other Chapters or Sections of the specifications, where they relate to work under this Section, will be listed in the Pricing Schedule.

Table C13.8-1: Payment items from other Chapters or Sections

Activity	Section 13.8 reference	Section item reference
End Blocks	C13.8.2	Chapter 4 - All applicable items
Cast in situ no-fines concrete	C13.8.8	C13.4.7.1 - All applicable items

(v) Items specifically for this Section of the specifications

Item	Description	Unit
C13.8.1	**Concrete barriers and parapets** (refer to drawings)	
C13.8.1.1	Barriers	metre (m)
C13.8.1.2	Parapets	metre (m)

The unit of measurement for concrete parapets shall be the metre of concrete parapet complete in accordance with the drawings. Concrete parapets shall include all work above the top level of the sidewalks or, where not placed on a sidewalk, above the top of the bridge deck concrete, wingwalls or retaining walls and shall also include any kerbing and coping forming an integral part of the concrete parapet.

The tendered rate for concrete parapets shall include full compensation for all concrete, formwork, service ducts, drawing wires and accessories. The rates will exclude only the cost of reinforcing steel as this will be measured and paid for under another pay item.

The tendered rate shall also include for sealing of joints between barriers and parapet units as shown on the drawings.

Item	Description	Unit
C13.8.2	**End blocks** (length indicated)	**number (No)**

The unit of measurement of bridge end blocks shall be the number of end blocks constructed complete including all built in items in accordance with the drawings.

The tendered rate shall include full compensation for all materials, labour, plant, and other incidentals required for constructing the end blocks complete as specified excluding only reinforcing steel. The rate for end blocks shall also include all the attachment brackets, bolts and other fixtures required to attach the steel traffic barriers to the end block. All barrier attachment brackets off the end block shall be measured under the appropriate pay items in Chapter 4.

Item	Description	Unit
C13.8.3	**Concrete transition blocks** (length indicated)	**number (No)**

The unit of measurement shall be the number of each size of concrete transition block constructed complete in accordance with the details shown on the drawings.

The tendered rate shall include full compensation for all labour, constructional plant, materials and all incidentals required for constructing the transition blocks.

Item	Description	Unit
C13.8.4	**Concrete pedestrian railings**	**metre (m)**

The unit of measurement shall be the metre of railing complete in accordance with the drawings.

The tendered rate shall include full compensation for all labour, plant and materials (including reinforcing steel and prestressing requirements) for the manufacture and erection of the precast concrete railings. The concrete railing shall include for fixing the concrete railing into the sidewalk.

Item	Description	Unit
C13.8.5	**Steel railings (type described)**	**metre (m)**

The unit of measurement for steel railings shall be the metre of railing complete in accordance with the drawings.

The tendered rate for steel railings shall include full compensation for all steelwork and corrosion protection, including fastenings, anchor bolts, mortar bedding, etc, as may be required, and for erecting the steel railings, complete as specified.

Item	Description	Unit
C13.8.6	**Service ducts in structures**	
C13.8.6.1	Type and size (diameter)	metre (m)
C13.8.6.2	Joint in ducts at bridge deck expansion joints	number (No)

The unit of measurement shall be the metre of service duct installed.

The tendered rate shall include full compensation for procuring and installing service ducts, including, end caps, draw wires and complete installation.

Item	Description	Unit
C13.8.7	**Numbers for structures:** (refer to drawings)	
C13.8.7.1	Number plates	number (No)
C13.8.7.2	Painted numbers	number (No)
C13.8.7.3	Numbers formed in concrete	number (No)
C13.8.7.4	Numbers on concrete pedestals	number (No)

The unit of measurement shall be either the number of bridge number plates provided and installed, or the number of complete numbers painted on the structures, or the number of complete numbers formed in concrete. A bridge number may consist of a combination of letters and digits, e.g. B1533.

The tendered rates shall include full compensation for providing and installing either the number plates, or preparing the surface and painting the numbers, or forming the numbers in concrete, and for all material, labour and equipment required in this connection.

Item	Description	Unit
C13.8.8	**Cast in situ no-fines concrete** (class of concrete indicated)	**cubic metre**

The provisions of Clause A13.4.7.12f) and item C13.4.7.1 shall apply mutatis mutandis.

Item	Description	Unit
C13.8.9	**Precast no-fines concrete units** (class of concrete and description of unit)	**number (No)**

The unit of measurement shall be the number of complete units of each size and type in position in the works.

The tendered rate for each precast concrete unit shall include full compensation for providing all the materials, labour, plant and formwork required for manufacturing the unit complete as shown on the drawings and for transporting and placing the unit in position.

Item	Description	Unit
C13.8.10	**Drainage pipes and weep holes:**	
C13.8.10.1	Drainage pipes:	
(a)	(Type and size indicated)	metre (m)
(b)	(Type and size indicated)	number (No)
C13.8.10.2	Weep holes:	
(a)	(Type and size indicated)	metre (m)
(b)	(Type and size indicated)	number (No)

The unit of measurement shall be either the metre of pipe/weep hole or the number of pipes/weep holes of each type and size of pipe/weep hole completed as specified on the drawings.

The tendered rates shall include full compensation for supplying all the materials, manufacturing and installing the pipes and making weep holes.

Item	Description	Unit
C13.8.11	**Drainage gulley's** (description of each type given)	**number (No)**

The unit of measurement shall be the number of drainage gulleys of each type installed.

The tendered rate shall include full compensation for providing all the material and manufacturing and installing the drainage inlets.

Item	Description	Unit
C13.8.12	**Synthetic-fibre filter fabric** (type indicated and description)	**square metre (m^2)**

The unit of measurement shall be the square metre of filter fabric installed as specified, including the specified overlap.

The tendered rate shall include full compensation for supplying, cutting and installing the filter fabric, and for waste material.

Item	Description	Unit
C13.8.13	**Concrete channels adjoining structural works** (size indicated)	**metre (m)**

The unit of measurement shall be the metre of completed concrete channeling of each size constructed.

The tendered rate shall include full compensation for providing all the material, all labour, equipment and expenses required for completing the work.

Item	Description	Unit
C13.8.14	**Crushed stone in drainage strips** (stone size indicated)	**cubic metre (m3)**

The unit of measurement shall be the cubic metre of crushed stone placed in position as specified, in accordance with the details shown on the drawings or instructed by the Engineer.

The tendered rate shall include full compensation for procuring, furnishing and placing the crushed stone, and for wrapping it in synthetic-fibre geotextile as specified.

The geotextile will be measured for payment under item C13.8.12.

Item	Description	Unit
C13.8.15	**Drainage strips** (type, size and grade indicated)	**metre (m)**

The unit of measurement shall be the linear metre of drainage strips placed at the structure / earth interfaces as shown on the drawing.

The tendered rate shall include full compensation for all material, labour, and equipment to supply and install the strips as shown.

Item	Description	Unit
C13.8.16	**Perforated drainage pipes:**	
C13.8.16.1	Size (diameter) and type of pipe wrapped in synthetic – filter fabric as specified (describe type, grade etc.)	metre (m)

The unit of measurement shall be the linear metre of perforated drainage pipes placed behind the earth faces as shown on the drawing.

The tendered rate shall include full compensation for all material, labour, and equipment to supply and install the perforated pipes as shown including the 300 mm wide by 50 mm thick mortar bed under the core.

Item	Description	Unit
C13.8.17	**Supplying and installing bolt groups complete with electrification brackets:**	
C13.8.17.1	Single-bolt groups	number (No)
C13.8.17.2	Double-bolt groups	number (No)

The unit of measurement shall be the number of each type of bolt group and brackets supplied and installed complete in position in accordance with the details shown on the drawings.

The tendered rates shall include full compensation for procuring and furnishing all materials, manufacturing, transporting and storing, and all labour, constructional plant and materials required for installing the bolt groups as specified.

D13.8 ANCILLARY STRUCTURAL ELEMENTS
PART D: GUARANTEES AND COMPLIANCE CERTIFICATES

CONTENTS

D13.8.1 SCOPE

D13.8.2 GENERAL

D13.8.3 PERFORMANCE GUARANTEE REQUIREMENTS

D13.8.4 FUNCTIONAL PERFORMANCE ASSESSMENTS

D13.8.5 VISUALLY ASSESSED PROPERTIES

D13.8.6 INSTRUMENTALLY ASSESSED PROPERTIES

D13.8.7 EVALUATION FOR ACCEPTANCE

D13.8.8 ADDITIONAL PROCEDURES TO BE ADOPTED IN THE EVENT OF FAILURE

D13.8.9 NOTIFICATION OF REMEDIAL WORK

D13.8.10 REMEDIAL WORK

D13.8.1 SCOPE

The scope of this Section covers the following:

- Product conformance specifications
- Warranties for product or element design and installation of proprietary systems
- Performance specifications

D13.8.2 GENERAL

D13.8.2.1 Product conformance specifications

The Contractor shall within 28 days before manufacture submit to the Engineer conformance documentation related to the specifications. All products used in the manufacture and installation of Ancillary Structural Elements shall be in compliance with the specifications contained in Section A13.8.

Compliance documentation shall be provided for:

a) Concrete Pedestrian Railings.
b) Steel Pedestrian Railings.
c) PVC or Polyethylene Drainage Pipes.
d) Drainage Gullies
e) Synthetic-fibre filter fabric
f) Perforated PVC or Polyethylene pipes.
g) Bridge Number Plates.

D13.8.3 PERFORMANCE GUARANTEE REQUIREMENTS

D13.8.3.1 Warranties for product or element design and installation of proprietary systems

No warranties are required for Ancillary Structural Elements.

D13.8.3.2 Performance specifications

Performance based specifications shall be contained in the Contract Documentation for the project.

13.9 STRUCTURAL STEELWORK FOR MINOR STRUCTURES

CONTENTS

PART A: SPECIFICATIONS

A13.9.1 SCOPE

A13.9.2 DEFINITIONS

A13.9.3 GENERAL

A13.9.4 DESIGN BY CONTRACTOR / PERFORMANCE BASED SYSTEMS

A13.9.5 MATERIALS

A13.9.6 CONSTRUCTION EQUIPMENT

A13.9.7 EXECUTION OF THE WORKS

A13.9.8 WORKMANSHIP

PART B: LABOUR ENHANCEMENT

PART C: MEASUREMENT AND PAYMENT

PART D: GUARANTEES AND COMPLIANCE CERTIFICATES

A13.9 STRUCTURAL STEELWORK FOR MINOR STRUCTURES

PART A: SPECIFICATIONS

A13.9.1 SCOPE

This Section covers the manufacture, transport and erection of structural steelwork for minor structures, e.g. overhead road-sign structures and light mast anchor bolts. It does not apply to major steel structures such as steel and composite steel bridges, which is covered in Section A13.11.

A13.9.2 DEFINITIONS

A13.9.3 GENERAL

A13.9.4 DESIGN BY CONTRACTOR / PERFORMANCE BASED SYSTEMS

A13.9.4.1 Codes of practice

The design, where undertaken by the Contractor, of all work shall comply with the requirements of SANS 10162.

A13.9.4.2 Shop details

Where shop details have not been furnished on the drawings, the Contractor shall prepare his own shop details in accordance with the provisions of Clause A1.2.4 of Chapter 1. Shop details shall be approved and signed by the Engineer prior to the fabrication of any items.

A13.9.5 MATERIALS

A13.9.5.1 Structural steel

Structural steel shall comply with the following requirements:

Mild steel: SANS 50025 (EN 10025) grade S275JR

High-yield stress steel: SANS 50025 (EN 10025) grade S355JR

The dimensions and properties of rolled steel sections shall comply with the prescriptions given in the structural steel tables issued by the SA Institute of Steel Construction.

A13.9.5.2 Steel tubes

Steel tubes shall comply with the requirements of SANS 657, part 1.

A13.9.5.3 Bolts, nuts and washers

Ordinary bolts and nuts shall be bolts and nuts used for transferring forces by tensile stress, compressive stress and shear stress without any friction-grip action being considered. Ordinary bolts and nuts shall comply with SANS 1700-7, SANS 1700-14 or SANS 1143.

Washers for ordinary bolts and nuts shall comply with the requirements of SANS 1700-16.

Friction-grip fasteners:

High-strength friction-grip bolts, nuts and washers shall comply with the requirements of SANS 1700-7 and SANS 1700-14.

Other friction-grip fasteners equal to the above shall only be used if approved by the Engineer.

A13.9.5.4 Rivets

Mild-steel rivets shall comply with the requirements of SANS 1700-18. High-tensile rivets shall be so manufactured that they can be driven and their heads formed satisfactorily without the physical properties of the steel being impaired.

A13.9.5.5 Welding consumable

Welding electrodes shall comply with the requirements of SANS 455.

The quality, handling and storage of all consumables shall be so as to achieve the desirable properties of the weld metal.

The welding consumables used shall be appropriate to produce weld metal which will yield all the weld-metal test specimens as specified in BS EN ISO 4136, BS EN ISO 5173, BS EN ISO 5178, BS EN ISO 9015, BS EN ISO 9016, BS EN ISO 9017, BS EN ISO 9018 and BS EN ISO 17639, having both minimum yield and minimum tensile strengths not less than those of the parent metal.

A13.9.5.6 Test certificates

The Contractor shall submit test certificates, as required by the Engineer, of the structural steel and anchor bolts that will be used.

A13.9.6 CONSTRUCTION EQUIPMENT

A13.9.7 EXECUTION OF THE WORKS

A13.9.7.1 Fabrication and assembly

a) General

All structural steel both before and after fabrication shall be within the tolerances specified in Clause A13.9.8.2 and shall be flat, straight (unless required to be formed to another shape) and free from twists.

b) Marking the steel

At all stages of fabrication, all structural steel other than grade S275JR steel shall be clearly marked by grade by means of a suitable marking system.

c) Cutting

Steel shall be cut by sawing, shearing with shears, cropping, or flame-cutting.

Edges shall be free from any defects or distortions and all burrs, notches and similar defects shall be removed.

d) Holes for fasteners

Holes for fasteners shall not be formed by flame cutting. Holes in light members not thicker than 12 mm or the diameter of the hole, whichever is the smaller, may be punched.

Holes for fasteners of up to 25 mm in diameter shall not be more than 2,0 mm larger than the diameter of the fastener and holes for larger fasteners not more than 3,0 mm larger than the diameter of the fastener.

Holes for friction-grip fasteners shall be in accordance with SANS 10094.

All burrs shall be removed from holes before assembly.

e) Joints in compression

The abutting surfaces of joints dependent on contact for the transmission of load shall be accurately prepared so that the full area intended for bearing will be in contact as specified in Clause A13.9.8.2.

f) Hollow sections

Unless protection against corrosion is provided by other means, the interior of any hollow section shall be sealed to prevent the ingress of moisture. Where a sealed hollow member is holed for a fastener or pin, precautionary measures shall be taken to prevent the ingress of water to the interior of the member. Vent holes for galvanising shall be sealed after galvanising has been completed.

g) Alignment of holes

All matching holes for fasteners or pins shall be accurately aligned so that the fasteners can be inserted freely through the assembled members in a direction at right angles to the faces in contact. Drifting for aligning the holes shall not distort the metal or enlarge the holes.

h) Welding

Welding shall be done in accordance with the requirements of BS EN 1011.

The welding techniques shall be such as to avoid undue distortion and to minimise shrinking stresses.

All slag shall be removed.

Where required for certain welding:

(i) the manufacturer shall hold a valid welding-procedures certificate in accordance with SANS 15607 for grade B welding joints, and the welding shall be done by a welder qualified in accordance with SANS 9606; or

(ii) the welder shall hold a valid certificate of competency in accordance with SANS 9606 for the specified type of welding.

All structural welds shall be full-strength joints.

i) Bolting

The jointed parts shall be firmly drawn together. Where necessary, tapering washers shall be used for each bolt head and nut to transfer the compressive stress over its full surface. Where bolt holes have greater than normal clearance, washers shall be placed under the bolt heads and nuts.

The length of each bolt shall be such that, after tightening, at least one full thread projects through the nut on the outside and at least one full thread (in addition to the thread run-out) remains clear between the nut and the bolt head.

j) Friction-grip and anchor bolt fastening

The use of friction-grip bolts shall be in accordance with SANS 10094. Where use is made of equivalent types of friction-grip fasteners, they shall comply with the requirements of SANS 10094 for equivalent fasteners and shall be installed in accordance with the appropriate requirements of SANS 10094.

Friction-grip bolts and anchor bolts shall be tightened by “method of turn” and not by torque wrench. Due care shall be taken to avoid over-tightening leading to fatigue failure.

k) Riveting

Wherever possible, riveting shall be done with pneumatic equipment.

Riveted units shall have all parts firmly drawn together and aligned before riveting. Every rivet shall, when driven, completely fill the hole and shall have a well-formed head or, if countersunk, fill the countersink completely.

All loose, eccentric-headed, badly formed, burnt or otherwise defective rivets shall be cut out and replaced.

l) Trimming

All fabricated steel work shall be neatly trimmed so as not to show any sharp edges. Acute angles shall be rounded off to a radius of at least 1 mm.

m) Corrosion prevention

(i) Painting

Before removal from the place of manufacture the steelwork shall be painted as specified in Section A13.10.

Where the finishing coats are to be applied on the site, the shop painting shall include the application of an undercoat as specified in Section A13.10.

Galvanised steel shall not be painted unless painting is specifically called for in the specifications or on the drawings.

(ii) Sprayed metal coatings

Where the sprayed metal coating of steel surfaces is called for, it shall be done in accordance with the requirements of SANS 2063. The type of metal used shall be as specified, and, unless otherwise specified, the metal coating shall comply with the requirements of type Al 150 or type Zn 150.

(iii) Galvanising

Where the galvanising of structural steelwork is required, the members shall be hot-dip galvanised. Structural steel members shall be given an 85 micrometre coating or such other thickness as may be specified in accordance with SANS 121, and sheet steel and strip shall be given a class M coating in accordance with SANS 4998.

All steel to be galvanised shall be compatible with the galvanising process. Due care shall be taken to avoid hydrogen embrittlement.

All nuts, bolts, screws and threaded articles shall be hot-dipped galvanised in accordance with the appropriate requirements of SANS 121 for type C1 or type C2 articles. Electroplating shall not be used.

Cut ends and small damaged areas shall be repaired by the application of a zinc-rich paint or by zinc spraying. Large damaged areas and site welds shall be repaired by zinc spraying.

A13.9.7.2 Erection

a) General

Where specified, details of the method of erection shall be submitted to the Engineer for approval. All structural steel shall be stored, transported, handled and erected so as not to subject it to undue stress or damage.

Erection over traffic is not permitted, and a temporary deviation for traffic shall be provided.

Provision for traffic accommodation will be paid for in accordance with the appropriate items under Section C1.5 of Chapter 1.

b) Safety during erection

During the erection of a structure, the steelwork shall be bolted, braced or otherwise secured so as to make adequate provision for all erection loads.

c) Alignment

Each part of a structure shall be aligned as soon as possible after erection. Members shall not be permanently connected until sufficiently large members of the structure have been aligned, plumbed, levelled, and temporarily secured to prevent their displacement during the erection or alignment of the remainder of the structure.

d) Corrections

Drift pins, jacking equipment and the like shall not be used for bringing improperly fabricated members into place. A moderate degree of cutting and reaming may be done to correct minor misfits if, in the opinion of the Engineer, this will not be detrimental to the appearance or strength of the structure. The burning of holes will not be permitted without written approval.

e) Repairs to painting and site painting

Repairs to painting and site painting shall be effected in accordance with the provisions of Clause A13.10.7.5.

f) Grouting

The grout shall be poured under and around the base plates of columns after the steelwork has been finally checked for alignment and height and after the approval of the Engineer has been obtained to proceed with the grouting. The column base plates shall be supported by the top and bottom nuts and by steel wedges. The area under the steel shall be thoroughly cleaned and shall be dust and oil-free, and the concrete shall be thoroughly rinsed with water to leave the surface clean and moist.

The grout shall be an approved non-shrinking, pourable, cementitious grout. The grout shall be prepared and applied strictly in accordance with the manufacturer's recommendations and the Engineer's directives.

Leak-proof formwork shall be used for the pourable grout, and all corners shall be chamfered. The surface finish shall be class F2 and class U2 as applicable.

A13.9.8 WORKMANSHIP

A13.9.8.1 Testing

a) Testing by the Engineer

The Engineer may nominate a testing authority to inspect the works and to conduct such tests as he may deem to be necessary to test compliance with the specifications. Where required, test samples of welds shall be prepared by the Contractor, free of charge.

Payment for these tests shall be made under Section C20.1 of Chapter 20.

b) Process control

Welds shall be regularly inspected and tested by the Contractor in terms of his obligations in regard to process control, as described in Clause A1.2.8.1 of Chapter 1. This shall include visual inspection of welds to ensure that no undercutting, uneven lengths, porosity, or evidence of cracking occurs and that full fusion of the metals has been achieved. In doubtful areas, cores containing weld metal and adjacent parent material shall, if so required by the Engineer, be cut out, polished and examined and the hole repaired.

At least 30 % of the welds shall be examined by ultrasonic or radiographic means. If more than 5 % of the examined welds show unsatisfactory results, additional examinations covering all welds shall be performed. Certificates of the examination confirming that the steel plates and welds comply with the requirements of SANS 15614 shall be submitted to the Engineer.

The cost of testing shall be deemed to be included in the rate tendered for item C13.9.1 Structural steel.

A13.9.8.2 Tolerances

The tolerances given below shall be the maximum permissible deviations from the specified dimensions, levels, alignment, positions, etc., shown on the drawings of the structures or structural members.

a) General

The fabrication and assembly tolerances on all dimensions for structural steel shall be ± 2,0 mm. Holes for connections shall be drilled/punched and aligned as specified in Clauses A13.9.7.1 d) and g) respectively.

b) Cross-section

The tolerances on cross-sectional dimensions of rolled sections shall be as specified in the Structural Steel Tables, published by the SA Institute of Steel Construction.

c) Straightness

A structural member before erection shall not deviate from straightness or the specified shape by more than the following:

For compression members and beams, one-thousandth of the length between points which are laterally restrained.

For other members, one five hundredth of the overall length, but not exceeding 25 mm.

d) Length

The length of a member shall not deviate from its prescribed length by more than the following:

For compression members faced at both ends for bearing, ± 1,0 mm

For other members, + 0, -4,0 mm.

For such members as trusses and lattice girders, the above tolerances shall apply to the members as a whole.

The lengths of component parts shall be such that the structural member can be properly assembled with the required accuracy.

e) Bearing surfaces

Where two steel surfaces are required to be in contact for transferring compressive forces, the maximum clearance between the bearing surfaces shall not exceed 1,0 mm when the members in contact are aligned.

f) Accuracy of erection

Steelwork shall not be out of plumb over any vertical distance by more than 5,0 mm or one thousandth of the distance, whichever is the greater.

B13.9 STRUCTURAL STEELWORK FOR MINOR STRUCTURES
PART B: LABOUR ENHANCEMENT

CONTENTS

B13.9.1 SCOPE

B13.9.2 DEFINITIONS

B13.9.3 GENERAL

B13.9.4 DESIGN BY CONTRACTOR / PERFORMANCE BASED SYSTEMS

B13.9.5 MATERIALS

B13.9.6 CONSTRUCTION EQUIPMENT

B13.9.7 EXECUTION OF THE WORKS

B13.9.8 WORKMANSHIP

B13.9.1 SCOPE

This Section covers the manufacture, transport and erection of structural steelwork for minor structures, e.g. overhead road-sign structures. It does not apply to major steel structures such as steel and composite steel bridges, which is covered in Section A13.12. Part A is suitable for labour enhanced work at varying skill levels.

B13.9.2 DEFINITIONS

The provisions of Part A shall apply.

B13.9.3 GENERAL

The provisions of Part A shall apply.

B13.9.4 DESIGN BY CONTRACTOR / PERFORMANCE BASED SYSTEMS

The provisions of Part A shall apply.

B13.9.5 MATERIALS

The provisions of Part A shall apply.

B13.9.6 CONSTRUCTION EQUIPMENT

The provisions of Part A shall apply.

B13.9.7 EXECUTION OF THE WORKS

The provisions of Part A shall apply.

B13.9.8 WORKMANSHIP

The provisions of Part A shall apply.

C13.9 STRUCTURAL STEELWORK FOR MINOR STRUCTURES

PART C: MEASUREMENT AND PAYMENT

(i) Preamble

The tendered rate for each item shall include full compensation for providing, maintaining and decommissioning upon completion, of all the plant, equipment, labour, tools, incidentals and supervision to carry out the activity or construct the works in the item, unless otherwise stated.

Any prime cost or provisional sums shall be paid in accordance with the provisions of the conditions of contract. The charge or mark-up tendered or allowed for is a percentage of the amount actually paid under the prime cost or provisional sum. This percentage shall cover all the Contractor's handling, supervision, profit and liability costs to provide the services in the prime cost or provisional sum item.

The requirements of Section C1.1 of Chapter 1 shall apply.

Where pay item descriptions include any wording in brackets it is an indication that contract specific information is to be inserted in the Pricing Schedule included in the Contract Documentation.

(ii) Notes on measurement and pay items

None.

(iii) Items that will not be measured separately

The following activities, whether required to complete the specified work or not, will not be measured and paid for separately and the Contractor shall include the cost thereof in other pay items as he deems appropriate:

1. No separate payment will be made for setting out the works.
2. No separate payment will be made for the protection or repair as required of any existing or new road furniture, structures, buildings, infrastructure or services damaged by the Contractor's activities.
3. No additional payment shall be made, nor shall any claim for additional payment be considered, for any specified work in confined or restricted areas. Any additional costs associated with working in confined or restricted areas shall be deemed to be included in the standard applicable pay items.
4. No separate payment will be made for the loading of any materials.
5. No separate payment will be made for the hauling of any materials where the material is moved over a distance of less than, and up to 1,0 km and for labour enhanced construction, less than and up to 50 m.
6. No separate payment will be made for transporting materials from commercial sources irrespective of the haul distance.
7. No separate payment will be made for the removal or any surplus material imported to complete the works.
8. For all Works performed, precautionary measures required in terms of the Occupational Health and Safety Act (Act 85 of 1993) and the latest amendments thereof as well as the latest Construction Regulations shall be deemed included in the rates tendered for the relevant products.

(iv) Items to be measured and paid for using items specified elsewhere in the specifications

For activities in Table C13.9-1 pay items specified in other Chapters or Sections of the specifications, where they relate to work under this Section, will be listed in the Pricing Schedule.

Table C13.9-1: Payment items from other Chapters or Sections

Activity	Section 13.9 reference	Section item reference
Corrosion Protection	C13.9.3.1 and C13.9.3.2	C13.10.1 - All applicable items

(v) Items specifically for this Section of the specifications

Item	Description	Unit
C13.9.1	**Structural steel:**	
C13.9.1.1	(Structure/article described)	ton (t)
C13.9.1.2	(Structure/article described)	metre (m)
C13.9.1.3	(Structure/article described)	number (No)

The unit of measurement shall be either the ton or the metre of erected permanent steel structures or articles, or the number of erected permanent steel structures or articles. Where the unit of measurement is the ton, the mass of the steel waste caused by punching, drilling, sheared edges, milling or planing, or metal cut-outs shall not be deducted, and the mass of rivets, bolts, nuts, washers, welding fillets or temporary bracing shall not be added. In computing the mass of steel, the nominal mass per unit of length or area will be used and tolerances and other permissible deviations will be ignored.

The tendered rates shall include full compensation for preparing shop details not provided on the drawings, the supply of all the required materials, fabrication, process control, loading, transporting to the site, off-loading, and erecting. It shall also include full compensation for all welding, nuts, bolts, washers, rivets, cutting, waste, and any temporary bracing necessary for transporting and erecting.

The tendered rate shall also include full compensation for supplying and pouring the specified grout under and around the base plates of steel columns, for procuring and supplying all the necessary labour, constructional plant, tools and materials, as well as waste, formwork for the grout, and finishing to obtain the required surface finish for the grout under and around base plates of steel columns.

Item	Description	Unit
C13.9.2	**Anchor bolts:**	
C13.9.2.1	(Description of each assembly, and grade/type of steel, diameter and length indicated)	kilogram (kg)
C13.9.2.2	(Description of each assembly, and grade/type of steel, diameter and length indicated)	number (No)

The unit of measurement shall be either the kilogram of installed anchor-bolt assemblies or the number of installed anchor-bolt assemblies.

The tendered rates shall include full compensation for the materials, fabrication, handling, transporting and installing the anchor-bolt assemblies, including corrosion protection.

Item	Description	Unit
C13.9.3	**Corrosion protection:**	
C13.9.3.1	Sprayed-on metal:	
(a)	(Type of metal and thickness or type symbol of coating indicated)	ton (t)
(b)	(Type of metal and thickness or type symbol of coating indicated)	metre (m)
(c)	(Type of metal and thickness or type symbol of coating indicated)	number (No)
C13.9.3.2	Galvanising	
(a)	(Thickness or type symbol of zinc coat indicated)	ton (t)
(b)	(Thickness or type symbol of zinc coat indicated)	metre (m)
(c)	(Thickness or type symbol of zinc coat indicated)	number (No)

The unit of measurement shall be either a ton or a metre of steel structures or articles protected against corrosion, or the number of steel structures or articles protected against corrosion. The quantities are calculated as specified in item C13.9.1.

The tendered rates shall be extra over the rates for item C13.9.1 and shall include full compensation for applying the specified corrosion protection, including surface preparation, materials, labour, tools, equipment and all incidentals required.

Note:

Payment for painting shall be made under item C13.10.1.

D13.9 STRUCTURAL STEELWORK FOR MINOR STRUCTURES
PART D: GUARANTEES AND COMPLIANCE CERTIFICATES

CONTENTS

D13.9.1 SCOPE

D13.9.2 GENERAL

D13.9.3 PERFORMANCE GUARANTEE REQUIREMENTS

D13.9.4 FUNCTIONAL PERFORMANCE ASSESSMENTS

D13.9.5 VISUALLY ASSESSED PROPERTIES

D13.9.6 INSTRUMENTALLY ASSESSED PROPERTIES

D13.9.7 EVALUATION FOR ACCEPTANCE

D13.9.8 ADDITIONAL PROCEDURES TO BE ADOPTED IN THE EVENT OF FAILURE

D13.9.9 NOTIFICATION OF REMEDIAL WORK

D13.9.10 REMEDIAL WORK

D13.9.1 SCOPE

The scope of this Section covers the following:

- Product conformance specifications
- Warranties for product or element design and installation of proprietary systems
- Performance specifications

Note that the requirements for performance specifications are not limited to that given in Part C only but includes all of the requirements in the Contract Documentation.

D13.9.2 GENERAL

D13.9.2.1 Product conformance specifications

The Contractor shall, within 28 days of entering into the contract with the Employer, submit to the Engineer conformance documentation related to the specifications.

Conformance documentation shall be provided for:

a) Structural steel: each type and batch;
b) Other structural steel materials including bolts, nuts, washers, welding material, etc.;
c) Welding procedures; and
d) Certification of welders.

D13.9.3 PERFORMANCE GUARANTEE REQUIREMENTS

D13.9.3.1 Warranties for product or element design and installation of proprietary systems

No additional requirements.

D13.9.3.2 Performance specifications

Performance based specifications shall be contained in the Contract Documentation for the project.

13.10 PAINTING OF MINOR STRUCTURES

CONTENTS

PART A: SPECIFICATIONS

A13.10.1 SCOPE

A13.10.2 DEFINITIONS

A13.10.3 GENERAL

A13.10.4 DESIGN BY CONTRACTOR / PERFORMANCE BASED SYSTEMS

A13.10.5 MATERIALS

A13.10.6 CONSTRUCTION EQUIPMENT

A13.10.7 EXECUTION OF THE WORKS

A13.10.8 WORKMANSHIP

PART B: LABOUR ENHANCEMENT

PART C: MEASUREMENT AND PAYMENT

PART D: GUARANTEES AND COMPLIANCE CERTIFICATES

A13.10 PAINTING OF MINOR STRUCTURES

PART A: SPECIFICATIONS

A13.10.1 SCOPE

This section covers the painting of structural steel to minor structures, guard rails, overhead road sign supports and other minor structures. Painting of steel and composite steel bridges is covered in Section A13.12.

It excludes the corrosion protection of steel work exposed to aggressive or severe conditions.

A13.10.2 DEFINITIONS

A13.10.3 GENERAL

A13.10.4 DESIGN BY CONTRACTOR / PERFORMANCE BASED SYSTEMS

A13.10.5 MATERIALS

Paints shall comply with the requirements of the following specifications:

A13.10.5.1 Primers

Wash primer (metal etch primer)..... SANS 723

Calcium-plumbate primer..... SANS 912

Two-pack zinc-rich epoxy primer ..... SANS 926

A13.10.5.2 Undercoats

Undercoat ..... SANS 681 (type II)

A13.10.5.3 Finishing coats

Decorative enamel for interior and exterior use ..... SANS 630

High-gloss paint..... SANS 684 (type A)

Micaceous iron-ore-pigmented paint..... SANS 684

Baking enamels..... SABS 783

Emulsion paint for exterior use (polyacrylic)..... SANS 1586

Chloro-rubber paint.....Contract Documentation

Bituminous aluminium paint ..... SANS 802

A13.10.5.4 Other

Epoxy-tar paints ..... SANS 801 (type I)

Bonding liquid for concrete surfaces ..... CKS 564

Powder coating..... SANS 1274

Bituminous-emulsion paint shall consist of a stable bituminous emulsion with a minimum of 45 % of bitumen and about 5 % of approved fibre.

A13.10.6 CONSTRUCTION EQUIPMENT

A13.10.7 EXECUTION OF THE WORKS

A13.10.7.1 General

a) No paint shall be applied to surfaces containing physically adhering contaminants such as oil, grease, dirt, marking material, water-soluble salts, wax, paint and temporary protectives, or to surfaces containing chemically bonded contaminants such as rust, mill scale, slag and flux.

b) All surfaces which are painted shall be dry.

c) All traces of soluble salts and corrosive airborne contaminants shall be thoroughly washed from the surface prior to painting, and the surface shall be dried and painted immediately afterwards.

d) Where surfaces are to be welded, unless otherwise specified, any paint shall not be applied within 75 mm of the weld position prior to welding.

e) After the welding has been completed, the welds and adjacent parent metal shall be completely deslagged, and the surfaces shall then be inspected and approved. All spatter shall be removed prior to the surfaces being painted. The weld area shall be abrasive-blasted and/or ground and all contaminants such as flux shall be removed prior to the surface being painted.

f) Surfaces which are to rest on concrete or other floors shall receive all the prescribed coats of paint, and the paint shall be dry before the members are erected.

g) Damaged paint areas shall be cleaned, rust spots removed and the surface again be primed so that the patch painting covers the damaged areas and extends over a strip of 20 mm beyond each damaged area.

h) Where the shop coat is allowed to age for a few months before the next layer of paint is applied, light sanding with sandpaper or rubbing with steel wool and scrubbing with clean water with a bristle brush shall be carried out.

i) Steel members embedded in concrete shall be entirely painted to a distance of 75 mm within the concrete measured from the concrete outer surface, and the paint shall be dry before the members are installed.

j) The paint manufacturer's instructions shall be strictly adhered to.

k) Painted steel members shall be stacked so as to be off the ground.

l) Friction-grip surfaces shall not be painted unless specified otherwise.

A13.10.7.2 Applying the paint

Unless otherwise specified, paint may be applied either by brush, spray or roller method, or by any combination of these three methods, or by powder coating.

Where brushes are used, they shall have sufficient body and length of bristle for spreading the paint in a uniform coat. Paint shall be evenly spread and thoroughly brushed out. If brush marks are visible, it will be considered that the paint has been improperly applied, and the paint will not be accepted.

On all surfaces which are inaccessible to painting by regular painting equipment, the paint shall be applied by bottle brushes, sheepskin daubers, or by any other acceptable method so as to render the required coating of paint.

If spray methods are used, the operator shall be thoroughly experienced.

Where runs, sags, thin areas in the paint coat, or where air bubbles have formed or the paint has delaminated, or any skips exist, it shall be considered as being unsatisfactory, and the Contractor will be required to repaint the surface.

A water trap and an air-regulating valve acceptable to the Engineer shall be furnished and installed on the equipment used for spray-painting.

Mechanical mixers shall be used for mixing paint properly when no ready-mixed paints are used. Prior to application, the paint shall be remixed for a sufficient length of time to mix the pigment and vehicle thoroughly. Paint shall be constantly kept well stirred to keep the pigments in suspension during its application. All skins in the paint shall be removed by screening. If it cannot be removed effectively, the paint and paintwork already completed may be condemned at the discretion of the Engineer.

Paint shall not be applied when the temperature of the steel is not at least 3°C above dew point or when the temperature of the steel is below 5°C or above 35°C, unless otherwise prescribed by the Engineer.

Paint shall not be applied in fog or mist, when it is raining or when rain is expected, or when the relative humidity is above 85 %.

A13.10.7.3 Protecting the works during painting operations

The Contractor shall protect all parts of the structure against disfigurement by spatters, splashes and/or smirches of paint or of paint materials. The Contractor shall be responsible for any damage to or paint on or contamination to vehicles, persons or property, including plants and animals, as a result of his operations, and he will be required to provide protective measures at his own cost to prevent such damage.

Any unsightly paint stains shall be removed by the Contractor at his own cost.

If passing traffic creates sufficient dust to harm or spoil the appearance of painted surfaces, the Contractor shall sprinkle the adjacent roads and shoulders with water at his own cost, for a sufficient distance on each side of the location where the painting is being done, to keep the dust away from freshly painted surfaces. The Contractor shall, at his own cost, also furnish and post appropriate temporary road signs and take other necessary precautions to prevent dust and dirt from adhering onto freshly painted surfaces.

A13.10.7.4 Preparing surfaces for painting

Before paint is applied to any surface, the appropriate specified surface preparation shall be carried out in accordance with the relevant sections of SANS 10064 or as specified herein.

A13.10.7.5 Painting structural steel

a) General

The surface preparation, priming and application of an undercoat shall be carried out under cover at the fabricator's works. Where possible, all painting shall be done at the fabricator's works but, where this is unfeasible, the Engineer may permit the application of the finishing coats on the site, in which case an undercoat shall be applied at the fabricator's works prior to the members being dispatched to the works.

Unless otherwise specified, the protection described in Clauses A13.10.7.5c), d) and e) shall be applied to all steel work.

b) Surface preparation

(i) New structures

After all cutting, drilling, welding and punching have been completed, it shall be ascertained that all sharp edges have been uniformly rounded off and smoothed down. All physically adhering contaminants shall be removed and the surface shall then be abrasive-blasted to Sa 2½ finish in accordance with BS EN ISO 8501-1. The profile limit of the surface finish shall be between 30 and 60 µm. The abrasive-blasting profile shall be measured in accordance with SANS 5772 and shall comply with SANS 10064.

No abrasive-blasting shall be done during rainy weather or when corrosive air conditions prevail.

Unless the application of a primer follows within 4 hours of abrasive blasting and before any oxidation of the prepared surface takes place, the abrasive-blasted surface shall immediately after abrasive blasting be given one coat of a wash primer.

(ii) Existing structures

The surface preparation of existing steel structures shall be carried out on site in accordance with Clauses 3 and 4.4 of SANS 10064.

c) Primer

The prepared surface shall be given two coats of a zinc-chromate primer in accordance with SABS 679, type 1, grade II. The first coat shall be applied within 12 hours in the case of wash-primed surfaces and within 4 hours, but before any oxidation of the surface takes place, in the case of abrasive-blasted surfaces that have not been wash-primed. A fast-drying zinc chromate in accordance with SANS 679, type II, grade II, may be used as primer. In all cases the dry-film thickness shall not be less than 30 µm per coat.

When steel has to be welded after the primer has been applied, the steel shall be left unpainted for a distance of 75 mm from the weld joint unless a weldable type of paint has been used. The welds shall be treated in accordance with the instructions of Clauses A13.11.7.1 and A13.10.7.5.

d) Undercoat

Where the finishing coats are to be applied on the site, the primed surfaces shall be given one coat of a universal undercoat with a suitable colour in the fabricator's shop before despatch. The undercoat shall be applied as soon as the prime coat has dried sufficiently. The dry-film thickness shall not be less than 25 µm.

e) Finishing coat

Two finishing coats of high-gloss structural paint (SANS 684, type A) of the specified colour shall be applied to leave a dry-film thickness of not less than 25 µm per coat.

Where the finishing coats are applied on the site, the undercoat shall be lightly sanded and the members washed and cleaned of all contaminants. The first finishing coat shall be applied as soon as the structural members are dry.

Where specified, the second finishing coat shall consist of a micaceous iron-ore-pigmented structural paint of the specified colour to a dry-film thickness of not less than 30 µm. In all cases the second finishing coat shall be applied within 48 hours of the application of the first finishing coat.

The dry-film thickness of the total paint system shall not be less than 110 µm when no undercoat is used and not less than 135 µm when an undercoat is used. Where the second finishing coat is an iron-ore-pigmented paint, these thicknesses shall be increased by 5 µm.

f) Mating surfaces

When mating surfaces are brought together, both surfaces shall already have been covered with all the specified coats of paint, but, where this is impossible, each surface shall be given a copious coating of primer and the surfaces drawn up while the paint is still wet.

g) Back-to-back members and areas not easily accessible

Back-to-back members and areas not easily accessible shall be fully coated with all the specified coats of paint up to and including the finishing coats before erection.

h) Damaged areas

Damaged areas shall be treated as follows:

Sand down to bright metal and clean. Spot prime with two coats and sand down lightly when hard. Rinse off with water and allow to dry. Apply two finishing coats.

i) Structural steel to be embedded below ground

Those parts of structural-steel members to be embedded in soil and all bases to a height of 500 mm shall be given two coats of an epoxy-tar prime instead of the zinc-chromate prime specified for other surfaces.

A13.10.7.6 Painting guard rails

a) General

Guard rails are not painted unless otherwise prescribed.

b) Surface preparation and priming

All dirt, loose mill scale and loose corrosion products shall be removed by hand or power tools and all rust and mill scale by pickling, after which the surface shall be rinsed and a neutralising rinse shall be applied, or the surface shall be phosphated.

c) Priming

Apply two coats of zinc-chromate primer to a dry-film thickness of not less than 20 µm per coat.

After the prime coats have hardened, the guard rails may be transported to the site.

d) Storage on the site

The primed guard rails shall be stored off the ground under cover and protected against rain and weather until erection. Guard rails shall be stacked individually and not nested so as to prevent corrosion during storage. The finishing coats shall be applied as soon as possible and the primed surfaces shall not be allowed to corrode as a result of prolonged exposure to the weather. Any guard rails showing signs of rust before the application of the finishing coats shall be rubbed down with steel wool or fine sandpaper until all rust is removed, and it shall then be recoated with a zinc-chromate primer.

e) Finishing

Before the first finishing coat is applied, the guard rails shall be thoroughly washed down to remove all traces of salt and/or other air-borne corrosive materials and all dirt or other contaminants.

As soon as the rinsed guard rails are dry, a finishing coat of aluminium paint in accordance with SANS 802 or a white high-gloss enamel in accordance with SANS 684 shall be applied to a dry-film thickness of not less than 25 µm. Within 48 hours this shall be followed by a second coat as described before.

The guard rails shall preferably be given both finishing coats before erection, but, where this is impossible, the Engineer may permit the finishing coats to be applied after the guard rails have been erected, provided that all mating surfaces and spots which are not easily accessible shall be painted with the finishing coats before the guard rails may be erected.

The total dry-film thickness of all coats of the paint shall not be less than 90 µm. All damaged spots shall be treated as specified in Clause A13.10.7.5h).

A13.10.7.7 Painting concrete

a) Surface preparation

The surface of the concrete to be painted shall be cleaned of all dust, loose particles, laitance, impurities and other deleterious materials, and then washed and allowed to dry.

Unless the surface is to be covered with a bituminous paint, all cracks, holes and cavities shall be filled with grout or an acrylic filler.

b) Sealing and priming

The surface shall be sealed with an approved clear sealer which complies with CKS 564 and then primed with a primer consisting of an undercoat diluted to 50 %.

c) Undercoat and finishing

An undercoat shall be applied after priming, followed by two finishing coats of the prescribed paint.

d) Bituminous paint

The surface shall be prepared in accordance with the requirements of Clause A13.10.7.7a). Before it dries out, a primer shall be applied in accordance with the instructions of the fabricator of the bituminous paint.

After the primer has been applied, two coats of bituminous paint shall be applied at the rate of 0,75 l/m^2/coat. No paint coat shall be applied unless the previous coat has dried out completely, and no paint shall be applied to the paintwork for so long as any moisture occurs on the surface.

A13.10.7.8 Painting galvanised surfaces.

Galvanised surfaces shall be painted as specified in this section for steel surfaces, except that the surface preparation and priming shall be as follows:

a) Surface preparation

Freshly galvanised surfaces shall be thoroughly scrubbed down with an approved galvanised-iron cleaner to remove all traces of the resin protective coating.

The surface shall be washed down and scrubbed to remove all traces of grease, oil, dirt, etc.

b) Priming

Two coats of calcium-plumbate primer shall be applied to a dry-film thickness of at least 25 µm.

The undercoat shall follow within one week of the primer.

c) Treatment of site welds and damage to galvanising

Site welds to galvanised elements and isolated areas of damage to galvanising which is to be painted later or which has already been painted may be repaired with low melting point zinc alloy after surface preparation. Alternatively, the whole of the affected area including exposed steel substrate shall, after surface preparation, be given a coat of adhesion promoter which, when wet cleaned and finally dry, shall be overcoated with two coats of Zinc Phosphate High Build Quick Drying Epoxy (2 pack) blast primer or Extended Cure Epoxy (2 pack) primer, minimum dry film thickness of 75 microns each. The adhesion promoter shall not be applied over existing paints.

A13.10.7.9 Safety of painting operation

Some paints and preparation processes are harmful, including being flammable, carcinogenic and containing volatiles harmful to a person.

The supplier's instructions regarding health and safety shall be strictly adhered to. This includes storage, handling, protective equipment, breathing apparatus and masks.

Appropriate protective clothing and breathing apparatus shall be worn during preparation of surfaces to be painted.

A13.10.8 WORKMANSHIP

A13.10.8.1 Measuring paint thicknesses

The dry-film thickness of paint shall be determined in accordance with SANS 2808.

At least 90 % of all thickness measurements shall comply with the minimum specified requirements. The thickness shall not in any case be less than 70 % of the specified thickness.

In addition, painters shall be supplied with, and instructed to use, wet-film thickness gauges.

B13.10 PAINTING OF MINOR STRUCTURES
PART B: LABOUR ENHANCEMENT

CONTENTS

B13.10.1 SCOPE

B13.10.2 DEFINITIONS

B13.10.3 GENERAL

B13.10.4 DESIGN BY CONTRACTOR / PERFORMANCE BASED SYSTEMS

B13.10.5 MATERIALS

B13.10.6 CONSTRUCTION EQUIPMENT

B13.10.7 EXECUTION OF THE WORKS

B13.10.8 WORKMANSHIP

B13.10.1 SCOPE

This Section covers the painting of structural steel to minor structures, guard rails, overhead road sign supports and other minor structures. Painting of steel and composite steel bridges is covered in Section A13.12.

It excludes the corrosion protection of steel work exposed to aggressive or severe conditions.

This Section is suitable for labour enhanced construction activities and is subject to the Occupational, Health and Safety requirements, particularly related to zinc chromate primers.

B13.10.2 DEFINITIONS

The provisions of Part A, shall apply, in addition to the following:

VOC = Volatile Organic Compounds

Low VOC paints contain < 50 g/litre of VOCs

B13.10.3 GENERAL

The provisions of Part A shall apply.

B13.10.4 DESIGN BY CONTRACTOR/PERFORMANCE BASED SYSTEMS

The provisions of Part A shall apply.

B13.10.5 MATERIALS

The provisions of Part A shall apply with the following amendments.

Paints shall comply with the requirements of the following specifications:

All primers, undercoats and paints shall contain low levels of Volatile Organic Compounds (VOC) and shall be non-toxic. Where toxicity or absorption of the toxic element is low, such paints may be used provided that adequate precautions are taken during the application of the paints.

For labour enhanced work, Zinc-chromate primers for steel shall NOT be used. Alternatives such as zinc-phosphate primer shall be submitted to the Engineer for approval.

B13.10.6 CONSTRUCTION EQUIPMENT

The provisions of Part A shall apply.

B13.10.7 EXECUTION OF THE WORKS

The provisions of Part A shall apply with the following ammendments:

B13.10.7.1 Painting Structural Steel

Primer [= Clause A13.10.7.5c)]

Add:

An approved non-toxic primer shall be applied in accordance with the manufacturer's instructions, for labour enhanced work.

B13.10.7.2 Painting Guard Rails

Priming [= Clause A13.10.7.6c)]

Add:

An approved non-toxic primer shall be applied in accordance with the manufacturer's instructions, for labour enhanced work.

C13.10 PAINTING OF MINOR STRUCTURES

PART C: MEASUREMENT AND PAYMENT

(i) Preamble

The tendered rate for each item shall include full compensation for providing, maintaining and decommissioning upon completion, of all the plant, equipment, labour, tools, incidentals and supervision to carry out the activity or construct the works in the item, unless otherwise stated.

Any prime cost or provisional sums shall be paid in accordance with the provisions of the conditions of contract. The charge or mark-up tendered or allowed for is a percentage of the amount actually paid under the prime cost or provisional sum. This percentage shall cover all the Contractor's handling, supervision, profit and liability costs to provide the services in the prime cost or provisional sum item.

The requirements of Section C1.1 of Chapter 1 shall apply.

Where pay item descriptions include any wording in brackets it is an indication that contract specific information is to be inserted in the Pricing Schedule included in the Contract Documentation.

(ii) Notes on measurement and pay items

None.

(iii) Items that will not be measured separately

The following activities, whether required to complete the specified work or not, will not be measured and paid for separately and the Contractor shall include the cost thereof in other pay items as he deems appropriate:

1. No separate payment will be made for the protection or repair as required of any existing or new road furniture, structures, buildings, infrastructure or services damaged by the Contractor's activities.
2. No additional payment shall be made, nor shall any claim for additional payment be considered, for any specified work in confined or restricted areas. Any additional costs associated with working in confined or restricted areas shall be deemed to be included in the standard applicable pay items.
3. No separate payment will be made for the loading of any materials.
4. No separate payment will be made for the hauling of any materials where the material is moved over a distance of less than, and up to 1,0 km and for labour enhanced construction, less than and up to 50 m.
5. No separate payment will be made for transporting materials from commercial sources irrespective of the haul distance.
6. No separate payment will be made for the removal or any surplus material imported to complete the works.
7. For all Works performed, precautionary measures required in terms of the Occupational Health and Safety Act (Act 85 of 1993) and the latest amendments thereof as well as the latest Construction Regulations shall be deemed included in the rates tendered for the relevant products.

(iv) Items to be measured and paid for using items specified elsewhere in the specifications

For activities in Table C13.10-1 pay items specified in other Chapters or Sections of the specifications, where they relate to work under this Section, will be listed in the Pricing Schedule.

Table C13.10-1: Payment items from other Chapters or Sections

Activity	Section 13.10 reference	Section item reference
Painting	C13.10.1	C13.9.1 - All applicable items

(v) Items specifically for this Section of the specifications

Item	Description	Unit
C13.10.1	**Painting:**	
C13.10.1.1	(Describe structure/article)	square metre (m^2)
C13.10.1.2	(Describe structure/article)	number (No)
C13.10.1.3	(Describe structure/article)	metre (m)
C13.10.1.4	(Describe structure/article)	ton (t)

The unit of measurement shall be the square metre of surface painted. Only the surface covered by the final finishing coat shall be measured.

The unit of measurement may also be the number of structures or articles painted, or a metre length of the structures or articles painted, or a ton of the structures or articles painted, the quantities are calculated as specified in item C13.9.1.

The tendered rates shall include full compensation for surface preparation, applying all the coats of paint, repairing any damaged surfaces, and all materials and construction plant necessary for completing the work.

Item	Description	Unit
C13.10.2	**Extra-over item C13.10.2, using non-toxic materials:**	
C13.10.2.1	(Describe structure/article)	square metre (m^2)
C13.10.2.2	(Describe structure/article)	number (No)
C13.10.2.3	(Describe structure/article)	metre (m)
C13.10.2.4	(Describe structure/article)	ton (t)

D13.10 PAINTING OF MINOR STRUCTURES
PART D: GUARANTEES AND COMPLIANCE CERTIFICATES

CONTENTS

D13.10.1 SCOPE

D13.10.2 GENERAL

D13.10.3 PERFORMANCE GUARANTEE REQUIREMENTS

D13.10.4 FUNCTIONAL PERFORMANCE ASSESSMENTS

D13.10.5 VISUALLY ASSESSED PROPERTIES

D13.10.6 INSTRUMENTALLY ASSESSED PROPERTIES

D13.10.7 EVALUATION FOR ACCEPTANCE

D13.10.8 ADDITIONAL PROCEDURES TO BE ADOPTED IN THE EVENT OF FAILURE

D13.10.9 NOTIFICATION OF REMEDIAL WORK

D13.10.10 REMEDIAL WORK

D13.10.1 SCOPE

The scope of this Section covers the following:

- Product conformance specifications
- Warranties for product or element design and installation of proprietary systems
- Performance specifications

Note that the requirements for performance specifications are not limited to that given in Part C only but includes all of the requirements in the Contract Documentation.

D13.10.2 GENERAL

D13.10.2.1 Product conformance specifications

The Contractor shall, within 28 days of entering into the contract with the Employer, submit to the Engineer conformance documentation related to the specifications.

Conformance documentation shall be provided for:

a) Primers;
b) Undercoats; and
c) Finishing coats.

D13.10.3 PERFORMANCE GUARANTEE REQUIREMENTS

D13.10.3.1 Warranties for product or element design and installation of proprietary systems

No additional requirements.

D13.10.3.2 Performance specifications

Performance based specifications shall be contained in the Contract Documentation for the project.

13.11 STRUCTURAL STEELWORK FOR MAJOR STRUCTURES

CONTENTS

PART A: SPECIFICATIONS

A13.11.1 SCOPE

A13.11.2 DEFINITIONS

A13.11.3 GENERAL

A13.11.4 DESIGN BY CONTRACTOR / PERFORMANCE BASED SYSTEMS

A13.11.5 MATERIALS

A13.11.6 CONSTRUCTION EQUIPMENT

A13.11.7 EXECUTION OF THE WORKS

A13.11.8 WORKMANSHIP

PART B: LABOUR ENHANCEMENT

PART C: MEASUREMENT AND PAYMENT

PART D: GUARANTEES AND COMPLIANCE CERTIFICATES

A13.11 STRUCTURAL STEELWORK FOR MAJOR STRUCTURES

PART A: SPECIFICATIONS

A13.11.1 SCOPE

This Section covers the manufacture, transport and erection of structural steelwork for major steel structures, e.g. steel bridge decks, composite steel decks, and steel and composite steel cable-stay towers. It does not apply to minor steel structures such as sign gantries, which is covered in Section A13.9.

A13.11.2 DEFINITIONS

A13.11.3 GENERAL

The specification below in general refers to British and European Standards. Equivalent international standards will be accepted subject to the Engineer's approval.

A13.11.4 DESIGN BY CONTRACTOR / PERFORMANCE BASED SYSTEMS

A13.11.4.1 Fabrication drawings

The Contractor shall prepare fully annotated fabrication drawings which shall be submitted to the Engineer for approval at least 6 weeks prior to commencement of fabrication.

Fabrication drawings shall be A1 in size unless otherwise approved by the Engineer.

Drawings shall give all geometrical information including all dimensions, thicknesses, weld references/preparations, sizes, machining requirements, material specifications/surface preparation, protective treatment and all requirements for fabrication of the element.

A13.11.5 MATERIALS

A13.11.5.1 General

All steels shall comply with the requirements of EN 10025, EN 10113, EN 10137, EN 10155, EN 10210 or BS 7668 and cross referenced Standards therein.

Compliance shall be demonstrated by satisfactory testing in accordance with the requirements of the above standards.

Rimming steel shall not be used.

All steels shall be manufactured to a process acceptable to the Engineer to give required material properties.

The quality records of the plants manufacturing steels and products shall be provided together with other supporting information to show that the proposed steel maker produces steel and products to the required quality.

A13.11.5.2 Steel plate

Steel plate shall have the required weldability, and when elements are to be bent to form a specified profile, or heat-treated steels shall be manufactured with the required properties.

All steel shall be ultrasonically tested to Grade LC1 of EN 10160.

For welded cruciform joints transmitting primary tensile stresses through the plate thickness, on a band of width four times the thickness of the proposed attachment, ultrasonic testing to acceptance level B4 of EN 10160 shall be carried out.

The thickness tolerance of plates shall be in accordance with Class A of EN 10029.

All steel shall be supplied with test certificates giving mechanical, fracture toughness (Charpy) and chemical composition.

Both Ladle and Product Analysis shall be carried out.

The Engineer's representative shall be given the facility to select samples for and to witness testing, and to inspect the surface condition of steel products for acceptability prior to dispatch. Where weld repairs are proposed these procedures shall be submitted to the Engineer for approval.

The Contractor shall obtain from the steel manufacturer his proposal for steel making and the quality regime proposed for quality control and traceability in respect of contract requirements, and these submitted to the Engineer for acceptance.

Where steel is to be processed from a Merchant, each product shall carry full traceability documentation.

A13.11.5.3 Rolled sections

The substitution of hot rolled sections by cold formed sections shall not be permitted.

A13.11.5.4 Shear studs

Steel for headed stud type shear connectors shall have a minimum yield stress of 385 N/mm^2, a minimum tensile strength of 485 N/mm^2, and a minimum elongation of 15 % prior to the cold formation of the head.

Steel for other types of shear connectors, shall, comply with the requirements of the EN 10025, EN 10113, EN 10137, EN 10210, and BS 7668.

A13.11.5.5 Bolts

Unless noted otherwise on the Drawings all bolts incorporated in the permanent works shall be HSFG bolts and shall comply with BS 4395, AMD 1843 and BS 4604

As an alternative, equivalent bolts may be supplied in accordance with SANS 1282.

A13.11.6 CONSTRUCTION EQUIPMENT

A13.11.6.1 Welding equipment

All welding plant, cables, accessories, instruments, baking ovens and any ancillary equipment shall be maintained in good condition consistent with the manufacturers' specification for output performance.

As required by the Engineer the Contractor shall demonstrate that his equipment is in good working order. Where equipment is found to be unreliable it shall be removed from use until its reliability can be demonstrated.

The Contractor shall ensure that earthing cables to all items of plant and equipment are of adequate cross section and all connections are properly made and maintained to ensure current flow and to prevent stray arcing.

The Contractor shall provide all necessary equipment for measuring voltage, current, wire speed feed and temperature.

A13.11.7 EXECUTION OF THE WORKS

A13.11.7.1 Welding

a) General

All welding shall comply with the requirements of this specification and, where appropriate, EN 1011, SANS 10162 and other cross referenced British Standards.

The Contractor shall establish all necessary processes, procedure specifications including procedure qualification records, trials and welder qualification records, method statements, inspections, testing, calculations, reports on welding processes and other supporting documentation, quality control procedures, and the Inspection and Test Plan covering all aspects of welding. These shall be subject to the approval of the Engineer.

b) Welding processes

The Contractor is responsible for the design and selection of welding processes that ensure welded joints that have the necessary metallurgical strength, ductility and fracture toughness properties to meet the Specification requirements.

Welding processes shall reliably produce satisfactory joints and where, in the course of production, a welding process is shown to produce unsatisfactory results its use shall be discontinued.

Prior to adoption of a particular process the appropriate procedure trials shall be implemented and records of past performance of the welding process supplied to the Engineer for his examination.

The following welding processes may be acceptable subject to the above criteria being satisfied:

- Manual Metal Arc
- Semi-automatic, automatic and mechanised metal-arc welding
- Submerged arc welding
- Gas shielded processes
- Un-shielded semi-automatic arc welding

"Electro-Slag" or "Fusarc" type welding processes shall not be permitted.

c) Consumables: Electrode specification

Consumables including electrodes, electrode wire, flux, and filler rods shall have suitable specifications to ensure that the weld metal will have mechanical and chemical characteristics compatible with the parent metal and joint strength requirements and are suitable for the welding process and position.

The Contractor shall establish suitable control systems to ensure that the storage, handling and use of consumables shall be strictly controlled in accordance with the manufacturer's requirements.

Consumables which show signs of damage or deterioration shall not be permitted for use and shall be removed from the Works.

Consumables shall be stored in dry heated conditions in their original containers, and in accordance with the manufacturers' instructions.

Special treatment immediately prior to use, as recommended by the manufacturer shall be carried out to ensure that consumables are in the optimum condition for the production of welds of the required quality.

To ensure that weld metal deposited by hydrogen controlled electrodes does not have an unacceptable hydrogen content, drying and baking conditions shall be in accordance with the manufacturer's instructions.

After baking, electrodes shall be protected from moisture absorption, and shall be temporarily stored in heated quires immediately prior to use.

The numbers of electrodes issued at any one time shall be strictly controlled consistent with work requirements.

Where electrodes are returned to stores these shall be treated in accordance with the manufacturer's instructions before re-issue. Electrodes exposed to poor storage, or that have become damp shall be removed from the Works.

Wire and cored electrodes shall be protected against damage and stored in dry heated conditions in accordance with the manufacturers' instructions.

Flux materials shall be packed and stored to ensure that hydrogen controlled levels are achieved as required by the welding process to produce weld metal with the required characteristics.

Special manufacturer's instructions shall be fully implemented and demonstrated to the satisfaction of the Engineer.

d) Stud shear connectors: Welding and procedure trials

Stud shear connectors shall be welded in accordance with the manufacturer's instructions, including preheating where necessary. Welding shall not be carried out when the ambient temperature is below 0^0C or when the surface is wet. The studs and the surface to which the studs are welded shall be free from scale and rust, metal spray, grease oil, paint, or other material which would adversely affect the quality of the weld.

The welds shall be visually free from cracks and lack of fusion and shall be capable of developing at least the nominal ultimate strength of the studs.

Unless specified otherwise and before production welding of studs commences, procedure trials shall be carried out. The trials shall be made on samples of material and studs representative of those to be used in the work. The samples of materials and studs shall be agreed with the Engineer.

Where primers are to be applied to the work prior to fabrication, these shall be applied to the sample material before the procedure trials are made.

e) Weld edge preparation

The preparation of joint faces shall be by a method acceptable to the Engineer so as to provide fusion faces with properties suitable for welding with respect to chemical and mechanical properties.

Where flame cutting or shearing is used at least one of the following requirements shall be satisfied:

- The hardness of the cut edge does not exceed 350 HV 30 when tested in accordance with EN ISO 6507.
- The cut edge is entirely incorporated in a weld.
- The material from the edge is removed by grinding or machining to the extent of either 2mm or the minimum necessary to demonstrate that the hardness on the edge does not exceed 350 HV 30 when tested in accordance with EN ISO 6507.
- The edge is softened by a suitable heat treatment approved by the Engineer and is shown by dye penetrant or magnetic detection procedure to be free from cracks.
- Edge softening procedures shall incorporate recommendations of the steel manufacturer to ensure that proposed procedures are compatible with as supplied steel characteristics.

In addition to these requirements flame cut edges shall be ground or machined to remove all visible signs of drag lines.

Fusion face profiles shall be to a geometry consistent with the production of the required quality of welded joint.

Fusion face/joint configurations shall be subject to weld procedure trails as part of the approval procedures required by this specification.

Fusion faces shall be free of all cracks or other irregularities which would lead to weld defects.

Alignment of fusion faces and root gaps shall comply with tolerances which are consistent with the proposed strength requirement and welding process.

In the case of fillet welds, edges and surfaces to be joined shall be in as close contact as possible to minimise the risk of cracking. In no case shall the gap exceed 2,0 mm. Where the gap exceeds 2,0 mm rectification proposals shall be submitted to the Engineer for approval.

Before fabrication is commenced, flame cutting trials shall be carried out using representative samples of materials to be used in the work, samples of materials shall be subject to approval by the Engineer with appropriate documentation submitted.

Where primers are to be applied to the work prior to fabrication, these shall be applied to the sample material before the procedure trials are made.

For flame cutting, trials on materials 20 mm thick shall be deemed to cover all material up to and including 20 mm thick, trials on material 40 mm thick shall be deemed to cover all material over 20 mm thick up to and including 40 mm thick, material over 40 mm thick shall be tested for every thickness increment of 10 mm.

f) Assembly for welding

Elements to be welded shall be brought together in the correct relationship to ensure that completion of deposition of weld metal respective parts attain the require alignment.

Assembly of joints shall be arranged to give welders optimum access and versatility for the welding process.

g) Temporary attachments

The location and method of fixing of all temporary attachments shall be agreed with the Engineer. Welds for temporary attachments shall be made in accordance with the same requirements for permanent welds.

The minimum length of weld shall not be less than 50 mm.

Temporary welded attachments shall be removed carefully by cutting or chipping clear of the parent material and the surface of the material shall always be finished smooth by grinding followed by surface crack detection.

Temporary attachments shall not be removed by hammering.

Any scars from temporary attachments shall be made good to the satisfaction of the Engineer. Where weld repairs are required these shall comply with the requirements for repairs to permanent welds.

h) Pre-heat

The pre-heating temperature is defined as the temperature of the parent plate before welding commences.

In multi-run welds the pre-heating temperature may be adjusted to a lower level depending on the arc energy input and sequence of welding consistent with production of the required weld quality.

The required pre-heat temperature shall be applied to the parent metal in any direction from the joint preparation.

Where practicable the temperature shall be measured on the face opposite to that being heated.

The temperature shall be confirmed on the heated face at a time after removal of the heat source, related to the parent thickness to allow for temperature equalisation.

Where fixed permanent heaters are in use and there is no access to the reverse face for temperature measurement, readings shall be taken on the exposed parent metal surface immediately adjacent to the weld metal.

The combined thickness shall be determined as the sum of the parent metal thicknesses averaged over a distance of 75 mm from the weld line with due allowance for significant changes in thickness adjacent to the 75 mm zone.

Depending on plate thickness and arc energy input, the required pre-heat temperature shall be determined in accordance with EN 1011.

i) Weld repairs

The Contractor shall submit for the Engineer's approval his proposals and procedures for repairs to welded joints.

If after repair a welded joint is still not satisfactory, the Contractor shall revise and re-submit his proposals for approval by the Engineer.

Where the joint is subsequently re-tested and found to be unsatisfactory the element shall be scrapped.

j) Protection from the weather

Surfaces to be welded shall be dry. Whenever there is any evidence of condensation taking place on metal surfaces warming shall be carried out to remove such condensation.

In any case no welding shall be carried out on parent metal below 5°C.

When rain or snow is falling or during periods of high wind, necessary precautions shall be taken to protect outdoor welding areas. Draughts shall be prevented from blowing along the bores of structural hollow sections when the bores will be penetrated.

Where gas-shielded welding processes are being used, sufficient screening shall be used to keep winds and draughts away from the welding area to ensure that shielding gas is not disrupted.

A13.11.7.2 Shopwork

a) Dimensions and datums

The manufactured lengths of all items shall be such that, at datum temperature when the structure is complete and with full dead load applied, the profiles of cables and roadway shall correspond to that given on the Contract Drawings.

The datum temperature shall be taken as 22^0C.

The Contractor shall, where he deems necessary, provide additional overlength to fabricated elements to ensure that correct geometry is achieved. Where such overlength is provided it shall be trimmed on site to the required dimensions

b) Fabrication sequence

The Contractor shall take full account of the sequence of assembly and deposition of welds to minimise distortion and residual stresses to ensure that the element on completion is within permitted fabrication tolerances.

During assembly all elements shall be adequately supported to minimise self-weight stressing and distortion.

The proposed sequence of assembly and welding shall be submitted to the Engineer for comment.

c) Tolerances on fabrication

All parts in a fabricated or other assembly shall fit together accurately within tolerances specified in this specification.

Where a machined plane surface is specified by the Engineer, it shall be machined within a deviation of 0,25 mm for surfaces that can be inscribed within a square of 500 mm side.

Where the ends of stiffeners require to be fitted they shall be ground or machined as necessary to ensure that the maximum gap over 75 % of the contact area does not exceed 0,25 mm.

All bolted splices shall be provided with steel packing plates where necessary to ensure that the sum of any unintended steps between adjacent surfaces does not exceed 1,0 mm for HSFG bolted joints and 2,0 mm for other joints.

For welded butt joints any unintended deviation from planarity due only to a misalignment of parts shall not exceed the lesser of 0,15 times the thickness of the thinner part or 3,0 mm. However, if due either to a different thickness arising from rolling tolerances or a combination of rolling tolerances with the above permitted misalignment, this deviation exceeds 3,0 mm it shall be smoothed by a slope not steeper than 1 in 4.

Where machined butt joints are specified, abutting ends of respective elements shall be machined after fabrication is complete.

Due account shall be taken of post fabrication relaxation of the structure.

Elements shall be fabricated with due allowance for camber.

Tolerances on camber shall be agreed with the Engineer prior to fabrication and incorporated in the Fabrication Method Statement.

The checking of tolerances shall be carried out on the following basis unless otherwise agreed with the Engineer in writing.

All components shall be checked for deviations in accordance with the undernoted tolerance requirements.

The amount of checking may be reduced by agreement with the Engineer depending on the standard of fabrication actually achieved in practice. Notwithstanding this all components shall be carefully examined by visual inspection and the results recorded.

Continued surveillance may require the checking of imperfections to be increased and the Contractor is required to fully address the checking regime methodology in his fabrication Method Statement and Inspection and Test Plan.

Members and components of rolled and built-up sections shall be checked for compliance with tolerances given in BS5400 Part 6.

Imperfections shall be measured over the full extent of each gauge length and, the scanning device moved to ensure that panels or elements are comprehensively measured as follows.

For plate panels the out-of-plane deviation at right angles to surface shall be measured over the full extent of the panel.

For stiffeners, the out-of-straightness at right angles to the plane of the plate, may be checked either on the plate attached to the stiffener or on the stiffener, except in the vicinity of a site splice.

The outstand edge of a stiffener shall be checked for imperfections parallel to the plane of the plate.

At site joints plate panels shall be surveyed for imperfections for a distance of 1,0 m either side of the splice or up to the next boundary stiffener.

Stiffeners, at site joints, shall be checked for imperfections over the full extent of the panel containing the joint.

For cross frames the deviation shall be checked over the middle third length of the cross frame between each pair of webs.

For the web of a rolled section (Beam or Channel) the out of plane deviation shall be measured over a distance in the longitudinal direction equal to the depth of the section.

Non-compliance with Tolerance Requirements and Rejection shall be based on the following:

- Plate Panels

Where permitted deviations are exceeded in plate panels, the maximum deviation shall be measured in the panel in question together with the maximum deviations in adjoining panels.

- Stiffeners in plate panels

For stiffeners in plate panels the maximum deviation in the stiffener in question shall be measured as shall stiffeners in line in adjacent panels.

The measurements shall be submitted to the Engineer who will review the results and determine whether the component may be accepted, or whether it may be acceptable with rectification, or whether the component shall be rejected.

The Contractor shall be responsible for preparing for approval by the Engineer proposals for rectification.

- Columns, struts, rolled or fabricated girders, cross frames and girders, webs of rolled sections

The maximum deviation need only be measured for the element in question, however depending on the relationship to other elements in terms of structural interaction, measurement of maximum deviations of these may be required subject to the requirements of the Engineer.

The measurements shall be submitted to the Engineer who will review the results and determine whether the component may be accepted, or whether it may be accepted with rectification or whether the component shall be rejected.

The Contractor shall be responsible for preparing for approval by the Engineer proposals for rectification.

Support of elements during inspection and measurement shall be representative and be of a similar manner to that in the completed structure.

On a completed element there shall be no external restraint or load during measurement of deviations.

Compliance with tolerances shall be checked at the following stages:

- On completion of fabrication and before any subsequent operation including surface preparation, painting, lifting, transport or erection, the plate surface on the stiffener outstand shall be checked over the specified gauge length for the length of the stiffener.
- For plate panels and stiffeners on completion of site joints.
- For cross frames, and other parts in which deviations have apparently increased, for plate panels and stiffeners at limit of a specified tolerance, on completion of site assembly and final erection.

d) Imperfection surveys

The Contractor shall prepare a programme for undertaking imperfection surveys to cover the various stages of fabrication, assembly and final erection.

The Contractor shall prepare suitable forms and data sheets on which this information shall be recorded.

The Contractor shall make provision for Imperfection Surveys within an Inspection and Test Plan.

The Contractor shall undertake all surveys and present the results to the Engineer for acceptance.

Prior to commencement of surveys, the Contractor shall notify the Engineer, to provide the Engineer with opportunity to witness surveys as required.

Until the standard of workmanship has been shown to be of a consistent quality, all steelwork shall be surveyed, thereafter the extent of the survey may be reduced, notwithstanding that all steelwork shall be visually examined.

The foregoing shall be subject to the Engineer's approval.

(i) Preparation of edges, ends and surfaces

Any burring, abnormal irregularities or scales shall be removed.

(ii) Edges

Edges shall be either:

1. left as rolled, sawn, machined, machine flame cut; or
2. hand flame cut with subsequent grinding to a smooth profile; or
3. for stiffeners and gussets, both not more than 12 mm thick, sheared and subsequently ground to a smooth profile.

All external arrises shall be radiused to a minimum radius of 1,0 mm by grinding or filing.

(iii) Ends

Ends shall be either:

1. sawn, machined, machine flame cut; or
2. hand flame cut with subsequent grinding to a smooth profile; or
3. for stiffeners, of not more than 12 mm thick, sheared and subsequently ground to a smooth profile.

Where ends of stiffeners are required to be fitted they shall be ground, where necessary, so that the maximum gap over 60 % of the contact area does not exceed 0,25 mm.

(iv) Flame cutting and shearing

Where flame cutting or shearing, as specified above is used at least one of the following

requirements shall be satisfied:

1. the hardness of the cut edge does not exceed 350 HV 30 when tested in accordance with EN ISO 6507;
2. the cut edge is not subjected to applied stress;
3. the cut edge is wholly incorporated in a weld;
4. the material from the edge is removed by grinding or machining to the extent of either 2,0 mm, or the minimum necessary to demonstrate that the hardness on the edge does not exceed 350 HV 30 when tested in accordance with EN ISO 6507;
5. the edge is softened by a suitable heat treatment approved by the Engineer and is shown by dye penetrant or magnetic detection procedure to be free from cracks;

6. the material is grade 43 steel and is not greater than 40 mm thick and edge preparation is by machine flame cutting.

In addition to the requirements of 1. to 6. a first quality cut as defined by EN ISO 9013 shall be achieved.

e) Trial assembly

Steelwork shall be subject to a trial assembly before transportation to site.

The extent of trial assembly shall be sufficient to ensure that all parts fit together accurately on final assembly in the correct geometrical relationship.

The results of both trial and completed assembly shall be monitored in relation to specification requirements, and where unsatisfactory, the fabrication methodology shall be modified.

f) Storage

The Contractor may store fabricated materials at the site, at an approved storage yard or at his shops, but he shall remain responsible for their custody and care. He shall handle and store the materials in a careful and systematic manner, so as to prevent any damage, corrosion or loss. Stored material shall not be permitted to rest on the ground or in water and shall be placed on suitable supports.

A13.11.8 WORKMANSHIP

A13.11.8.1 Welding

a) Weld procedures

Written weld procedures are required for all welds and shall be subject to approval by the Engineer.

The following items of information shall be provided as appropriate:

- Welding processes to be used in making the joint.
- Parent metal specification, thicknesses of plate, and geometry of proposed joint.
- Whether weld is to be performed on site or in the fabrication shop.
- Proposals for cleaning, inter-run cleaning.
- Details of type, size, classification, specification for electrodes and other consumables.
- For manual metal arc-welding details of electrode size, welding current, fillet weld leg length, number of runs and electrode run-out length.
- For semi-automatic, automatic and mechanised welding, the size of electrode, welding current, arc voltage, travel speed, wire feed speed, electrode extension or fillet weld leg length and number of runs, rate of flow of shedding gases, rates of consumption of other process materials.
- The temperature and time adopted for drying and baking of welding consumables before use.
- Diagram to show edge preparation, fit-ups, approximate number and disposition of runs in multi-run welds.
- Jigging arrangements to hold respective pieces in the correct relationship.
- Tack welding.
- Backing strips, material, method of fixing.
- Welding positions.
- Welding sequence.
- Preheat temperature and interpass temperature range, methods of confirmation and maintenance of required temperatures.
- Back gouging.
- Post-weld heat treatment.
- Matters arising from restraint and effects on weld metal and parent plate.
- Matters in relation to fracture toughness of weld metal and heat affected zone.
- Procedures to avoid cracking of welds.
- Package of information from which welders will work which must be sufficiently comprehensive.

All weld procedures shall be carried out in accordance with EN 288 to the satisfaction of the Engineer to demonstrate that the Contractor can produce satisfactory welds.

Before fabrication is commenced, welding trials shall be carried out using representative samples of materials to be used in the work, samples of materials shall be subject to approval by the Engineer and have appropriate documentation.

Welding trials shall demonstrate to the satisfaction of the Engineer the procedures to be adopted in the fabrication of the work, and as a minimum shall comply with the requirements of EN 1011 & EN 288

Where primers are to be applied to the work prior to fabrication, these shall be applied to the sample material before the procedure trials are made. Where galvanising or other metal coating of the material is to be applied to a part which is to be subsequently welded in the shop or on site, the same coating shall be applied to the sample material before the procedure trials are made.

b) Welder qualification and testing

The Contractor shall ensure that all welders he employs on the Works are competent and qualified to carry out welds in accordance with approved welding procedures.

The Contractor shall ensure that welds will only be performed by welders qualified to each specific weld procedure.

Approval testing and certification of welders shall be in accordance with EN 287.

c) Identification of welds

The Contractor shall implement a system to enable welds to be traced to the welder by whom it was made.

Hard stamping of steel is not permitted.

d) Procedure trials

(i) Testing of welding for structural steels

Non-destructive and Destructive Testing

With the exception of all weld tensile tests, non-destructive and destructive testing of welding shall be carried out as specified in EN 288. The root bend and face bend tests specified in EN 288 shall have the weld root and the weld face respectively in tension as described in the transverse bend tests of EN 910. Additionally, hardness tests shall be carried out on weld metal, heat affected zone and parent material of a macro section from each weld procedure test sample and the results recorded and submitted to the Engineer.

Charpy V-Notch impact tests for butt welds and heat affected zones of butt welds shall be carried out as given below.

Weld Metal and Heat Affected Zone (HAZ) Charpy V-notch Impact Test Requirements for Tension Areas.

e) Butt welds including corner or T-Butt welds parallel or transverse to main tension stress.

The minimum Charpy energy absorption requirements and test temperature shall be the same as that specified for the parent material joined. In the case of parent material on each side of the joint which have different specified Charpy requirements, the weld metal requirements shall be those of the parent material with the lower test temperature or, in the event that the test temperatures are the same, the higher energy absorption requirement.

f) Heat Affected Zone (HAZ)

The fusion boundary region of the HAZ of butt welds, including corner or T-butt welds, which are transverse to and carry the main tension stress shall have the following notch ductility requirements:

Heat welding input up to and including 5 kJ/mm – no test requirement

Heat welding input over 5 kJ/mm – as per parent metal.

g) Location and orientation of specimens and orientation of notch.

For Charpy tests in the weld metal the length of specimen shall be taken transverse to the line of the weld and the specimens notched so that the line of the notch root is perpendicular to the plate surface and is on the centre line of the weld joint.

For symmetrical and asymmetrical double V double J and double bevel joint preparations the specimen shall be cut so that one face is substantially parallel to, and within 3,0 mm of, the surface of the weld.

Additionally, for the asymmetrical preparation the specimen shall be taken from the side with the smaller preparation.

For single V, singled and single level joint preparations the specimen shall be cut so that one face is substantially parallel to and within 3,0 mm of the root surface of the weld.

For Charpy tests in the fusion boundary region of the HAZ, specimens shall be taken with their length transverse to the line of the weld and notched so that the line of the notch root is perpendicular to the original plate surface.

As far as possible, the notch at mid-thickness of the specimen should lie on the fusion boundary of the HAZ of the weld under test. The specimens shall be cut so that one face is substantially parallel to, and within 3,0 mm of, the original plate surface.

h) Number of specimens

Initially, three specimens for each weld or HAZ under consideration shall be taken and depending on the test results for these specimens, a further three specimens may be taken from the same joint.

i) Testing and acceptance criteria

The initial three specimens shall be tested and if the average of the three impact test results is less than the specified minimum average values, or if one individual result is less than 70 % of the specified minimum average value, or if two results are less than the specified minimum average value, then three additional test pieces from the sample shall be tested and the results added to those previously obtained and a new average value calculated.

The new average value shall not be less than the specified minimum average value.

Not more than three of the total of six results shall be less than the specified minimum average value, nor more than two results less than 70 % of the specified minimum average value and no individual result shall be less than 50 % of the specified minimum average value.

If the results fail to comply with the above requirements, the procedures concerned shall be rejected.

The cause of failure shall be established and depending on the causes either the procedure shall be modified without necessitating a new procedure test, as given in EN 288 or a new procedure shall be established and approved by the Engineer.

j) Stud shear connectors

For each procedure trial, examination and testing shall be carried out on six specimens as follows:

Metallographic examination and hardness tests shall be carried out on macrosections prepared on a plane along the axis of the stud of three of the specimens. The weld shall be free from macroscopic defects visible to the naked eye. The hardness of the weld metal shall lie in the range 150 HV 30 to 350 HV 30 when tested in accordance with EN ISO 6507. The hardness of the HAZ in the stud and the flange shall not exceed 350 HV 30 as given in EN ISO 6507 where the applied principal tensile stress at the ultimate limit state in the flange is equal to or greater than 100 N/mm^2 or 400 HV 30 where the flange is in compression or the applied principal tensile stress at the ultimate limit state in the flange is less than 100 N/mm^2.

Each of the remaining three studs of the sample shall be bent to a lateral movement of the head of approximately half of the height of the stud and then bent straight again without failure of the weld.

k) Production tests

(i) Destructive Testing of Welding for Structural Steel

- Production Test Plates

  Unless specified by the Engineer, approximately one in five pairs of "run-off" plates for transverse butt welds in tension flanges and one in 10 pairs for other butt welds shall be production test plates.

  The combined size of each pair of production test plates shall be adequate for the number and size of specimens to be tested.

  The material quality of the run-off plates shall be the same as that of the plates to be welded.

  On completion of the welds the "run-off" production test plates shall not be removed until they have been marked in a manner, agreed by the Engineer, to identify them with the joints to which they are attached.

  Testing

  The following tests shall be carried out on the production test plates.

- Transverse Tensile Test

  One transverse tensile test comprising sufficient specimens to cover the full plate thickness shall be made in accordance with EN 895 and the tensile strength shall be not less than the corresponding specified minimum value for the parent plate.

  If any specimen fails to meet the test requirement then a further test shall be made from the same production test plate.

  If any specimen from this further test fails to meet the test requirement then the joint shall be rejected.

- Bend test

  Bend tests shall be made in accordance with EN 910. For materials less than 10 mm in thickness one transverse root bend test and one face bend test shall be made.

  For material 10 mm in thickness and over, one side bend test comprising sufficient specimens to cover the full plate thickness shall be made.

  The diameter of the former and the angle of the bend used in the test shall comply with the requirements of EN 288.

  On completion of bending any defects in the tension surface of the test specimen shall be investigated and their cause established before the specimen is either accepted or rejected.

  Slight tearing at the edges of the test specimen shall not be a cause for rejection.

  If any specimen fails to meet the test requirement then a further test shall be made from the same production test plate.

  If any specimen from this further test fails to meet the list requirement then the joint shall be rejected.

- Charpy V - notch impact test

  Charpy V-notch impact tests shall be made in accordance with EN 875 on weld metal in butt welds transverse to and carrying the main tension stress.

  Additionally, where specified by the Engineer, Charpy V-notch impact tests shall be made on the fusion boundary region of the HAZ and shall comply with the requirements of (d) (i) above.

  Re-welding and Re-testing

  In the event of failure to meet the testing requirements of above the results shall be submitted to the Engineer who will determine whether the joints concerned and those represented by the tests may be accepted without additional work, or accepted subject to other satisfactory tests or additional work, or rejected.

  Rejected joints shall be cut out, re-welded and the tests repeated.

  Non-Destructive Testing of Welding for Structural Steel.

  Testing requirements are given in A13.11.8.1f).

  In the case of b), and c), the particular length of welds to be tested shall be agreed with the Engineer.

  Where specified by the Engineer, ultrasonic testing of support diaphragms or bearing stiffeners adjacent to welds, plates in box girder construction adjacent to web/flange welds material at cruciform welds or other corner details shall be carried out after fabrication.

  Any lamination, lamellar tearing or other defect found shall be recorded and reported to the Engineer for his decision.

l) Quality of welds

Welded joints require to be free from defects which would impair the performance of the structure.

Sub-surface and surface defects shall be in accordance with the requirements given in BS5400 Part 6 for fillet welds and for butt welds.

Non-destructive testing of welds shall be carried out as follows:

	Element	Extent	Acceptance Quality Category
1.	Transverse Butt Welds	100% US 100% MPI	A
2.	Longitudinal butt welds	10% US 10% MPI	B
3.	Fillet Welds	10% MPI	B
4.	Fillet welds at bearing stiffeners, at central movement joint, & cable stay anchorages	100% MPI	A

m) Stud shear connectors weld testing

Stud shear connectors shall be subjected to the following tests.

The fixing of studs after being welded in position shall be tested to the satisfaction of the Engineer by striking the side of the head of the stud with a 2,0 kg hammer.

Any stud selected by the Engineer shall be capable of being bent by striking the side of the head of the stud with a 6,0 kg hammer until its head is displaced approximately 0,25 times the height of the stud. The stud weld shall not show any signs of cracking or lack of fusion. Satisfactory studs shall not be bent back. The Contractor shall ensure that the direction of the test does not interfere with the fixing of reinforcement.

All fixed studs shall be subjected to the hammer ring test.

Where studs fail the hammer ring test, the Contractor shall increase the number of shear studs on that element of steelwork by 10 % together with replacing the faulty stud. The extra connectors shall be placed in positions agreed by the Engineer

A minimum of 1 % or 2 No, whichever is greater, of the studs attached to any one element of steelwork shall be tested.

Should a stud fail the bend test, 10 further studs shall be tested on the same item of steelwork. If any of the further studs fail the test, the Contractor shall submit a revised weld procedure for approval and shall carry out weld procedure trial at his own cost.

Further to the requirements above, before the start of each day's welding, three studs shall be welded to a plate of the same thickness as the steelwork being worked on and tested in accordance with the above requirements. If any of these studs fail, a further set of three studs shall be welded and tested until satisfactory results are obtained, before any studs are welded to the permanent steelwork.

n) Supervision

All welding shall be carried out under the control and supervision of appropriately qualified and experienced supervisory staff.

A13.11.8.2 Shopwork

a) Supervision

All fabrication and assembly shall be carried out under the supervision of suitably qualified and experienced staff with particular experience of the type of fabrication and assembly required by this contract.

Proposals for supervision and management structure of the supervisory team shall be submitted to the Engineer for acceptance 6 weeks prior to commencement of the fabrication process.

b) Dimension control

All measuring instruments shall be calibrated against reference standards acceptable to the Engineer.

Only calibrated instruments shall be used in the works.

The Contractor shall maintain a continuous record of calibration of each instrument; the Contractor shall submit for the Engineer's approval his proposed method and programme for instrument servicing and control of calibration.

Reference standards for calibration shall be in Laboratories approved by the Engineer.

For each element a full record of dimensions, pre- and post fabrication shall be prepared by the Contractor and submitted to the Engineer.

These shall be provided for the Engineer's acceptance, and the Contractor shall provide full access and assistance to enable the Engineer to check any dimensions as required.

The Contractor shall make due allowance in his programme for time required by the Engineer to check dimensions.

The accuracy of equipment for scanning imperfections shall be calibrated to ± 0,5 mm.

c) Fabrication Method Statement

The Contractor shall prepare a detailed method statement with explanatory diagrams to demonstrate his intended sequence of operations in fabrication and assembly.

The method statement shall be submitted to the Engineer for approval, and shall be re-submitted if revisions are required by the Engineer.

The method statement shall be submitted at least six weeks prior to commencement of fabrication.

d) Traceability

The Contractor shall operate a full documentation and control system designed to ensure that all elements have full traceability from material production through fabrication to final assembly, protective treatment, and erection.

Ingots, billets, slabs, plates, steel sections, bars and other products shall be clearly marked with identification marks to enable finished steel to be traced to the cast from which it was made. Grades of steel shall be clearly identified.

The proposed system shall be subject to approval by the Engineer, and 6 weeks prior to commencement of work details of the proposed system, including its supervision, shall be submitted.

The traceability system will be subject to independent audit by the Engineer.

Aspects covered by the traceability system shall be sufficient in extent to demonstrate adequate control.

The system shall embrace:

- production of steel plate
- marking of plate; control in stockyard
- sub-division of parent plate into sub-elements
- preparation
- dimensional control from material cutting through to final assembly, checking of dimensions at each stage
- welding process
- welder to weld identification
- electrode manufacture, storage and subsequent use
- Imperfections surveys
- Non-conformance controls and rectification
- Protective treatment
- Trial assembly
- Final assembly
- Erection
- All testing and inspection records

Further items as necessary are to be incorporated to ensure that all aspects of fabrication, assembly and erection are covered.

e) Inspection

The Contractor is responsible for preparation and implementation of an Inspection and Test Plan for the fabrication of all elements of the bridge.

The Inspection and Test Plan shall address all operations, stages involved, inspection and testing required at each stage, quantum of inspection and testing to be carried out, the type of documentation record to be produced, hold points, and points for independent inspection and testing by the Engineer.

The Inspection and Test Plan will be submitted to the Engineer for approval and identification of inspection and testing points required by the Engineer 6 weeks prior to the commencement date of manufacturing.

B13.11 STRUCTURAL STEELWORK FOR MAJOR STRUCTURES
PART B: LABOUR ENHANCEMENT

CONTENTS

B13.11.1 SCOPE

B13.11.2 DEFINITIONS

B13.11.3 GENERAL

B13.11.4 DESIGN BY CONTRACTOR / PERFORMANCE BASED SYSTEMS

B13.11.5 MATERIALS

B13.11.6 CONSTRUCTION EQUIPMENT

B13.11.7 EXECUTION OF THE WORKS

B13.11.8 WORKMANSHIP

B13.11.1 SCOPE

This Section covers the manufacture, transport and erection of structural steelwork for major steel structures, e g steel bridge decks, composite steel decks, and steel and composite steel cable-stay towers. It does not apply to minor steel structures such as sign gantries, which is covered in Section A13.9. Due to the specialist nature of the activities associated with this work, it is deemed unsuitable for labour enhanced work.

B13.11.2 DEFINITIONS

The provisions of Part A shall apply with no additional requirements.

B13.11.3 GENERAL

The provisions of Part A shall apply with no additional requirements.

B13.11.4 DESIGN BY CONTRACTOR / PERFORMANCE BASED SYSTEMS

The provisions of Part A shall apply with no additional requirements.

B13.11.5 MATERIALS

The provisions of Part A shall apply with no additional requirements.

B13.11.6 CONSTRUCTION EQUIPMENT

The provisions of Part A shall apply with no additional requirements.

B13.11.7 EXECUTION OF THE WORKS

The provisions of Part A shall apply with no additional requirements.

B13.11.8 WORKMANSHIP

The provisions of Part A shall apply with no additional requirements.

C13.11 STRUCTURAL STEELWORK FOR MAJOR STRUCTURES

PART C: MEASUREMENT AND PAYMENT

(i) Preamble

The tendered rate for each item shall include full compensation for providing, maintaining and decommissioning upon completion, of all the plant, equipment, labour, tools, incidentals and supervision to carry out the activity or construct the works in the item, unless otherwise stated.

Any prime cost or provisional sums shall be paid in accordance with the provisions of the conditions of contract. The charge or mark-up tendered or allowed for is a percentage of the amount actually paid under the prime cost or provisional sum. This percentage shall cover all the Contractor's handling, supervision, profit and liability costs to provide the services in the prime cost or provisional sum item.

The requirements of Section C1.1 of Chapter 1 shall apply.

Where pay item descriptions include any wording in brackets it is an indication that contract specific information is to be inserted in the Pricing Schedule included in the Contract Documentation.

(ii) Notes on measurement and pay items

None.

(iii) Items that will not be measured separately

The following activities, whether required to complete the specified work or not, will not be measured and paid for separately and the Contractor shall include the cost thereof in other pay items as he deems appropriate:

1. No separate payment will be made for setting out the works.
2. No separate payment will be made for the protection or repair as required of any existing or new road furniture, structures, buildings, infrastructure or services damaged by the Contractor's activities.
3. No additional payment shall be made, nor shall any claim for additional payment be considered, for any specified work in confined or restricted areas. Any additional costs associated with working in confined or restricted areas shall be deemed to be included in the standard applicable pay items.
4. No separate payment will be made for the loading of any materials.
5. No separate payment will be made for the hauling of any materials where the material is moved over a distance of less than, and up to 1,0 km and for labour enhanced construction, less than and up to 50 m.
6. No separate payment will be made for transporting materials from commercial sources irrespective of the haul distance.
7. No separate payment will be made for the removal or any surplus material imported to complete the works.
8. For all Works performed, precautionary measures required in terms of the Occupational Health and Safety Act (Act 85 of 1993) and the latest amendments thereof as well as the latest Construction Regulations shall be deemed included in the rates tendered for the relevant products.

(iv) Items to be measured and paid for using items specified elsewhere in the specifications

Not applicable to this Section.

(v) Items specifically for this Section of the specifications

Item	Description	Unit
C13.11.1	**Supply, fabrication and erection of steelwork** (location, member, grade and type identified)	**ton (t)**

The unit of measurement shall be the computed mass of the finished member comprising plates, rolled sections, shear connectors, stiffeners, cleats, packs, spliced plates, access hatches, doorways and all fittings, without allowance for tolerances for rolling margins and other permissible deviations from standard masses or nominal dimensions and excluding the masses of welds, bolts, nuts, washers, rivets and protective coating. No deductions shall be made for notches, cope holes, bolt and rivet holes, and the like, which are less than 0,03 m^2. No allowance will be made for overlength provided in order to achieve the correct line and level.

The tendered rate shall include for the production of detailed fabrication and shop drawings.

The computed mass of rolled steel shall be determined from the dimensions given on the contract drawings and the density of steel given as 7850 kg per cubic metre.

The Contractor should check the masses and quantities of steel for the various grades himself. Should the Engineer instruct a design change involving a change to the mass of the steel shown in the contract drawings, then the unit price for that unit or piece only may be revised.

For ease of measurement, of Fabrication and Erection of Steelwork at each location specified above, measurement shall be identified by member and steel grade.

The tendered rates shall include full compensation for the following:

(a) supply of steelwork;
(b) delivery of steelwork to site;
(c) labour and plant associated with erecting and fixing the steelwork
(d) examining and checking for segregation, laminations, cracks and surface flaws and carrying out any remedial measures required by the Engineer in respect to these defects;
(e) weld testing in accordance with the specification,
(f) cutting, marking off, drilling, notching, machining, treatment of outside arises, smoothing of slopes, form fitting, end and edge preparation and cambering;

(g) bolting, assembling and pre-heating;
(H) welds, packing plates, bolts (including holding down bolts), nuts and washers required to fabricate and to complete the erection and installation on site, together with spares and service bolts, drifts, draw up cleats and the like; pre-production procedural trials;
(i) welder approval trials and provision of certificates;
(j) checking of deviations in plate panels and rolled and built–up sections and of alignment at joints, including taking measurements and observations and recording and supplying one copy of the records to the Engineer;
(k) preparation and supply of marked erection drawings, marking members for identification and delivery in matching sequence.
(l) Temporary bracing or stays to prevent displacement including the provision and removal of temporary attachments;
(m) Proving dimensions, cambers and profiles and alignment of joints through trial erection;
(n) Match-marking members as required for permanent erection;
(o) Dismantling trial erections;
(p) Modification and refitting of members as a result of trial erection;
(q) Permanent bolted and welded connections including the provision of preheat and shelters for welding;
(r) Erection to the correct line and level,
(s) All incidental items to completely finish the work.

Item	Description	Unit
C13.11.2	**Miscellaneous metalwork** (location and member to be specified)	**number (No)**

Miscellaneous metalwork shall comprise items of metalwork incorporated into structures necessary to provide access for inspection and maintenance and shall include ladders, access covers and frames, mesh panels, walkway panels, screens, grilles, handrailing, kick plates, material hoists, fall arrest systems and the like.

Items of metalwork which are included in the computed weight of fabricated items or are included in the measurement of other items shall not be measured as miscellaneous metalwork.

The tendered rate shall include full compensation for miscellaneous metalwork including the delivery and supply of all materials, labour, plant, permanent and temporary fixings, bolts, nuts, washers, rivets, frames, holding down systems, support steelwork and restraints and where specified in the Contract drawings, Contractor's design and checking services, necessary to design and erect the miscellaneous metalwork, installation, testing, commissioning and documentation.

D13.11 STRUCTURAL STEELWORK FOR MAJOR STRUCTURES
PART D: GUARANTEES AND COMPLIANCE CERTIFICATES

CONTENTS

D13.11.1 SCOPE

D13.11.2 GENERAL

D13.11.3 PERFORMANCE GUARANTEE REQUIREMENTS

D13.11.4 FUNCTIONAL PERFORMANCE ASSESSMENTS

D13.11.5 VISUALLY ASSESSED PROPERTIES

D13.11.6 INSTRUMENTALLY ASSESSED PROPERTIES

D13.11.7 EVALUATION FOR ACCEPTANCE

D13.11.8 ADDITIONAL PROCEDURES TO BE ADOPTED IN THE EVENT OF FAILURE

D13.11.9 NOTIFICATION OF REMEDIAL WORK

D13.11.10 REMEDIAL WORK

D13.11.1 SCOPE

The scope of this Section covers the following:

- Product conformance specifications
- Warranties for product or element design and installation of proprietary systems
- Performance specifications

Note that the requirements for performance specifications are not limited to that given in Part C only but includes all of the requirements in the Contract Documentation.

D13.11.2 GENERAL

D13.11.2.1 Product conformance specifications

The Contractor shall, within 28 days of entering into the contract with the Employer, submit to the Engineer conformance documentation related to the specifications.

Conformance documentation shall be provided for:

(a) Structural steel: each type and batch;
(b) Other structural steel materials including shear studs, bolts, nuts, washers, welding material, etc.;
(c) Welding procedures; and
(d) Welder qualification and testing.

D13.11.3 PERFORMANCE GUARANTEE REQUIREMENTS

D13.11.3.1 Warranties for product or element design and installation of proprietary systems

No additional requirements.

D13.11.3.2 Performance specifications

Performance based specifications shall be contained in the Contract Documentation for the project.

13.12 STRUCTURAL STEEL PROTECTIVE TREATMENT OF MAJOR STRUCTURES

CONTENTS

PART A: SPECIFICATIONS

A13.12.1 SCOPE

A13.12.2 DEFINITIONS

A13.12.3 GENERAL

A13.12.4 DESIGN BY CONTRACTOR / PERFORMANCE BASED SYSTEMS

A13.12.5 MATERIALS

A13.12.6 CONSTRUCTION EQUIPMENT

A13.12.7 EXECUTION OF THE WORKS

A13.12.8 WORKMANSHIP

PART B: LABOUR ENHANCEMENT

PART C: MEASUREMENT AND PAYMENT

PART D: GUARANTEES AND COMPLIANCE CERTIFICATES

A13.12 STRUCTURAL STEEL PROTECTIVE TREATMENT OF MAJOR STRUCTURES

PART A: SPECIFICATIONS

A13.12.1 SCOPE

This Section covers the protective treatment of structural steelwork for major steel structures, e.g. steel bridge decks, composite steel decks, and steel and composite steel cable-stay towers. It does not apply to protective treatment of minor steel structures such as sign gantries, which is covered in Section A13.10.

A13.12.2 DEFINITIONS

A13.12.3 GENERAL

The Specification below in general refers to European and British Standards. Equivalent international standards will be accepted subject to the Engineer's approval.

The Contractor shall establish implementation procedures which shall ensure the integrity of the protective treatment systems to be applied to the various elements of the bridge. Both the supplier and applicator of the protective treatment shall have a quality system in accordance with ISO 9001.

The Contractor shall prepare, for approval by the Engineer, method statements, procedures and Inspection and Test Plans covering each aspect of protective treatment from paint manufacture (including paint manufacture quality control systems, testing and traceability), storage of paint, paint system application procedure trials, the various stages of steel preparation, paint coat application, ambient conditions control, inspection, testing, restoration and repair, compliance with all health and safety requirements and reporting of results.

Surface preparation and protection against corrosion of steelwork shall be carried out in accordance with the undernoted Clauses with due account taken of the design and fabrication of the structure.

The Contractor shall establish measures to contain people, plant, materials, dust and debris during preparation and application of protective coatings.

A13.12.4 DESIGN BY CONTRACTOR / PERFORMANCE BASED SYSTEMS

A13.12.5 MATERIALS

A13.12.5.1 Paint and similar protective coatings

The term paint shall be deemed to refer also to similar protective coatings including specialist coatings such as grease paints.

All paints incorporated in the Permanent Works shall conform to the formulations which have been registered by the manufacturer. All materials comprising the paint system shall be supplied from a single manufacturer

All paints shall be supplied in sealed containers of not more than 5 litres capacity and these shall be used in order of delivery. Each container shall be clearly marked on the side to show the name of the manufacturer, registered description of the material (including purpose, e.g. whether primer, undercoat or finish), colour, paint manufacturer's reference number, batch number and date of manufacture. Where date of manufacture is coded, the Contractor shall provide the Engineer with the code key.

The Contractor shall ensure that the properties of the paints he has selected are suitable for the conditions in the shops and on site, including temperature and humidity, and that he is able to apply the paints satisfactorily to all parts of the structure in these conditions.

All paints forming any one protective system or overlapping systems, shall be obtained from the same manufacturer, as named by the Contractor on the approved Paint System Data Sheet, see Clause A13.12.8.4, submitted by the Contractor.

A13.12.5.2 Storage requirements and keeping periods for paints

On delivery to the shops or site, paint shall be unloaded directly into one or more secure paint stores. Unless otherwise agreed by the Engineer, paint shall be stored within 100 metres of the painting area. Insulation and means of heating and ventilating shall be provided as necessary to maintain the temperature of paint stores between 5°C and 27°C.

If at any time or place paint in tins, painters' kettle or airless spray containers is allowed to reach temperatures outside the 5° and 27° limits, the paint shall be discarded and not used in the Permanent Works. The Contractor shall also implement any additional storage restrictions recommended by the paint manufacturer.

Paint which has not been used within the shelf life recommended by the manufacturer or within 18 months of the date of manufacture, whichever is the lesser, shall be discarded and not used in the Permanent Works.

Chemically or moisture cured paints shall not be used after the expiry of the pot life or at the end of each working day/night whichever is the less. All other paints in opened tins or open containers including painter's kettles shall be returned to store and kept in sealed containers with not more than 10 % ullage.

Exceptionally, and subject to agreement by the Engineer, components of Polyamide-cured Epoxy paints may have their keeping period extended to 24 months provided that the Contractor returns the paints to the paint manufacturer and ascertains that the manufacturer examines the contents of each tin and reconstitutes the paints as necessary so that such paints are equal in all respects to the paints described in the Contract.

Each tin of reconstituted paint returned to the shops or site by the manufacturer shall have an additional label affixed stating 'Extended Keeping Period to (date)'. The previous date marking shall remain and not be obscured. Testing in compliance with

Clause A13.12.8.2 shall apply to reconstituted paints.

A13.12.6 CONSTRUCTION EQUIPMENT

A13.12.7 EXECUTION OF THE WORKS

A13.12.7.1 General requirements for surface preparation (shop & site work)

Prior to blast cleaning or abrading steel surfaces or overcoating painted or galvanised surfaces, contamination shall be removed by wet cleaning. Solvents shall not be used.

Clean water shall be used for cleaning and rinsing provided it does not leave harmful residues.

Only cleaning agents which do not leave harmful residues on the surface after final rinsing shall be used for cleaning.

Surface preparation shall be continued until the required standard has been achieved. The surfaces are required to be free from condensation, oil, grease, dust residues and detrimental contamination such as chlorides and sulphides. These can be tested using the procedures of EN ISO 8502.

Weld spatter shall be removed from areas to be galvanised or protected by metal spray or paint. Weld spatter shall be removed before blast cleaning.

After dry surface preparation of internal surfaces and before any wet cleaning, all dust and debris shall be removed by sweeping and vacuum cleaning.

Before application of each coat of paint, the Contractor shall ensure that the surfaces:

- meet the required standard of preparation;
- are free from harmful residues including mortar, concrete, dust, grit and paint degradation products;
- are free from detrimental contamination;
- are free from moisture detrimental to the coating to be applied.

Joints shall be sealed in accordance with Clause A13.12.7.5b)(viii) & (ix)

Paint coats shall be free from embedded metallic or other foreign particles and such adherent matter on metallic coatings or painted surfaces shall be immediately removed and coatings damaged in the process restored.

The final shops coats on external surfaces shall be wet cleaned on site to remove any harmful residues and contaminants.

A13.12.7.2 Materials and methods for surface preparation

a) Dry blast cleaning in the shops

The following materials shall be used:

Chilled-iron grit complying with EN ISO 11124-2, high carbon cast-steel or grit complying with EN ISO 11124-3 with a hardness value greater than 650 HV, fused aluminium oxide complying with EN ISO 11126-7; non-metallic abrasive such as fused aluminium oxide to EN ISO 11126-7 almandite garnet to BS 7079-F10, copper slag to EN ISO 11126-3 or recycled glass complying with EN ISO 11126-7.

Grades for metallic abrasives shall comply with the following:

Profile	Grade
Fine	G050 or S060
Medium	G070 or S100
Coarse	G100 or S120

The particle size of metallic abrasive in plant or equipment shall not exceed the maximum of the relevant grade as specified above.

Before the start of blast cleaning and during blast cleaning the Contractor shall ensure that the abrasive is free from matter which could leave detrimental contamination on the surfaces to be coated.

b) Surface preparation by abrading in the shops or on site

Any matter or paint which is difficult to remove by abrading alone shall be dislodged by scraping, by hand or power wire-brushing and shall be completed before abrading the areas so affected.

Abrading shall be by use of abrasive paper or other material or a flexible abrasive disc mounted on a power driven flexible pad and may be used to remove weld spatter. Wet abrading may be used for the preparation of finishes over sound undercoats, over unsound systems over galvanising, or galvanising. Wet abrading shall not be allowed to come into contact with exposed thermally sprayed metal coatings.

All equipment, tools, abrasive sheets and discs and shall be suitable for the purpose. The use of hard grinding wheels for abrading shall not be acceptable.

A burnished appearance caused by polishing in paint, rust or dirt shall not be accepted.

Corroded steel or unsound metal coatings which have been prepared by abrading to bright steel or bright metal coating, and blast cleaned, where appropriate, shall be protected by the primer and next coat of the paint system prior to cleaning or preparation of adjacent surfaces.

c) Surface preparation by wet cleaning in the shops or on site

Wet cleaning shall be carried out by scrubbing with a stiff-bristled brush using water and an approved cleaning agent or a pressure washer and immediately after cleaning, surfaces shall be thoroughly rinsed.

d) Surface preparation by dry cleaning in the shops or on site

Surfaces shall be cleaned by scrubbing with a dry stiff-bristled brush.

e) Surface preparation by dry blast cleaning on site

Metallic grit abrasives shall comply with section (a) of this Clause and shall be used for dry blast cleaning of small areas to be metal sprayed, as at site welds, at areas prepared to clean steel or areas where a metal spray is to be restored, as indicated in Clause 13.12.7.4(b). The Contractor shall ensure that the grade and particle shape of proposed non-metallic abrasives are adequate for the purpose intended: non-metallic abrasives shall not be recycled.

f) Surface preparation by low or high pressure wet blast cleaning on site

Subject to the Engineer's approval an adjustable low pressure air/water/abrasive system shall be used with the air/water pressure at the nozzle limited to 7,0 kgf/cm^2 maximum and shall be fully adjustable. The quantity of non-metallic abrasive to be fed into the air/water mixture shall be fully adjustable by remote control and the air, water abrasive mixture thoroughly mixed and projected by a single bore nozzle. Inhibitors shall not be permitted.

Subject to the Engineer's approval an adjustable high pressure water system shall be used with the water pressure at the nozzle limited to 562 kgf/cm^2 for high pressure or between 1750 and 2860 kgf/cm^2 for ultra high pressure. The system shall incorporate a mechanical metering device controlled by the operator at the nozzle, to regulate from zero to the maximum quantity of non-metallic abrasive being fed into the water.

g) Surface preparation by combined wet/dry blast cleaning on site

Wet blast cleaning using the low pressure air/water/abrasive system in compliance with the above Clauses shall be followed by dry blast cleaning as specified above.

The specified standard of surface preparation shall be achieved by wet blast cleaning and washing; dry blast cleaning shall be used to remove flash rusting or to restore surface preparation to the required standard.

h) Other requirements

Within 1 hour of wet blast cleaning, the whole of the cleaned surface shall be thoroughly washed using the blast cleaning equipment with air and water and any remaining deposits of abrasive and debris removed by the same process before the end of the working day. After washing, the surfaces shall be free from all particles of dust and debris. Tests for freedom from detrimental contamination shall be made after the washing.

Where it is intended that surface preparation is to be by dry blast cleaning and, on adjacent surfaces, by wet cleaning and or abrading, then after dry surface preparation of internal surfaces and before any wet cleaning the wet cleaning and any abrading shall be carried out first.

When combined wet/dry blast cleaning has been specified instead of dry blast cleaning only, the above sequence may be reversed. Wet blast cleaned areas shall be cleaned and rinsed prior to dry blast cleaning.

i) Grinding after surface preparation in the shops or on site

Subject to approval of the Engineer grinding wheels and discs shall be of the size, shape and grade of coarseness and speed appropriate to the particular operation.

A13.12.7.3 Workmanship standards for the surface preparation of steel by blast cleaning, abrading, grinding and cleaning

The surface profile to be achieved by blast cleaning, either 'Fine', 'Medium' or 'Coarse', as appropriate, shall be within the limits set by the Surface Profile Comparator for the Assessment of Abrasive Blast Cleaned Surfaces, conforming to EN ISO 8503: Part 1.

Blast cleaned surfaces shall be virtually free from sharp spikes of parent metal defined as 'rogue peaks' formed by the impact of abrasive particles and which project above the blast cleaning profile. Any 'rogue peaks' which in the opinion of the Engineer would be detrimental to the protective system shall be removed.

'Hackles' and inclusions caused by the rolling process, visible after blast cleaning, shall be removed. Affected surfaces shall be prepared by grinding or abrading to bright steel in compliance with Clause A13.12.7.6 where appropriate. Sharp edges shall be rounded. If metal spray is to be applied the surfaces shall then be blast cleaned.

Steel surfaces to be prepared by any of the methods described in the Contract shall be such that after surface preparation the surfaces are free from detrimental contamination and conform to the following.

a) Visual cleanliness

Surface preparation by blast cleaning shall be to one or more of the following standards of visual cleanliness:

- 'Clean steel' SA3 to EN ISO 8501 – 1

Appearance: There shall be a blast cleaning pattern overall. The surface profile shall be free from mill scale, rust and foreign matter when viewed through a X10 illuminated magnifying glass.

- 'Clean steel' SA2½ to EN ISO 8501 - 1

Appearance: There shall be a blast cleaning pattern overall. The surface profile shall be free from mill scale, rust and foreign matter when viewed by normal vision.

- 'Bare Steel' (blast cleaned or abraded)

Appearance: The surface shall be free from all rust scale, loose rust and loose mill scale.

After surface preparation by blast cleaning to SA3 or SA2½ the surface profile shall be virtually free from embedded abrasive particles when viewed through a 10X illuminated magnifying glass of a type approved by the Engineer. Surfaces assessed as unsatisfactory in this respect by the Engineer shall be blast cleaned again with fresh abrasive. Another abrasive complying with the Specification may be used if necessary.

b) 'Harmful residues' or 'detrimental contamination':

Surfaces shall be deemed to be free from 'harmful residues' or 'detrimental contamination' after surface preparation when, in the opinion of the Engineer, any such remaining matter will not reduce the required durability of the specified protective system.

c) 'Bright steel':

Surfaces free from defects or prepared to this standard by grinding or abrading shall have an overall bright appearance.

A13.12.7.4 Workmanship standards for the surface preparation of coated steelwork by blast clearing, abrading, grinding and cleaning

a) Before overcoating

Before overcoating, surfaces shall be free from:

(i) any visible gloss which may, in the opinion of the Engineer, prevent adequate adhesion of the next coat
(ii) any unsound paint down to sound paint
(iii) any unsound paint down to clean steel
(iv) any unsound paint down to bright steel
(v) any unsound paint down to sound metal coating
(vi) any unsound paint down to bright metal coating
(vii) any unsound metal coating down to sound metal coating
(viii) any unsound metal coating down to bright metal coating
(ix) any unsound metal coating down to clean steel
(x) any unsound metal coating down to bright steel
(xi) detrimental contamination

b) Definitions of terms

Definitions of terms used in describing the above standards of workmanship are as follows:

(i) 'Clean steel', as in Clause A13.12.7.3a)
(ii) 'Bright steel', as in Clause A13.12.7.3c)
(iii) 'Free from detrimental contamination', as in Clause A13.12.7.3b)
(iv) 'Bright metal coating' resulting from abrading, a metal coating whose surfaces are free from all corrosion products and of bright appearance overall
(v) 'Unsound metal coating', a metal coating showing signs of disruption, inadequate adhesion or penetration by rust or other corrosion products
(vi) 'Sound metal coating', a metal coating which complies with Clause A13.12.7.8b) including such a metal coating which has been blast cleaned but which has a reduced thickness in accordance with Clause A13.12.7.7.
(vii) 'Unsound paint', paint showing signs of disruption, rusting through, having inadequate adhesion or covering rust scale, loose rust, loose mill scale or other detrimental products
(viii) 'Sound paint', paint which is sound down to a metal substrate.

Definitions of terms used in Clauses A13.12.7.5, A13.12.7.6 and A13.12.7.7 are as follows:

(i) 'Restored' coatings. When paint or similar coatings or metal spray coatings are to be restored, the standard of surface preparation and coating material shall comply with the original standard. Damaged or failed paint systems over metal spray shall be restored using dry blast cleaning. The thickness of any underlying metal spray or paint coating which may have been reduced in thickness during surface preparation shall be brought up to specification.
(ii) 'Restored' surface preparation. The original standard shall be obtained. When further metal spray coating is to be applied, the surface of the existing metal spray coating shall be restored by dry blast cleaning with metallic grit abrasive to sound metal coating.
(iii) 'Local failure'. An isolated breakdown of a protective coating or system due to extraneous causes excluding mechanical damage.

c) Permitted residual metal sprayed aluminium and zinc

When 'clean steel' is exposed through a metal spray coating during remedial surface preparation, remnants of sound aluminium metal spray coating may, subject to the agreement of the Engineer, be retained in a blast cleaning profile; also, subject to the agreement of the Engineer, be retained in a blast cleaning profile; also, subject to the agreement of the Engineer, traces of zinc metal may remain occluded within the surface of a blast cleaning profile after the removal of a zinc metal spray coating.

A13.12.7.5 Treatment at joints

a) Fasteners, joint material and parent metal in joints, before assembly or welding, in the shops or on site

(i) Fasteners (Bolts, nuts and washers)

Surfaces of uncoated fasteners shall be free from all traces of oil or grease before assembly.

Threaded fasteners at joints in galvanised steelwork, or galvanised steelwork which is to be painted, shall be galvanised. Galvanised fasteners which are to be painted shall be etched before assembly.

Metal coatings on surfaces of fasteners which are to be painted shall be:

- free from all traces of oil or grease and then etched; or
- treated at the same time as the parent material where fasteners are already assembled.

Fasteners that have been etched shall be pressure-rinsed with water and allowed to dry before assembly or packing for delivery at least one hour and not more than four hours after satisfactory application of an etch primer.

Fasteners that have become difficult to tighten because of corrosion shall be replaced.

(ii) Joint material and parent material in joints

The standard of initial blast cleaning of joint material and parent material in joints shall be at least equal to that for the parent material. Before a joint is made on site, contact surfaces shall be restored to clean steel, SA 2½ or to sound metal coating.

(iii) Joints made with high strength friction grip and tension control bolts

In steelwork painted only overall:

The blast primer applied to the parent material shall be taken 10 mm to 15 mm inside the perimeter of the joints. The outer surfaces and edges of site joint material may, at the option of the Contractor, also be given a coat of the blast primer.

In steelwork with thermally sprayed metal coating at joints only, and painted overall:

The thermally sprayed metal coating shall be applied to the contact surfaces of the joints and to the outer surfaces and edges of joint material. The thermally sprayed metal coating on the contact surfaces of the parent material shall be taken 10 mm to 15 mm outside the perimeter of the joints. The blast primer applied to the parent material shall be taken 10 mm to 15 mm inside the perimeter of the joints. The thermally sprayed metal coating on the outer surfaces and edges of site joint material shall be given a coat of aluminium epoxy sealer (2 packs).

In steelwork with thermally sprayed metal coating overall and sealed only or painted overall:

The thermally sprayed metal coating shall be applied to the contact surfaces of the joints and to the outer surfaces and edges of joint material. The sealer applied to the parent material shall be taken 10 mm to 15 mm inside the perimeter of the joints. The thermally sprayed metal coating on outer surfaces and edges of site joint material shall be given a coat of aluminium epoxy (2 pack) sealer.

In steelwork hot dip galvanized only or hot dip galvanized and painted overall:

All material at joints shall be hot dip galvanized. When an adhesion promoter and a first undercoat are applied before a joint is made they shall be taken 10 mm to 15 mm inside the perimeter of the joint; these coats shall also be applied to edges and outer surfaces of the joint material.

The thickness of a protective paint coat applied to the outer surfaces of joint material prior to assembly of any high strength friction grip or tension control bolted joint shall not exceed 20 microns dry film thickness.

(iv) Non friction grip bolted joints

At shop joints in all steelwork other than in galvanised steelwork the blast primer alone or metal spray plus sealer shall be applied initially to parent and joint material. Immediately before assembly of a joint which is to be painted the first undercoat shall be applied to the contact surfaces and the joint made while the paint is wet.

At site joints in all steelwork other than in galvanised steelwork all surfaces except those of fasteners, shall receive in the shops the shop protective system which is applied to the parent material.

At shop and site joints in galvanised steelwork an etch primer and shop coats may be applied to the joint material before or after shop joints are made. When galvanised steelwork is painted on site etch primer and paint shall be applied to joint material after the joint has been made.

(v) Welded Joints

At shop and site joints in all steelwork, surfaces to be welded shall be blast cleaned to SA 2½ or to bright steel and shall be free of any protective or other coating.

b) Shop treatment of parent material adjacent to joints to be assembled or welded later on site

(i) At high strength friction grip and tension control bolted joints

The paint coats with the exception of the primer or first coat of paint, shall be stepped back at 30 mm intervals commencing 10 mm from the perimeter of the joints.

(ii) At non friction grip bolted joints

Shop paint coats are required to be stepped back.

(iii) Welded joints

Metal spray coating shall be separated from the weld by a distance of not less than 200 mm and a maximum of 300 mm from the joint. The separation area shall be masked during metal spraying. Galvanising shall be removed a minimum of 10 mm back from the edges of weld areas. Paint coats shall be stepped back at 30 mm intervals commencing at least 100 mm from the joint, or from the edge of the metal spray.

(iv) Completed joints

Within 14 days of a joint being completed, exposed surfaces of parent and joint material shall be prepared as specified in the undernoted Clauses.

(v) Bolted joints

Steelwork to be painted overall with blast cleaned or primed surfaces shall be prepared by dry blast cleaning to provide the required standard of surface preparation.

Steelwork metal sprayed at joints only, and to be painted overall, primed or sealed metal sprayed coatings shall be prepared by dry blast cleaning to the required standard.

Steelwork metal sprayed overall, and sealed only or painted overall, metal spray coatings shall be prepared in accordance with the undernoted Clauses.

Steelwork galvanised or galvanised and painted overall, the surfaces shall be free from detrimental contamination.

(vi) At welded joints

In all steelwork welds shall be prepared by the methods and to the standards described for shop or site work as appropriate. Surfaces of areas adjacent to the weld shall be similarly prepared. For site welds in galvanised steelwork, surfaces shall be treated in accordance with the above Clauses.

(vii) Surfaces of fasteners

Uncoated and temporarily coated fasteners shall be free from all traces of oil and grease and blast cleaned to clean steel, SA 2½, Medium profile, before painting.

Metal coated fasteners which have been etch primed before assembly shall be dry cleaned after final surface preparation of the joint and then painted.

Fasteners which are to be metal sprayed after assembly shall be blast cleaned to clean steel, SA3, medium profile, with chilled cast iron grit, cast steel grit or aluminium oxide.

(viii) Sealing of joints and plies

Bolted joints or built-up sections shall be free from any water which has penetrated the plies.

After drying out is complete and surfaces are dry after surface preparation, fine gaps around the perimeter of joints or along plies shall be sealed by application of undercoat paint. All wider gaps shall be sealed with a sealant compatible with the paint system.

(ix) Sealing of gaps at nibs of load indicating fasteners or washers

Gaps shall be sealed by brush application of primer and successive undercoats, of the types used on adjacent areas

A13.12.7.6 Treatment at areas of mechanical damage/surface defects

Scores and indentations in the surface of a steel substrate or of a metal coating shall be treated by abrading or grinding to bright steel or bright metal coating, to produce a surface without sharp edges or abrupt change in contour. Damage to unprepared surfaces shall be treated before blast cleaning. A blast cleaning profile shall be restored on areas to be metal sprayed but not necessarily areas to be painted only. Other surface defects in the steel substrate are subject to the approval of the Engineer.

In the case of damage to paint coatings only, surface preparation shall be by blast cleaning or abrading and the paint coatings restored.

When a two-pack epoxy paint system is restored over a steel substrate prepared by abrading, the adhesion of the first coat of paint to the substrate shall be checked in accordance with EN 24624 or EN 22063 Annex A, method 1, before overcoating with the next coat in the system.

The first coat over abraded surfaces shall be an aluminium epoxy (2 Pack) primer.

Areas of metal spray to be repaired shall be dry blast cleaned immediately before further application of metal spray.

In the shops, a damaged metal spray coating, together with any damaged sealer or paint coats, shall be restored.

On site, with the exception of the small areas permitted above a damaged metal spray coating, together with any damaged sealer or paint coats shall be repaired with a minimum thickness of 150 microns of metal spray.

On site, small areas of isolated damage in a metal spray coating plus paint system, need not be restored; after surface preparation the metal spray shall be replaced by 100 microns of the first undercoats, omitting the sealer. Adjacent paint coats, excluding the sealer shall then be restored over the repaired area.

In the shops, in the case of galvanising only, small isolated areas of up to 40 mm^2 may, after surface preparation, be repaired with low melting point zinc alloy.

Isolated areas of damage larger than 40mm^2 in galvanising which is to be painted later or which has already been painted may be repaired with low melting point zinc alloy after surface preparation. Alternatively, the whole of the affected area including exposed steel substrate shall, after surface preparation, be given a coat of adhesion promoter which, when wet cleaned in accordance with Clause A1312.7.2c) and finally dry, shall be overcoated with two coats of Zinc Phosphate High Build Quick Drying Epoxy (2 pack) blast primer or Extended Cure Epoxy (2 pack) primer, minimum dry film thickness of 75 microns each. The adhesion promoter shall not be applied over existing paints.

On site, surface of galvanised components found to have minor damage shall be prepared and coated with zinc rich primer of 100 microns mdft, complying with BS 4652 Type 2 or 3. Alternatively, the components shall be regalvanised.

In all cases where paint coats only are to be repaired, or metal spray coats replaced or repaired, or galvanising is to be replaced by paint, the edges of paint coatings or metal coatings adjacent to the affected area shall be bevelled back into sound paint or metal coating. This work shall be carried out before any final blast cleaning described above.

Unless otherwise agreed by the Engineer, etch primer applied outside the agreed areas shall be removed immediately by wet cleaning.

In the shops exposure and overcoating times shall not exceed those specified in Clause A13.12.7.9.

On site, unless otherwise agreed by the Engineer, overcoating shall be started immediately after surface preparation of the affected area and continued as soon as each coat is dry enough for overcoating.

Final coats shall be feathered into existing paintwork to ensure uniformity of appearance.

A13.12.7.7 Treatment of local failure in protective coatings

In the shops, failed paint coatings and failed metal spray coatings shall be restored. Abrading down to sound paint only, is permissible. If a metal spray coating is damaged or reduced to less than 80% of the specified minimum thickness during abrading, it shall be restored.

On site, failed paint coatings and metal spray coatings shall be restored except that:

- abrading down to sound paint or to bright steel; or
- blast cleaning to clean steel, SA2½,

are permissible methods of surface preparation when restoring paint systems over a steel substrate.

In the shops, and on site unless otherwise agreed by the Engineer, galvanised components showing signs of failure of the coating shall be regalvanised.

On site, in exceptional circumstances agreed by the Engineer, defective galvanising may be replaced by sealed aluminium metal spray of 100 microns minimum thickness in areas blast cleaned to clean steel, SA2½, medium profile using chilled cast iron grit abrasive. Blast cleaning and aluminium metal spray shall taper off 50 mm into sound galvanising.

In the shops and on site, failed paint coatings over galvanising shall be restored. Unless otherwise agreed by the Engineer, surface preparation shall be by abrading. Areas of sound galvanising exposed through a paint system shall be abraded only as necessary to ensure satisfactory application of etch primer and paint. If the galvanising is damaged or reduced to less than 80 % of the specified minimum thickness during abrading, the component shall be regalvanised.

In all cases of local failure, the extent of the failure and the required surface preparation, including extent of initial wet or dry cleaning down, shall be agreed with the Engineer. Restoration of protective coatings shall not be started until the standard of surface preparation, including the cleanliness of the surface, has been passed as satisfactory by the Engineer. Final coats shall be feathered into existing paintwork to ensure uniformity of appearance.

A13.12.7.8 Metal coatings

a) Galvanised coatings

Galvanised coatings except for wire products shall comply with EN ISO 1461 and with the following:

- Inhibited hydrochloric acid with a strength not exceeding 14 % and within a temperature range of 15°C to 25°C or inhibited sulphuric acid with a strength not exceeding 19 % and within a temperature range of 60°C to 80°C shall be used for pickling.
- Components shall not be immersed in the pickling acid longer than is necessary for cleaning the surfaces prior to galvanising.
- The surfaces of components to be galvanised shall be dried before immersion in the molten zinc.
- When an aqueous flux is to be used, all traces of acid shall be washed off immediately after pickling.
- Galvanised coatings shall be virtually free from imperfections, including porosity, to the satisfaction of the Engineer.
- Detrimental surface contamination of galvanised coatings which are to be painted shall be removed by wet cleaning in compliance with Clause A13.12.7.2c). Surfaces to be painted shall not receive chromate passivation treatment.
- Vent holes drilled in hollow sections prior to galvanising shall be plugged to the satisfaction of the Engineer.

b) Sprayed metal coatings

Sprayed metal coatings shall comply with EN 22063 and with the following:

- Aluminium coating shall be of a material with minimum quality in accordance with type A1 99.5 (1050A) of ISO 209-1. Zinc coating shall have a composition in accordance with type Zn 99.99 of ISO 752.
- The thickness of the coating shall be not less than 100 microns.
- The strength of adhesion of metal spray coatings shall not be less than the following:

Aluminium 50 kgf/cm^2 Zinc 50 kgf/cm^2

- Metal spray coatings shall be applied continuously over each 0,5 m^2 per gun or the area of the component whichever is the lesser until the specified thickness has been achieved.
- The application of thermally sprayed metal in separate layers will not be permitted.
- All surfaces to be metal sprayed, including that of the reference panel having equivalent hardness to that of the parent material, shall be blast cleaned with chilled cast iron grit with a hardness value greater than 650HV, or aluminium oxide with a hardness value greater than 9 Mohs, and the standard shall be clean steel, SA3, medium profile.

c) Sherardized coatings

Sherardized coatings shall comply with Class 1, Table 1 of BS 4921 : 1988.

d) Electroplated coatings

Electroplated coatings shall comply with BS 3382: Part 2. Additionally, BS 3382: Part 2 shall be deemed to cover the electroplating of components up to and including 36 mm in diameter. Electroplated surfaces which are to be painted shall not receive chromate passivation treatment.

e) Other requirements

Before proceeding with the galvanising process the Contractor shall provide full details of the surface preparation and coating methods he proposes to adopt and shall not put the work in hand until the Engineer's approval has been obtained. When instructed by the Engineer, similar requirements shall apply in the case of other metal coatings.

When a metal coating is required on only part of a component it shall be applied before the rest of the component receives paint.

A13.12.7.9 Application of protective coatings

a) General

Paint shall be supplied from the Contractor's paint store to the painters ready for application. Any addition of solvent shall be made in the store in the presence of the Engineer, and shall not exceed 5 % by volume on the paint.

Paint shall be applied only to surfaces which have been prepared and cleaned as described in this Series.

A coat of paint in a system shall be applied by one of the following methods:

- brush (B)
- airless spray (AS)
- air pressure spray

Paint shall not be applied under the following conditions:

- when the ambient temperature falls below 5°C or the relative humidity rises above 70 % in an enclosed workshop or 90 % on site;
- during rain, snow, fog, mist or in a dust laden atmosphere;
- when the amount of moisture likely to be deposited on the surface by condensation or rain before or after painting, may have a harmful effect on the paint;

- when wind-borne dust may have a harmful effect on the paint.

All shop painting of steelwork shall be carried out in a fully enclosed workshop unless otherwise agreed by the Engineer.

Before starting the procedure trials described in Clause A13.12.8.3, and as required by the Engineer, the Contractor shall furnish the Engineer with details of the overall wet film thickness for each coat he proposes to apply. He shall also provide information as to the total amount of paint he expects to use for each coat of each system for which procedure trials are required. The calculation of the amount of paint to be used shall be based on the volume solids plus an allowance for waste.

The following requirements on paint film thicknesses shall apply:

- Wet film thickness gauges shall be used where practicable to check that the wet film thickness is not less than:
- minimum dry film thickness (mdft) x 100/volume solids %
- During the application of a paint system the Contractor shall ensure that the progressive total thickness of the applied coats will allow the specified minimum total dft of the system to be attained without exceeding, overall, the proposed wet film thicknesses referred to above by more than 20 %.
- In no cases shall the total dry film thickness of a paint system or the mdft of the last undercoat and finish be less than that specified in the Paint System Sheet.
- The local dry film thickness for any primer shall not exceed the specified mdft by more than 30 % and for other paints by more than 75 %.

Each coat of paint of a specified system shall have satisfactory adhesion as demonstrated by an adhesion test approved by the Engineer.

Each coat of paint of a specified system at whatever thickness applied shall be virtually free from surface defects, particularly cratering, pin-holing, blistering, rivelling, sagging, bittiness, dry spray and cissing. The finished system shall be an even and uniform appearance. When required by the Engineer, the finishing paint in visually sensitive areas shall be from the same batch.

When required by the Engineer, the degree of gloss of a finishing coat shall be agreed before the procedure trials. A painted tin plate reference panel, 150 mm x 100 mm, shall be provided by the Contractor for this purpose.

All successive coats in a system including the stripe coats shall be in contrasting colours to aid identification.

Two pack chemically cured paints shall not be applied when the steel or ambient temperatures are below those advised by the paint manufacturer, nor shall such paints be applied when the temperature is likely to fall below the advised temperatures during the curing period.

b) Stripe coats

Unless otherwise described in this section, two stripe coats shall be applied to all welds and all fasteners including washers and to all external corners except those of rolled hollow sections. The first stripe coat, using second undercoat paint, shall be applied over the primer, sealer of etch primer. The second stripe coat, using first or second undercoat paint, shall be applied before the last undercoat of the complete system in the shops or on site as appropriate. The first stripe coat on etch primer fasteners shall be applied by brush; other stripe coats may be applied by brush or airless spray as appropriate.

A solvent shall be used to remove final traces of grease from etch primer fasteners.

The Contractor shall enter the details of the stripe coats he has selected, giving the colour and method of application.

Square solid infill bars shall, after the second undercoat has been applied, be given an extra coat of first undercoat in lieu of stripe coats.

c) Exposure times for prepared steel surfaces and for metal coatings exposure times and treatment of etch primer and overcoating times for paints

Clean steel prepared by dry blast cleaning or bright steel prepared by abrading or by grinding shall be primed within 4 hours.

Clean steel prepared by wet blasting cleaning only, shall be primed within 4 hours of being dry enough for painting.

Clean steel prepared by combined wet/dry blast cleaning shall be primed within 4 hours of dry blast cleaning.

Steel or steelwork blast primed at the mills or in the shops shall be overcoated within 8 weeks. The primed surfaces shall only be exposed outside for a maximum of 2 weeks of the 8 week period. Prepared surfaces affected by detrimental contamination or corrosion which in the opinion of the Engineer will reduce the required durability of the protective system shall be restored when directed by the Engineer.

Shop steelwork which has been metal sprayed shall be primed and sealed within 4 hours. The next coat shall be applied within 72 hours.

Shop prepared steel surfaces, unsealed metal spray coatings and undercoats, except final shop undercoat, shall not be exposed outside.

All etch primer surfaces, except those of fasteners which have been treated in compliance with Clause A13.12.7.5a)(i), shall, after initial drying, be wet cleaned in compliance with Clause A13.12.7.2c), taking care not to remove adhering etch primer, and allowed to dry before overcoating. The first coat of paint shall be applied within 48 hours of the etch primer surfaces being first dry enough for painting over.

Where galvanised steel is to be protected by a paint system etch primer shall be applied not later than 7 days after delivery to site unless otherwise agreed by the Engineer.

A first shop undercoat shall be overcoated within 72 hours. Unless otherwise agreed with the Engineer, further shop coats shall be applied within 72 hour intervals per coat.

The application of sealant in gaps may be carried out either before or after application, as appropriate, of the first coat of paint to be applied to the completed joints or assembled plies.

Prepared steel surfaces and sprayed metal coatings which have been restored, also paint coats and galvanising which have been prepared after surface damage or deterioration shall be overcoated with the sealer primer or first undercoat as appropriate before the surfaces have been affected by moisture and in any case within 4 hours.

On site, steel surfaces and metal spray coatings shall be primed or sealed within 4 hours and shall have the following coat applied within 72 hours unless otherwise agreed with the Engineer. The next coat shall be applied within a further 72 hours unless otherwise agreed with the Engineer.

A13.12.7.10 Storage and transport of steel and fabricated steelwork

Steel awaiting fabrication for the Permanent Works and uncoated steelwork shall be adequately protected from contaminants liable to cause heavy rusting and possibly pitting of the surfaces.

Steelwork shall not be loaded for transport until the paint system is sufficiently hard for handling.

During storage, steelwork shall be kept clear of the ground and shall be laid out or stacked so as to prevent water or dirt accumulating on or against any of the surfaces. Suitable packings shall be placed between layers of stacked steelwork. When cover is provided it shall be ventilated sufficiently to keep condensation to a minimum.

Components weighing less than one tonne shall be kept in a storage area away from their erection point in order to minimise damage to protective coatings.

Lengths of parapet and individual lighting columns shall be supported on timber, and precautions taken to prevent damage to their protective coatings and ingress of water. They shall only be positioned adjacent to their erection point immediately before erection. If the planned erection time is delayed by more than 72 hours the components shall be returned to the storage area.

If in the opinion of the Engineer, damage to coatings is excessive, or may be difficult to deal with satisfactorily after erection, the Contractor shall restore the coatings before erection.

A13.12.7.11 Surfaces in contact with concrete

Metal spray coatings and all shop paint coats shall be returned 25 mm into the concrete/steelwork contact area.

Where aluminium metal spray, which has been sealed only, is returned into the contact area, it shall be given a coat of Phosphate Epoxy Ester Undercoat of 40 microns mdft, not later than 48 hours before concreting. Application of the paint outside the contact area shall be prevented, by masking if necessary.

Galvanised coatings shall be applied overall and may come into contact with concrete.

A13.12.7.12 Access and lighting

Without prejudice to the Conditions of Contract, access for inspection by the Engineer shall be provided and erected by the Contractor. The access shall be agreed with the Engineer as being adequate and safe in all respects for inspection purposes.

Manual surface preparation and coating application work shall not be carried out when light intensity at the workface is less than 500 lux. When the natural light intensity falls below this level the Contractor shall install and maintain temporary lighting which shall provide a minimum light intensity of 500 lux over at least 1,0 m^2 at the workface during the work and also for inspection when required by the Engineer.

A13.12.7.13 Additional requirements for the protection of steel in bridge bearings

Work described in this Clause shall be carried out in compliance with the foregoing Clauses, as appropriate.

All external surfaces of the bearings shall be given full protective treatment. When seeking approval of a particular bearing manufacturer the Contractor shall provide full details of the protective treatment of the proposed bearing. This shall include the proposed treatment of all metal surfaces within the bearing and all screwed or other fastenings Information, including the name of the paint manufacturer, required for completing the Paint System Sheet, for the bearings, shall be obtained by the Contractor from the bearing manufacturer.

Etch primer and MIO Epoxy paints when required for application on site shall be obtained from the manufacturer of the shop applied coats. Paint applied to the bearings on site to match the bridge steelwork paint system shall be obtained from the manufacturer of that system.

A13.12.7.14 Powder coating

Aluminium sheeting and sections shall be powder coated in accordance with SANS 1796 – Coatings of durable organic powder for external architectural aluminium. Powder coating used shall be of the 'Super Durable' type and comply with SANS 1578 – Durable organic powder for coating of external architectural aluminium.

The powder coating shall have a 25 year life in the service environment and this shall be guaranteed in writing by the powder coating supplier and powder coating applicator. An insurance backed guarantee shall be offered to the Client.

A SANS 1578 certified mark holder only shall apply the powder. The applicator must show in writing approval from the powder manufacturer for the pre-treatment process and powder application process to be used.

Unless otherwise advised by the powder manufacturer the thickness of the applied and cured powder coating shall be at least 80 microns. All powder coated sheeting shall be totally free of pinholes. Colour and gloss shall be uniform on all sheeting.

The powder coating shall be nominally semi-gloss, the actual gloss level and colour shall be agreed with and approved by the Engineer before any powder coating is manufactured.

Powder coating supplier and applicator shall have a quality system in accordance with ISO 9001.

Documentation in support of the Guarantee shall be accordance with Association of Architectural Aluminium Manufacturers of South Africa (AAAMSA) recommendations as a minimum.

Once powder coating and inspection is completed all approved coated sheeting shall be protected adequately using bubble wrap or polythene adhesive film to minimise damage during transportation, storage and during and after installation.

Powder coated sheeting shall be stored in accordance with the powder coating manufacturer's recommendations. Any situation that might result in water marking of the powder coating shall be avoided.

Damaged powder coating shall be repaired strictly in accordance with the powder manufacturer's recommendations and Guarantee requirements. The Engineer shall decide if any damaged sheet is to be replaced rather than repaired.

The powder manufacturer shall advise the Engineer what, if any, cleaning and maintenance procedures are required to ensure the Guarantee once sheeting is installed. This information shall be supplied before any powder coating commences.

A13.12.7.15 Specified paint systems

a) General

The undernoted systems shall be applied to the specified surface areas.

Subject to the approval of the Engineer, alternative systems may be proposed by the Contractor, provided that they can be demonstrated to have equivalent durability.

The top coat shall be applied either at site or in the shop. The Contractor shall ensure that the final appearance of painted steelwork is uniform. The paint systems for external systems below include provision for an aesthetic paint layer. This paint layer is not considered part of the system for durability but is to be applied to ensure uniform appearance of exterior steel surfaces. At the discretion of the Engineer this layer may be omitted if the system top coat after completion of painting to all areas gives a satisfactory appearance.

Where quoted item numbers relate to the UK Highways Agency Design Note BD 35.

b) System 1:

Durability – major maintenance: 25-30 years

Surface Preparation - Blast clean to BS 7079 or EN ISO 11126 Sa 3 Medium Profile

Shop - Aluminium metal spray - 100 microns mdft

Shop - 1st coat Item 159 Aluminium Epoxy Sealer - applied at 12 to 20 sq.m/litre

Shop - 2nd coat Item 111 Zinc Phosphate HB QD Epoxy Blast Primer - mdft 100 microns

Shop - 3rd coat Item 112 MIO HB QD Epoxy undercoat/finish- mdft 125 microns

Shop/Site - 4th coat Item 169, semi-gloss, Acrylic Polyurethane (2 pack) finish - mdft 50 microns, colour as given in the specifications or on the drawings.

Stripe coat - 3rd coat on 2nd coat by brush at 75 microns mdft

Minimum system total dry film thickness - 425 microns including metal spray

Minimum total dry film thickness of paint system - 300 microns

Aesthetic top coat - Item 169, semi-gloss, Acrylic Polyurethane (2 pack) finish - mdft 50 microns, colour as given in the specifications or on the drawings.

HSFG joints – contact faces aluminium metal spray only; fasteners - aluminium metal spray after joint is made. Complete with system as above.

c) System 2:

Durability – major maintenance: 20-25 years

Surface Preparation - Blast clean to BS 7079 or EN ISO 11126 Sa 3 Medium Profile

Shop – 1st coat zinc rich epoxy primer to 50-75 microns dft

Shop – 2nd coat epoxy MIO undercoat to 100 microns mdft

Shop – 3rd coat epoxy MIO undercoat to 100 microns mdft

Shop/Site – 4th coat item 169, semi-gloss, acrylic polyurethane (2 pack) finish - dft 50 microns, colour as given in the specifications or on the drawings.

Stripe coat 3rd coat over 2nd coat

Minimum total dry film thickness 325 microns

Aesthetic top coat - Item 169, semi-gloss, Acrylic Polyurethane (2 pack) finish - mdft 50 microns, colour as given in the specifications or on the drawings.

d) System 3:

Durability – major maintenance: 25 years

Surface Preparation - Blast clean to BS 7079 or EN ISO 11126 Sa $2^{1}/_{2}$ Medium Profile

Shop – 1st coat Item 111 Zinc Phosphate HB QD Epoxy Blast Primer - mdft 125 microns

Shop – 2nd coat Item 112 MIO HB QD Epoxy undercoat/finish- mdft 100 microns

Stripe coat 2nd over 1st

Minimum total dry film thickness 250 microns

e) System 4:

Durability – major maintenance: 25 years

Surface preparation - Galvanize in accordance with EN ISO 14713/EN ISO 1461, degrease with a water emulsifyable degreaser and wash with fresh water, allow to dry. Sweep blast in accordance with EN ISO 12944 with a fine grade of non-metallic grit, such as garnet, at low air pressure taking care only to roughen and not remove the zinc coating.

1st coat – Epoxy MIO (formulated for application to galvanized steel) - mdft 75 microns

2nd coat – Epoxy MIO (formulated for application to galvanized steel) - mdft 75 microns

3rd coat – Acrylic polyurethane - dft 50 microns

Stripe coat 2nd over 1st

Minimum total dry film thickness 175 microns and a maximum of 300 microns

f) System 5:

Aluminium sheeting and sections to be powder coated in accordance with Clause A13.12.7.14, colour as given in the specifications or on the drawings.

A13.12.7.16 Safety of painting operation

Some paints and preparation processes are harmful, including being flammable, carcinogenic and containing volatiles harmful to a person.

The supplier's instructions regarding health and safety shall be strictly adhered to. This includes storage, handling, protective equipment, breathing apparatus and masks.

Appropriate protective clothing and breathing apparatus shall be worn during preparation of surfaces to be painted.

A13.12.8 WORKMANSHIP

A13.12.8.1 Testing of metal spray coatings

At the start of the Works, and later at intervals specified by the Engineer (with the exception of coatings on steel in bearings, curved surfaces, repairs to mechanical damage, local failure of metal spray at site joints or areas restored on site), the Contractor shall demonstrate by means of a pull off test, of a type approved by the Engineer, that the minimum adhesion requirement is being attained. In the excepted areas the Contractor shall demonstrate to the satisfaction of the Engineer that the adhesion is satisfactory when tested in accordance with EN 22063. Areas affected by the tests shall be restored.

The pull off tests shall be carried out initially on panels 150 mm x 150 mm x 6,0 mm which are of the same grade of steel as the parent material and which before blast cleaning had the same surface condition. The panels shall be blast cleaned and metal sprayed together with the parent material to the same standard and using the same technique.

The Contractor shall make arrangements for the Engineer to witness the preparation of the panels and all testing. When instructed by the Engineer, the Contractor shall carry out further tests on similarly prepared and metal sprayed panels.

If the adhesion requirement on any test panel is not met, the Contractor shall carry out a further test on the parent material adjacent to the panel position. In the case of adhesion failure on the steelwork itself by either method of test, unsound metal spray coating shall be restored and the tests repeated.

If more than two local areas of faulty adhesion occur on any one component, the whole of the metal spray coating on the component shall be considered as having failed, and it shall be restored. Clause A13.12.7.4c) is not applicable in the case of adhesion failure.

A13.12.8.2 Testing of paints

a) Provision of samples

The Contractor shall provide unopened 5 litre samples, known as 'A' samples, for quality assurance purposes, of each type of paint to be used for the Permanent Works. In addition, the Contractor shall supply 500 ml samples, known as 'B' samples, for application control purposes.

b) 'A' samples

'A' samples are required in all cases where more than 500 litres of any one coat of paint is to be applied. For 2 pack systems separate samples of the base and activator are required.

The first 'A' samples shall be taken from the first batch of each type of paint delivered to the fabricator's shop or to site and accepted by the Engineer as being representative of paint to be used for the Works. First batches of paint of less than 200 litres shall be discarded as not being representative and shall not be used in the Permanent Works.

Additional 'A' samples of the paints shall be provided by the Contractor depending on the weight of structural steelwork in the Permanent Works in accordance with the following:

- 250 tonnes to 500 tonnes : one set of samples;
- over 500 tonnes : a further set of samples for each part of or whole 500 tonnes.

When the Contractor instructed by the Engineer shall also provide an 'A' sample:

- of any replacement batch of paint subject to testing as above;
- returned paint described under Clause A13.12.5.2;
- when the paint, in the opinion of the Engineer, is showing unsatisfactory application characteristics under Clause A13.12.7.9.

Immediately after selection by the Engineer, the 'A' samples shall be despatched by the Contractor to the testing authority in accordance with the Engineer's instructions.

Paint shall be supplied in sufficient time to allow for sampling and testing before the start of application.

Unless permitted by the Engineer, painting, except for procedure trials, shall not start until the Engineer confirms that the first 'A' samples are satisfactory.

c) 'B' samples

The Contractor shall take 'B' samples when instructed by the Engineer, and only under his supervision. The samples shall be taken from painters' kettles or from nozzles of airless spray guns directly into clean, new 500ml tins which shall be filled and then sealed and handed to the Engineer. On return of the samples to the Contractor, the Contractor shall despatch them immediately to the testing authority in accordance with the Engineer's instructions.

d) Provision of 500ml tins, packing and transport of 'A' and 'B' samples

The Contractor shall provide 500 ml tins with lids and lid clips, for 'B' samples at the start of painting or before any procedure trials required by Clause A13.12.8.3. The quantity supplied shall be sufficient to avoid any delay in taking 'B' samples throughout the work.

The Contractor shall ensure that the lids of all tins of sample paint are securely clipped down when they are despatched for testing.

The Contractor shall be responsible for handling, packing as necessary, prompt despatch and transit of 'A' and 'B' samples.

A13.12.8.3 Procedure trials

The Contractor shall carry out to the approval of the Engineer shop and site procedure trials of the protective system when more than 50 litres of any coat of paint are to be applied to the steelwork.

Procedure trials are not required for systems applied to joints or for galvanising only. The procedure trials shall be completed at least ten days before the start of application of the systems on the main steelwork. The trials shall be carried out with the labour and equipment to be used for the work.

The Contractor shall provide for the shop trials, samples of steel from 2,0 m^2 to 10 m^2 representing the main steelwork, galvanised when necessary, as required by the Engineer. The Contractor shall demonstrate his ability to carry out surface preparation by blast cleaning and by using power assisted tools, to apply metal spray coatings and the paints he has selected. He shall provide sufficient paint for the trials.

Metal spray application and painting of the main steelwork shall not be started in the shops or on site until procedure trials have been completed to the satisfaction of the Engineer.

Any adjustment to the registered paint formulations shown to be required by the trials, other than an adjustment to the solvent shall be agreed with the Engineer and made at the paint manufacturer's works.

Unless otherwise agreed by the Engineer the Contractor shall carry out further procedure trials whenever he employs replacement skilled labour or proposes to use equipment of a different type.

A13.12.8.4 Paint system data sheet

A minimum of 56 days prior to first application of protective coatings the Contractor shall submit for approval a copy of the Paint System Data Sheets.

A sample Paint System Data Sheet is shown on the following page.

The Contractor shall submit details of other structures on which the proposed paint system has been applied, and in particular details of its durability.

The Contractor shall submit copies of the manufacturer’s instruction for application of the proposed paint system.

PAINT SYSTEM SHEET **Sheet No.**

1. CONTRACT TITLE:	STRUCT. NO.:	GRID REF:			2. DATE OF ISSUE OF DOCUMENTS TO TENDERERS:	
3. ENVIRONMENT AND ACCESSIBILITY:			4. REQUIRED DURABILITY OF SYSTEM NO MAINTENANCE : MINOR MAINTENANCE: MAJOR MAINTENANCE:			
5. PAINT SYSTEM TO BE APPLIED OVER:						
6. DETAILS	1st Coat	2nd Coat	3rd Coat	4th Coat	5th Coat	6th Coat
Registered Description						
Item No. & Colour						
Date Registered						
Brand Name and Manftr's Ref No.						
Data Sheet No.						
Where applied						
How applied						
Min dry film thickness (mdft)						
Max local dft (See Cl. I1015(a))						
7. STRIPE COAT DESCRIPTION (including Item No and Colour) Shop: Site:					8. PAINT MANUFACTURER'S OFFICIAL STAMP:	
9. MINIMUM TOTAL DRY FILM THICKNESS OF PAINT SYSTEM (See Note) NOTE: The calculated sum of the mdft, neglecting the thickness of primers under 25 microns applied to blast cleaned steel, sealed or unsealed aluminium metal spray, shall not be less than 84% of the minimum total dry film thickness of the paint system					10. APPROVED BY: DATE:	

B13.12 STRUCTURAL STEEL PROTECTIVE TREATMENT OF MAJOR STRUCTURES

PART B: LABOUR ENHANCEMENT

CONTENTS

B13.12.1 SCOPE

B13.12.2 DEFINITIONS

B13.12.3 GENERAL

B13.12.4 DESIGN BY CONTRACTOR / PERFORMANCE BASED SYSTEMS

B13.12.5 MATERIALS

B13.12.6 CONSTRUCTION EQUIPMENT

B13.12.7 EXECUTION OF THE WORKS

B13.12.8 WORKMANSHIP

B13.12.1 SCOPE

This Section covers the protective treatment of structural steelwork for major steel structures, e g steel bridge decks, composite steel decks, and steel and composite steel cable-stay towers. It does not apply to protective treatment of minor steel structures such as sign gantries, which is covered in Section A13.10. Due to the specialised application and skill levels, Part A is not suitable for labour enhanced work.

B13.12.2 DEFINITIONS

The provisions of Part A shall apply with no additional requirements.

B13.12.3 GENERAL

The provisions of Part A shall apply with no additional requirements.

B13.12.4 DESIGN BY CONTRACTOR / PERFORMANCE BASED SYSTEMS

The provisions of Part A shall apply with no additional requirements.

B13.12.5 MATERIALS

The provisions of Part A shall apply with no additional requirements.

B13.12.6 CONSTRUCTION EQUIPMENT

The provisions of Part A shall apply with no additional requirements.

B13.12.7 EXECUTION OF THE WORKS

The provisions of Part A shall apply with no additional requirements.

B13.12.8 WORKMANSHIP

The provisions of Part A shall apply with no additional requirements.

C13.12 STRUCTURAL STEEL PROTECTIVE TREATMENT OF MAJOR STRUCTURES

PART C: MEASUREMENT AND PAYMENT

(i) Preamble

The tendered rate for each item shall include full compensation for providing, maintaining and decommissioning upon completion, of all the plant, equipment, labour, tools, incidentals and supervision to carry out the activity or construct the works in the item, unless otherwise stated.

Any prime cost or provisional sums shall be paid in accordance with the provisions of the conditions of contract. The charge or mark-up tendered or allowed for is a percentage of the amount actually paid under the prime cost or provisional sum. This percentage shall cover all the Contractor's handling, supervision, profit and liability costs to provide the services in the prime cost or provisional sum item.

The requirements of Section C1.1 of Chapter 1 shall apply.

Where pay item descriptions include any wording in brackets it is an indication that contract specific information is to be inserted in the Pricing Schedule included in the Contract Documentation.

(ii) Notes on measurement and pay items

None.

(iii) Items that will not be measured separately

The following activities, whether required to complete the specified work or not, will not be measured and paid for separately and the Contractor shall include the cost thereof in other pay items as he deems appropriate:

1. No separate payment will be made for setting out the works.
2. No separate payment will be made for the protection or repair as required of any existing or new road furniture, structures, buildings, infrastructure or services damaged by the Contractor's activities.
3. No additional payment shall be made, nor shall any claim for additional payment be considered, for any specified work in confined or restricted areas. Any additional costs associated with working in confined or restricted areas shall be deemed to be included in the standard applicable pay items.
4. No separate payment will be made for the loading of any materials.
5. No separate payment will be made for the hauling of any materials where the material is moved over a distance of less than, and up to 1,0 km and for labour enhanced construction, less than and up to 50 m.
6. No separate payment will be made for transporting materials from commercial sources irrespective of the haul distance.
7. No separate payment will be made for the removal or any surplus material imported to complete the works.
8. For all Works performed, precautionary measures required in terms of the Occupational Health and Safety Act (Act 85 of 1993) and the latest amendments thereof as well as the latest Construction Regulations shall be deemed included in the rates tendered for the relevant products.

(iv) Items to be measured and paid for using items specified elsewhere in the specifications

Not applicable to this Section.

(v) Items specifically for this Section of the specifications

Item	Description	Unit
C13.12.1	**Steelwork protective system:**	
C13.12.1.1	(system and location to be specified)	square metre (m^2)
C13.12.1.2	(system and location to be specified)	square metre (m^2)

The unit of measurement shall be the calculated square area of steelwork to be protected. The item shall be measured once and shall include all shop and site coats specified to generate the itemised paint system.

The tendered rate shall include full compensation for the following:

(a) dispatching paint samples to testing authority;

(b) shop procedural trials;

(c) site procedural trials;

(d) compilation and where necessary re-compilation of painting programmes;

(e) masking and other measures to protect adjacent untreated work and the removal of masking and other measures upon completion;

(f) grounding down welds and removal of weld splatter;

(g) joint fillers and treatments of joints;

(h) curing agents;

(i) preparing materials for application

(j) preparation of surfaces and coating at the place of fabrication and on site including blast cleaning, solvents, detergents and where approved by the Engineer, acid washing;

(k) re-preparation where steelwork or coatings have become contaminated;

(l) complying with any special requirements in respect of ambient conditions including the containment of dust and debris and for intervals between successive operations and applications;

(m) labelling;

(n) storage;

(o) stripe coats;

(p) de-nibbing;

(q) heat treatment;

(r) obtaining the correct dry film thickness of paint or other coating and forwarding results to the Engineer;

(s) measures to protect uncoated steelwork;

(t) preparation and supply of system and data sheets;

(u) facilities, including lighting and access, and assistance to enable inspection by the Engineer;

D13.12 STRUCTURAL STEEL PROTECTIVE TREATMENT OF MAJOR STRUCTURES

PART D: GUARANTEES AND COMPLIANCE CERTIFICATES

CONTENTS

D13.12.1 SCOPE

D13.12.2 GENERAL

D13.12.3 PERFORMANCE GUARANTEE REQUIREMENTS

D13.12.4 FUNCTIONAL PERFORMANCE ASSESSMENTS

D13.12.5 VISUALLY ASSESSED PROPERTIES

D13.12.6 INSTRUMENTALLY ASSESSED PROPERTIES

D13.12.7 EVALUATION FOR ACCEPTANCE

D13.12.8 ADDITIONAL PROCEDURES TO BE ADOPTED IN THE EVENT OF FAILURE

D13.12.9 NOTIFICATION OF REMEDIAL WORK

D13.12.10 REMEDIAL WORK

D13.12.1 SCOPE

The scope of this Section covers the following:

- Product conformance specifications
- Warranties for product or element design and installation of proprietary systems
- Performance specifications

Note that the requirements for performance specifications are not limited to that given in Part C only but includes all of the requirements in the Contract Documentation.

D13.12.2 GENERAL

D13.12.2.1 Product conformance specifications

The Contractor shall, within 28 days of entering into the contract with the Employer, submit to the Engineer conformance documentation related to the specifications.

Conformance documentation shall be provided for:

Paint and similar protective coatings: each type and batch: Refer to the “Paint System Sheet”.

D13.12.3 PERFORMANCE GUARANTEE REQUIREMENTS

D13.12.3.1 Warranties for product or element design and installation of proprietary systems

a) No additional requirements.

D13.12.3.2 Performance specifications

Performance based specifications shall be contained in the Contract Documentation for the project.

Performance testing shall be carried out on the following coatings in accordance with the specifications:

(a) Metal spray coatings; and
(b) Paint.

13.13 INCREMENTAL LAUNCHING OF BRIDGE DECKS

CONTENTS

PART A: SPECIFICATIONS

A13.13.1 SCOPE

A13.13.2 DEFINITIONS

A13.13.3 GENERAL

A13.13.4 DESIGN BY CONTRACTOR / PERFORMANCE BASED SYSTEMS

A13.13.5 MATERIALS

A13.13.6 CONSTRUCTION EQUIPMENT

A13.13.7 EXECUTION OF THE WORKS

A13.13.8 WORKMANSHIP

PART B: LABOUR ENHANCEMENT

PART C: MEASUREMENT AND PAYMENT

PART D: GUARANTEES AND COMPLIANCE CERTIFICATES

A13.13 INCREMENTAL LAUNCHING OF BRIDGE DECKS

PART A: SPECIFICATIONS

A13.13.1 SCOPE

This Section covers the requirements for the incremental launching method of construction for bridge decks, and includes temporary work (i.e. all works temporary in nature and required for construction of the permanent works), launching of the deck segments and the permanent work not covered elsewhere in the Standard Specifications.

A13.13.2 DEFINITIONS

A13.13.3 GENERAL

A13.13.3.1 Method Statement and Procedural Manual

A detailed 'Method Statement and Procedural Manual' for the construction and launching of the deck shall be prepared and submitted to the Engineer at least 56 calendar days before first segment is launched, for consideration and approval. It shall include, inter alia, a detailed programme, details of the equipment and devices to be used including casting yard and launching anchors, anticipated maximum launching, restraining and pull-back forces, launching girder design, details of the method to be used in measuring pier deflections, control measures, monitoring systems and proposed emergency procedures.

A13.13.3.2 Superintendence

The Contractor's representative shall be an ECSA registered Professional Engineer or Technologist, who is conversant with all aspects of the incremental launching method of construction, in attendance for the full duration of construction up to completion of the expansion joint installation.

An experienced surveyor, using precision survey equipment, shall be responsible for the setting out, level control of the temporary and permanent work, and for controlling the launching alignment.

A13.13.3.3 Temporary work

Temporary work shall include all those elements of construction which are not permanently incorporated into the structure when completed, and shall include the casting yard, launching girder, fasteners and elements embedded in the permanent works to accommodate the temporary work.

On completion of the construction, the temporary works shall be removed and the permanent work repaired to the satisfaction of the Engineer. Where agreed to by the Engineer, parts of the temporary works need not be removed. Details of the temporary work shall be submitted to the Engineer at least 56 calendar days before first segment is launched.

A13.13.3.4 Design

Details of the temporary work and, if required, supporting calculations, shall be submitted to the Engineer for consideration. Approval or acceptance given by the Engineer for such designs and drawings will be subject to the provisions of Clause A1.2.4 of Chapter 1 of the Standard Specifications.

The Contractor shall accept full responsibility for the designs so prepared and shall include any modifications to the permanent work. Design work shall be certified by an ECSA Registered Professional Engineer.

A13.13.3.5 Design variations

In addition to the temporary work drawings, written descriptions highlighting variations from the contract drawings shall be submitted to the Engineer.

The incorporation of variations to the works occasioned by the Contractor's temporary work including a change in weight, stiffness and geometry of the launching girder, proposed pre-stressing system, method of installation of permanent bearings, launching equipment, launching method, or any proposed deviations from the original construction procedure, shall be subject to the approval of the Engineer.

Additional work and materials giving rise to extra cost (including any additional redesign costs of the permanent structure) as a result of design variations shall be for the Contractor's account and expense. The additional cost resulting from the variations shall be deemed to be included in the contract rates and sums. Measurement will be based on the contract drawings and payment will be based on the tendered rates and sums.

A13.13.3.6 Programme

A programme for construction and launching of the deck, detailing the proposed construction cycle and the daily activities, the time and sequence in which the concrete shall be placed and pre-stressed, and the curing period and method of curing to be used, shall be submitted to the Engineer at least 56 days prior to commencement of the launched bridge construction.

A13.13.4 DESIGN BY CONTRACTOR / PERFORMANCE BASED SYSTEMS

A13.13.5 MATERIALS

The relevant Clauses of relevant Chapters of the Specifications shall be binding unless otherwise specified in this Section.

A13.13.6 CONSTRUCTION EQUIPMENT

A13.13.6.1 General

The equipment shall include the jacks, mechanisms, devices and accessories necessary for the operation of the particular system for the launching of the bridge deck, for the girder lifting system, for installation of the bearings, for pulling back of a segment, for the emergency facilities and for anchoring, locking and braking of the deck. Full details of the equipment and devices shall be submitted to the Engineer.

Provision for fixing the equipment to the permanent work shall be made by casting the necessary sheaths, bars, anchors, etc. into the concrete.

A13.13.6.2 Jacking and measuring equipment

The jacking equipment shall be supplied with new hoses and connections which shall be operated, and where necessary replaced, in accordance with the manufacturer's instructions. All hydraulic hoses and connections shall be capable of withstanding 150 % of the rated load capacity. Calibration certificates, no older than one year, of all jacks used shall be provided to the Engineer.

The lifting jacks used for adjustments to the temporary bearings or for installation of permanent bearings, shall have self-levelling spherical heads and shall provide for adjustment to within 1mm of the required level. All the jacks used at a particular support shall be of the same model and shall be hydraulically linked to the same pressure source.

The launching and lifting jacks shall be equipped with mechanical locking devices to secure the deck in position.

The jacking system for launching the deck shall incorporate a control device which will automatically prevent the maximum jacking force, from being exceeded.

The launching equipment shall be designed to ensure that a power failure will not lead to uncontrolled movement of the deck.

A13.13.6.3 Design

Sufficient jacking or restraining force for launching of the bridge deck shall be provided to overcome the most adverse combination of forces arising from the frictional forces at the temporary bearings, the sliding resistance of the deck in the deck construction area, and the forces associated with the gradient of the bridge deck, taking construction inaccuracies into account.

The launching, restraining or pull-back forces shall act directly on the deck through fail-safe mechanical means and shall not rely on friction.

The restraining capacity to be provided, shall have a factor of safety of 1,3 against uncontrolled sliding.

For design of the restraining or braking mechanism, the sliding friction coefficient shall be assumed to be zero.

A13.13.6.4 Emergency facilities

An automatic emergency switch system, capable of immediately stopping the launching procedure, shall be installed at the top of each pier. This system must be activated automatically when the calculated pier deflection as given on the drawings, is exceeded.

Deflections at the top of the piers may be monitored utilising a high tensile steel wire stretched along the centre line of the bridge. The wire must be stressed sufficiently to negate the effect of temperature variation on the deflection measurements and equipped with a scale at each pier that will permit the direct reading of the deflection to an accuracy of 1,0 mm. It should be supported on low friction rollers at each pier. Details of this or any other proposed method of measuring the deflections shall be submitted to the Engineer for approval.

Provision shall be made at the top of the piers for the installation of emergency jacks under the webs which may be required to lift the deck in order to remove temporary bearings or launching pads or to effect adjustment of the temporary bearings. If insufficient space is available on top

of the piers, provision shall be made for the installation of brackets at the pier head to support the jacks. Alternatively, temporary deck diaphragms that will permit jacking under the soffit slab shall be provided.

A13.13.7 EXECUTION OF THE WORKS

A13.13.7.1 Deck construction area

a) General

The work required for establishing the deck construction area comprises inter alia: the treatment or substitution of the in situ material and construction of the earthworks; the design and construction of the foundations, structures and other temporary work to facilitate construction of the deck including temporary supports, jacking buttresses and anchors; modifications to the permanent work; and the provision of drainage to the area.

At least two control survey beacons shall be established in close proximity to the construction area and shall be suitably protected. The position and level of each beacon shall be established to within an accuracy of 1,0 mm and shall be monitored at intervals to be agreed with the Engineer.

The deck construction area shall be located at the end of the bridge as shown on the drawings or proposed by the contact.

Temporary concrete work in the construction area need not be demolished except for members, which in the opinion of the Engineer, could impede free drainage, interfere with the permanent work or detract from the appearance of the finished works.

Any modification of the abutment to suit the launching equipment and for pulling back of the deck shall be subject to the Engineer's approval.

b) Foundations

Foundations within the deck construction area shall be stable and not settle more than 10 mm during the course of construction. If settlement of more than 10 mm is anticipated, the spine beams and the support for the formwork assembly shall be constructed on piles or other suitable structures, with provision to compensate for elastic deformations. A geotechnical appraisal report is required in this regard confirming founding conditions and expected settlements.

c) Cover to casting area

The deck casting area shall be protected from the elements by means of a sturdy, mobile, covered structure of sufficient size to prevent rain, wind and direct sunlight from reaching the casting area, and to enable work to progress during inclement weather. The covering shall ensure that the launching cycle is maintained and shall prevent delays that result in extension of time of the construction of the bridge. The covering shall consist of durable material which is adequately secured and maintained during the construction period.

A13.13.7.2 Formwork assembly

a) General

The formwork assembly comprises the complete internal and external falsework and formwork including the access ladders and platforms, the spine beams and sliding surfaces and the jacks and devices required for aligning and operating the assembly. The complete assembly shall be constructed on the foundation prepared in the deck construction area.

b) Design

The spine beams shall not deflect more than 2,0 mm during construction of the deck nor shall the differential deflection between spine beams at any deck cross section exceed 2,0 mm.

The factor of safety for the formwork assembly against overturning at the serviceability limit state just before the launching nose reaches the next support shall be at least 1.20.

c) Construction

With the exception of the sliding surface on the spine beams, the formwork assembly shall allow for the contact between the external formwork and the concrete to be broken before the launching process takes place. It shall also provide for the independent adjustment of the spine beams from the deck formwork, and shall incorporate hydraulic or mechanical devices which will permit adjustment of the assembly to compensate for any settlement as referred to in Clause A13.13.7.1b). Any hydraulic equipment utilised, shall be equipped with mechanical locking devices which shall prevent movement during the placing of the concrete and launching.

The formwork assembly shall be sufficiently rigid and the spine beams firmly founded to ensure that the superstructure can be built within the specified tolerances.

The top of the spine beams shall be horizontal in the transverse direction unless shown otherwise on the drawings.

Welded joints on the sliding surfaces shall be ground flush with the adjoining parent material.

The formwork unit shall allow for any extra length of a segment which may be needed to compensate for the effects of elastic shortening, shrinkage and creep of the deck occurring during the course of construction.

The internal formwork for the deck section shall be adjustable, or shall consist of independent sets, which can be adapted to the variations on the inside of the deck section. For the subsequent construction of the diaphragms at the supports, the formwork for the webs shall accommodate splice bars or embedded couplers as shown on the drawings.

All formwork shall be steel. Any formwork panel that is damaged during launching shall be replaced before the next segment is prepared for construction. The shutter release agent and curing compound shall not stain the concrete.

The section of horizontal formwork which forms the sliding surface shall be located under the webs of the deck section and rest on the spine beams. The curvature of this formwork shall be the same as that of the bridge deck and the front shall be tangential to the back of the preceding deck segment. 'Marineply', at least 25 mm thick or an equivalent material shall be used and the contact surface between the formwork and the spine beams shall be treated with an approved lubricant to facilitate sliding from the deck construction area.

The 'Marineply' or equivalent material shall have no surface defects and shall be joined only in the transverse direction at agreed fixed intervals.

The material shall be replaced when the surface or the edges are damaged and a surface finish equivalent to F3 can no longer be achieved. After this formwork has been retrieved, it shall be cleaned and inspected for damage before reuse.

A13.13.7.3 Launching girder

a) Design

Details of the postulated launching girder geometry, weight and stiffness are indicated on the drawings. The Contractor shall use these details when designing the launching girder or may prefer to modify the specified details. Any modifications required to the postulated girder resulting in a redesign of the deck, shall be considered in accordance with the General Conditions of Contract: "Alternative Designs and Offers" and must take into account any design parameters given on the drawings and in the specifications. Increasing the weight of the launching girder above the postulated weight is also considered as an alternative design and the Contractor shall bear all additional costs including design, design checking, additional prestress, additional concrete and additional steel to the launching girder.

Shop drawings together with supporting calculations shall be submitted to the Engineer for consideration before commencing with the fabrication. It should be noted that any variation by the Contractor from the information given on the drawings may require redesign of the permanent work which is affected by the temporary works. Any additional construction costs incurred in the permanent works as a result of the Contractor's temporary works shall be to the Contractor's account.

The design of the girder shall conform to the requirements of the latest revision of BS5400: Part 3 'Code of practice for the design of steel bridges'. An alternative recognised design code may, however, be proposed for consideration. Acceptance of an alternative design code shall not relieve the Contractor of his responsibility to provide a safe launching girder.

The design shall also include details of the connection of the girder to the leading deck segment and any modifications to the segment. The anchorage system for the connection shall be arranged symmetrically around the vertical axis of the main girder and must be sufficient to prevent separation of the girder from the deck during launching.

The structural stiffness of the launching girder has a determining influence on the design of the bridge deck and the Contractor shall therefore allow full compensation in the rates and amounts for all extra costs for re-design and re-detailing associated with alternative launching girders.

The launching girder shall be designed such that it can be readily re-assembled during commencement and dismantled after completion of the launching.

Once the first two segments of the deck have been launched, the launching girder may not be used to steer the deck or move the deck sideways. All steering and lateral jacking shall take place on the bridge deck.

Where the bridge deck soffit is located on a vertical or horizontal curve, the postulated launching girder may follow the curvature of the deck soffit in a series of short chords, within the capability of the sliding pad width/bearings. The forces induced in the deck by the launching girder not following the curvature of the deck, shall not increase the deck design forces.

b) Fabrication

Radiographic examinations of all flange joints and at least 30 % of the total length of web and web/flange joints, shall be undertaken after fabrication of the launching girder. This requirement shall also apply to any alternative launching girder used previously on other contracts.

A certificate from an independent inspection authority certifying that the welding and fabrication of the launching girder complies in all respects with the design shall be submitted to the Engineer.

The front of the launching girder shall be fitted with a hydraulic lifting device capable of lifting the deflected girder onto the launching bearings at each temporary support.

A13.13.7.4 Temporary bearings, guides and pads

a) Temporary bearings and guides

(i) Design and fabrication

The anticipated loads on the temporary bearings are given on the drawings.

Side guides shall be provided on both sides of the deck at each support to safely control the alignment of the deck during launching. They must be designed to withstand the horizontal loads due to wind or earthquake during construction, as well as any construction inaccuracies or steering that may be required, and may be incorporated into the design of the temporary bearings.

The stainless steel sliding surface to the temporary bearings shall comply with the requirements of Clause A13.6.5.1d) and show no deviations exceeding 0,2 mm between two points. The entry and exit slopes shall be suitably radiused.

Temporary bearings shall be designed to permit replacement and adjustment during the course of construction if so required.

(ii) Installation and adjustment

The temporary bearings shall be installed with their centrelines coincident with the centrelines of each main web of the launching girder or as shown on the drawings. In the longitudinal direction, the slope of the sliding surface shall be tangential to the arc (if any) on which the deck is located at that point. In the transverse direction the bearings shall be horizontal unless the deck is launched on an inclined circle in which case the transverse slope is determined by the plane of the inclined circle.

The installation shall allow for the replacement of the bearings or for periodic adjustment of the level of the bearings as contemplated in Clause A13.13.7.8b).

When adjustment or replacement of a temporary bearing is required, the deck or the launching girder shall be lifted as specified in Clause A13.13.7.8i), subject to the provisions of Clause A13.13.6.2, and the bearing adjusted or installed to the prescribed level. Lifting of the deck may take place at one support only, at any one time.

The bedding of the temporary bearings shall be capable of transmitting the imposed load safely into the substructure.

(iii) Tolerances

Unless otherwise indicated on the drawings, the temporary bearings shall, in addition to the installation requirements indicated in Clauses A13.13.7.4a)(i) and A13.13.7.4a)(ii) above, be installed within all the following tolerances:

- Bearings be placed within 5,0 mm of their calculated theoretical value;
- The cumulative error between adjacent bearings on the same support, measured from a plane parallel to the deck soffit, should not exceed 2,0 mm; and that
- The cumulative error, measured from a plane parallel to the deck soffits, between any two points on a single temporary bearing should not exceed 1,0 mm.

b) Elastomeric launching bearing pads

The laminated elastomeric launching bearing pads shall be designed in accordance with SABS 0326 and comply with the requirements of SABS 1806. The pads shall be fabricated from natural rubber or chloroprene with a shore hardness of 60° and be designed to compensate elastically for local deviations of up to 2,0 mm in the sliding surface.

The formulation of the natural rubber or chloroprene shall be such that it does not mark the soffit of the deck. Details to be submitted to the Engineer for approval.

The elastomeric cover over the outer steel plates shall be 3,0 mm.

The bearing pads shall be designed to safely accommodate the maximum deck reactions during launching, as given on the drawings, with a maximum stress of 12 MPa.

The PTFE sliding surface bonded onto the elastomer shall be 2,0 mm thick and shall be thoroughly cleaned and lubricated immediately before reuse.

The bearing pads shall be replaced as soon as the PTFE sliding layer tears or debonds or the pad is damaged to such an extent that it is no longer serviceable.

Before a launch starts, at least one extra bearing pad shall be available at each temporary bearing, at any time. Notwithstanding this provision, the number of pads provided shall be sufficient to complete the work.

During launching, the edge distance between the bearing pad and the edge of the deck soffit shall fall within the specified tolerance. The Contractor shall specify in his method statement his procedures to control the edge distance.

A13.13.7.5 Platforms

At all of the supports, safe working platforms complete with access ladders and safety railings in compliance with current safety regulations and OHS requirements shall be provided and maintained. The platforms shall not be removed before acceptance by the Engineer of the installation of the permanent bearings and repair work to the supports.

Where necessary, access walkways to the platforms or direct access from the bridge deck shall be provided. If the platforms are damaged or become unstable from any cause, they shall immediately be repaired at the Contractor's expense.

If necessary, feeding trays for the elastomeric launching bearing pads shall be provided at each temporary bearing as part of the platform.

A13.13.7.6 Temporary supports

Temporary supports shall be located at the positions indicated on the drawings and be designed to resist the basic loads and, in order to limit the risks, any additional loads the Contractor considers necessary to cater for construction conditions, possible seismic effects, settlements and other incidental loads. If the support is of reinforced concrete, the design shall be in accordance with TMH-7 Part 3, and if in structural steel it shall be designed to BS 5400 Part 3. A geotechnical appraisal report is required for any temporary support founding.

The design of the support shall incorporate a facility which will permit adjustment of the level of the temporary bearing to compensate for vertical deformation of the support and for possible settlement of the foundations.

The founding conditions for the supports shall comply with the settlement criteria described in Clause A13.13.7.1b).

The position of the temporary support located between the deck construction area and the jacking abutment, shall not be moved without the written approval of the Engineer.

A13.13.7.7 Stays

Where shown on the drawings, high piers shall be stayed with staying cables symmetrically arranged around the centre of the pier. The stays shall be positively anchored to the top of the pier in a position that will not interfere with the working platform and at the other end, to the foundation of the adjacent pier. For each pier, the stays shall be simultaneously tensioned to a force that will limit the maximum pier deflection under launching to within the specified value without overstressing the pier. If during launching the limiting deflections are exceeded, or if the pier deflection is to be zeroed before installation of the permanent bearings, the stays shall be re-tensioned as directed by the Engineer.

A13.13.7.8 Deck construction

a) General

This subsection covers the requirements for the sequential construction of the deck and its component parts. On completion of launching the deck into its final position, the timing and sequence of the following remaining operations shall require the approval of the Engineer:

- Construction of deck diaphragms.
- Tensioning of draped pre-stressing tendons.
- Installation of permanent bearings.
- Construction of parapets, sidewalks and median island components.
- Installation of services and lighting (if required)
- Surfacing of decks.
- Installation of movement joints.

b) Control measures

Control measures shall be established and maintained to ensure that the work complies with the specified requirements. The measures shall be carried out by a skilled person well versed in the operation of the systems and equipment used.

Precision survey equipment shall be capable of direct measurement to 1,0 mm accuracy and shall be made available to the Engineer whenever required.

The level on the sliding surface of the temporary bearings shall be measured at regular intervals during the launching process as directed by the Engineer and if the limiting vertical tolerance of ± 1,0 mm is exceeded, the bearing levels shall be adjusted to compensate for deformation and settlement of the supports under the imposed loading.

Before casting any segment, the alignment and levels on the spine beams must be checked and corrected if the specified tolerances are exceeded.

During installation of the permanent bearings or during the adjustment or replacement of temporary bearings, the jacking forces and corresponding amount by which the deck is lifted, shall be accurately recorded and submitted to the Engineer for correlation purposes.

If at any instant a disproportionate variation is detected, the jacking operation shall be stopped immediately and the cause thereof ascertained and corrected before jacking is restarted.

The results of the control checks shall be reported to the Engineer systematically throughout the construction process in a manner to be agreed.

The total construction loads on the superstructure before all the pre-stressing is completed, shall not exceed 0,5 kN/m^2 on both the top and bottom slabs of the box girder.

c) Casting of the deck

Where the deck consists of a box girder, it shall be cast in two stages with a construction joint located between the webs and the top deck slab. Each casting stage shall extend over the full length of a segment and no intermediate vertical or inclined construction joints will be permitted. The time lapse between the placing of the concrete in the two stages shall not exceed three days.

The first segment shall be match cast with the launching girder and shall include all modifications to the end of the deck to accommodate the launching girder.

All web widenings required to accommodate the pre-stressing anchorages shall be cast together with the web.

d) Launching girder installation

The launching girder shall be fixed to the leading deck segment by means of either pre-stressing tendons or friction bolts cast into the concrete. The maximum stress in the tendons or bolts shall not exceed 60 % of the characteristic strength of the steel.

Where pre-stressing is used, the force in the tendons shall be monitored 4 weeks after installation and thereafter at intervals of 3 months.

The prestressing force provided shall prevent lift-off at the concrete to steel interface under the worst loading combination.

The interface between the sliding surface of the girder and the soffit of the concrete deck shall be flush. Any deviation shall be corrected over a distance of 100 times the deviation.

e) Tensioning of concentric pre-stressing tendons

The tensioning of the concentric tendons shall not be undertaken before the concrete in the deck segment has attained a strength of 35MPa. In this regard, the compressive strength shall be based on the test cubes that have been manufactured and cured on site adjacent to the launch yard. Sufficient test cubes shall be manufactured to ensure that a test result reflects the required sample size.

The sequence of tensioning the individual concentric tendons shall be undertaken symmetrically around the centroid of the deck cross section.

Grouting of tendons shall be carried out immediately after the launch of the segment.

f) Launching of deck

The launching operation shall be controlled by a person with extensive and appropriate experience in the construction system and procedure.

Launching of the segment may commence immediately after all the concentric pre-stressing tendons have been tensioned and the Engineer is satisfied that all requirements in terms of the contract have been satisfied.

The position at which the bridge deck is locked shall not be more than 4,0 m from the construction joint between the segment still in the formwork and the segment immediately ahead of it.

A mechanism shall be provided for temporarily anchoring the completed deck in position.

Pulling back operations shall be carried out under strict supervision and in the presence of the Engineer.

g) Construction of deck diaphragms

The deck diaphragms shall be cast as detailed on the drawings or in the Contract Documentation but always before the permanent bearings are installed. Where the diaphragm is constructed after the construction of the box section, the soffit slab shall be rigidly supported to carry the weight of the diaphragm concrete. Concrete shall be placed through the slots in the bridge deck.

h) Tensioning of draped pre-stressing tendons

The tensioning of the draped tendons shall not be undertaken before the concrete in the relevant deck diaphragms has attained a strength of 30MPa.

Stressing of the draped tendons shall be undertaken in two stages, sequentially along the length of the deck as follows:

Stage 1:

Tendons are to be stressed alternately in each web of span 1 until 50 % of the tendons have been tensioned.

Repeat for subsequent spans

Stage 2:

Complete stressing of unstressed tendons alternately in each web starting at the last span and working back to span 1.

i) Installation of permanent bearings

Details of the method to be used for the installation and securing of the permanent bearings in place shall be submitted to the Engineer for consideration and approval.

After completing the deck prestressing and diaphragm prestressing, the permanent bearings shall be installed in the sequence shown on the drawings

Lifting of the deck may take place at one support only at any one time and shall not commence before the concrete in the support diaphragm has attained a strength of 30 MPa.

The bridge deck shall be lifted simultaneously on both sides to a maximum height of 10 mm and shall be raised in such a manner that the relative difference in height, measured at corresponding positions along the soffit at the outside edges of the deck, does not exceed 2mm.

The bearings shall be installed to an accuracy of within 1,0 mm of the design level, the inclination of the bearings to within a tolerance of 1 in 1000 in any direction, and the orientation of the unidirectional bearings to within a tolerance of 1 in 200. The bearings shall be installed truly horizontal.

In the connection of the bearing to the substructure and deck, reliance on friction or adhesives will not be permitted. Studs or protrusions shall be used on the bearings and the deck and pier concrete scabbled to expose aggregate so that the failure plane due to horizontal loads passes through the grout or concrete and not at an interface. The proposed detail shall be submitted to the Engineer for approval.

A non-shrink cementitious or epoxy mortar with a compressive strength of 20 MPa after 24 hours and 50 MPa at 28 days shall be used as bedding for the bearings and for seating the deck on the bearings.

Precautions shall be taken to ensure that the deck cannot move whilst the bearings are being installed.

Where welding is used to secure the bearing in position, it shall comply with Clause A13.9.7.1h) of the standard specifications.

j) Construction of parapets, sidewalks and medians

Construction of the parapets, sidewalks and medians may commence simultaneously with the installation of the permanent bearings for the relevant deck, unless shown otherwise on the drawings or directed by the Engineer.

k) Installation of movement joints

Installation of the movement joints may commence after the permanent bearings have been installed, the concrete in the abutment curtain walls has gained full design strength and the asphalt surfacing has been completed.

A13.13.8 WORKMANSHIP

A13.13.8.1 Monitoring

In the context of this specification, monitoring shall include all those functions performed during the process of launching the deck, which inter alia includes the jacking of the bridge deck, measuring of support deflections, communication facilities and safety measures to be applied.

A detailed description of the proposed monitoring, together with the system for recording the jacking or restraining forces, incremental launching rate and the operation of the fail-safe systems, shall be submitted to the Engineer.

If the launching, restraining or pull-back force should vary disproportionately from the anticipated force at any instant, the jacking operation shall be stopped immediately and the cause thereof ascertained and corrected before jacking is restarted.

A supervisor, who is fully conversant with the sliding operation, potential malfunctions, and concomitant risk, shall be stationed at each support where sliding takes place. They shall be responsible for continuously monitoring the pier deflections during each launch, ensuring that the monitoring system is functioning correctly, and must be in radio contact with the launch controller at all times during the launching operation. No launch shall commence before radio contact has been established between the launch controller and each supervisor. In addition, a panic button shall be installed at each bearing where sliding is taking place, which when activated will immobilise the jacking operation.

Monitoring data shall be submitted to the Engineer on a daily basis.

A13.13.8.2 Tolerances

It is in the Contractor's interest to keep the tolerances as small as possible. This will reduce the loads and wear on the temporary works, especially jacking forces and launching bearing pad wear.

a) Sliding surfaces in the deck casting area: These shall be checked and adjusted after each launch.

- Dimensions:

  Width of the deck soffit on the plane of the side guides .....± 5,0 mm

  Thickness of sliding formwork (Marineply) .....± 1,0 mm

- Alignment:

  Deviation of the centre line of the sliding surface from the specified line ....1 in 1000 with maximum 5,0 mm deviation

- Levels:

  Levels on a sliding surface .....± 2,0 mm

  Relative difference in level between two corresponding

points on two adjacent sliding surfaces .....1,0 mm

- Slope:

  Slope in both directions on a sliding surface ..... ± 0,1 %

b) Temporary bearings

- Position:

  Transverse position of the side guides .....± 5,0 mm

  Temporary bearings.....± 5,0 mm

  Elastomeric launching pads relative to deck soffit edge .....± 10 mm

- Levels:

  Levels of bearings .....± 1,0 mm

  Relative difference in level between the sliding surfaces

  on corresponding bearings on consecutive piers, abutments or temporary supports .....4,0 mm

  Relative difference in level between sliding surface on adjacent

  bearings on the same pier, abutment or temporary support .....2,0 mm

- Slope:

  Slope in both directions ..... ± 0,1 %

- Dimensions:

  Thickness of elastomeric launching bearing pads .....± 1,0 mm

  The thickness of the pads are to be accurately measured on site and similar thickness pads then used at each support.

Note: The cumulative effect of the tolerances listed in (1) and (2i) above shall not result in a relative difference of more than 5,0 mm in level between two corresponding points on two adjacent sliding surfaces on the same pier, abutment or temporary support.

c) Jacks

Position:.....± 25 mm

d) Launching girder nose

- Fabrication and assembly:

  In accordance with Clause A13.11 of Chapter 13.

- Position:

  Transverse position at deck connection .....± 10 mm

- Alignment:

  Deviation of centre line of bottom flange from the specified line ... 3,0 mm over 12 m with maximum 5,0 mm deviation

  Deviation of the front of the girder from the theoretical position during

  launching, measured perpendicular and horizontally to the launching direction.....± 100 mm

- Surface regularity:

  Surface regularity of sliding surface ..... 1,0 mm over 1,0 m

- Slope:

  Slope in both directions on the sliding surface ..... ± 0,1 %

A13.13.8.3 Quality control

The Contractor shall provide a method statement of the quality control required for the assessment of all temporary works. All costs associated with testing of the temporary works shall be incorporated into the rates under this section, and shall not be deemed to form part of the Contractor's cost for a combined laboratory (if agreed to under the contract).

The Contractor, together with the designer of the temporary works, shall monitor the quality of the temporary works. The Engineer's responsibility will solely be to record the quality control being undertaken and inform the Contractor of any sub-standard work that arises.

B13.13 INCREMENTAL LAUNCHING OF BRIDGE DECKS
PART B: LABOUR ENHANCEMENT

CONTENTS

B13.13.1 SCOPE

B13.13.2 DEFINITIONS

B13.13.3 GENERAL

B13.13.4 DESIGN BY CONTRACTOR / PERFORMANCE BASED SYSTEMS

B13.13.5 MATERIALS

B13.13.6 CONSTRUCTION EQUIPMENT

B13.13.7 EXECUTION OF THE WORKS

B13.13.8 WORKMANSHIP

B13.13.1 SCOPE

This Section covers the requirements for the incremental launching method of construction for bridge decks, and includes temporary work (i.e. all works temporary in nature and required for construction of the permanent works), launching of the deck segments and the permanent work not covered elsewhere in the Standard Specifications. Although the labour component associated with the various construction activities is high, it is deemed to be of a specialist nature and therefore not suitable for labour enhanced work.

B13.13.2 DEFINITIONS

The provisions of Part A shall apply with no additional requirements.

B13.13.3 GENERAL

The provisions of Part A shall apply with no additional requirements.

B13.13.4 DESIGN BY CONTRACTOR / PERFORMANCE BASED SYSTEMS

The provisions of Part A shall apply with no additional requirements.

B13.13.5 MATERIALS

The provisions of Part A shall apply with no additional requirements.

B13.13.6 CONSTRUCTION EQUIPMENT

The provisions of Part A shall apply with no additional requirements.

B13.13.7 EXECUTION OF THE WORKS

The provisions of Part A shall apply with no additional requirements.

B13.13.8 WORKMANSHIP

The provisions of Part A shall apply with no additional requirements.

C13.13 INCREMENTAL LAUNCHING OF BRIDGE DECKS

PART C: MEASUREMENT AND PAYMENT

(i) Preamble

The tendered rate for each item shall include full compensation for providing, maintaining and decommissioning upon completion, of all the plant, equipment, labour, tools, incidentals and supervision to carry out the activity or construct the works in the item, unless otherwise stated.

Any prime cost or provisional sums shall be paid in accordance with the provisions of the conditions of contract. The charge or mark-up tendered or allowed for is a percentage of the amount actually paid under the prime cost or provisional sum. This percentage shall cover all the Contractor's handling, supervision, profit and liability costs to provide the services in the prime cost or provisional sum item.

The requirements of Section C1.1 of Chapter 1 shall apply.

Where pay item descriptions include any wording in brackets it is an indication that contract specific information is to be inserted in the Pricing Schedule included in the Contract Documentation.

(ii) Notes on measurement and pay items

None.

(iii) Items that will not be measured separately

The following activities, whether required to complete the specified work or not, will not be measured and paid for separately and the Contractor shall include the cost thereof in other pay items as he deems appropriate:

1. No separate payment will be made for setting out the works.
2. No separate payment will be made for the protection or repair as required of any existing or new road furniture, structures, buildings, infrastructure or services damaged by the Contractor's activities.
3. No additional payment shall be made, nor shall any claim for additional payment be considered, for any specified work in confined or restricted areas. Any additional costs associated with working in confined or restricted areas shall be deemed to be included in the standard applicable pay items.
4. No separate payment will be made for the loading of any materials.
5. No separate payment will be made for the hauling of any materials where the material is moved over a distance of less than, and up to 1,0 km and for labour enhanced construction, less than and up to 50 m.
6. No separate payment will be made for transporting materials from commercial sources irrespective of the haul distance.
7. No separate payment will be made for the removal or any surplus material imported to complete the works.
8. For all Works performed, precautionary measures required in terms of the Occupational Health and Safety Act (Act 85 of 1993) and the latest amendments thereof as well as the latest Construction Regulations shall be deemed included in the rates tendered for the relevant products.

(iv) Items to be measured and paid for using items specified elsewhere in the specifications

Not applicable to this Section.

(v) Items specifically for this Section of the specifications

Item	Description	Unit
C13.13.1	**Temporary bridge segment casting yard:**	
C13.13.1.1	Installation (Description of Structure)	lump Sum

The tendered lump sum shall include full compensation for the supply of all material, labour, equipment etc., for the installation of the access road, casting bed, temporary supports, all piling (if required), adjustable spine beam supports, reinforced or plain concrete work, drainage of the area and the clearing of the area on completion. The tendered rate shall include full compensation for all design, fabrication, erection and removal of all temporary works and earthworks associated with the incremental launching, including modification of the permanent works that is not measured elsewhere.

80 % of the rate will be paid when the construction area is complete and the final 10 % will be paid when the installation is removed from site. Increment payments of 10 % pro rata to progress shall be certified by the Engineer during construction of the deck area.

Item	Description	Unit
C13.13.2	**Cover to casting area:**	
C13.13.2.1	Provide cover (Description of Structure)	lump sum
C13.13.2.2	Re-use (Description of Structure)	lump sum

The tendered lumps sum shall include full compensation for the design, fabrication, supply and initial erection, for dismantling and re-assembly and for the subsequent removal from site of the necessary protection for the deck casting area.

90 % of the rate will be paid on completion of the cover to the casting area and the remaining 10 % when the cover is removed from site.

Item	Description	Unit
C13.13.3	**Launching girder:**	
C13.13.3.1	Provide launching girder (Description of Structure)	lump sum
C13.13.3.2	Re-use (Description of Structure)	lump sum

The tendered lump sums shall include full compensation for the design, drawings, fabrication, testing and certification, as well as transport, initial installation in position and fixing the girder to the deck and for all pre-stressing, anchorages, labour, handling, material and plant, for dismantling, transporting and re-erection, the subsequent removal from site of the launching girder and any repairs required to the end of the deck after removal of the girder. No additional payment shall be made for a launching girder that is heavier than the design girder, and for any additional costs associated with the heavier girder.

50 % of the rate will be paid when the launching girder is delivered to site, a further 40 % when it successfully reaches the first support pier and the remaining 10 % when it is removed from site.

Item	Description	Unit
C13.13.4	**Formwork assembly:**	
C13.13.4.1	Supply formwork assembly (Description of Structure)	lump sum
C13.13.4.2	Re-use (Description of Structure)	lump sum

The tendered lump sums shall include full compensation for the design, fabrication, supply and initial erection, for dismantling and re-assembly and for the subsequent removal from site of the formwork assembly. The tendered amounts shall include the operation and maintenance of the formwork assembly to achieve the required concrete finish. The internal and external formwork to the launched bridge deck shall not be measured in other Sections: all formwork, concrete finish and curing costs shall be included in the pay items under Section A13.13, unless measured elsewhere.

30 % of the rate will be paid when the formwork assembly is delivered to site, a further 60 % pro rata to physical progress with bridge deck casting and the remaining 10 % when it is removed from site.

Item	Description	Unit
C13.13.5	**Launching equipment:**	
C13.13.5.1	Supply launching equipment (Description of Structure)	lump sum
C13.13.5.2	Re-use (Description of Structure)	lump sum

The tendered lump sums shall include full compensation for the design, supply and installation of the launching equipment, which includes control and monitoring equipment, for dismantling and re-assembly and for the subsequent removal from site of the equipment.

50 % of the rate will be paid when the equipment is delivered to site, a further 40 % pro rata to successful bridge deck launching and the remaining 10 % when it is removed from site.

Item	Description	Unit
C13.13.6	**Temporary bearings, side guides and launching pads:**	
C13.13.6.1	Supply temporary bearings	number (No)
C13.13.6.2	Supply side guides	number (No)
C13.13.6.3	Re-use of temporary bearings	number (No)
C13.13.6.4	Re-use of side guides	number (No)

The unit of measurement shall be the number of temporary supports. Note that a single temporary support as measured comprises both a vertical and a horizontal temporary support component. At the permanent and temporary piers two temporary supports are generally required per pier, and at least two sliding pads are required per temporary support.

The tendered amounts shall include full compensation for the design, fabrication, supply and installation of the temporary bearings and side guides, for dismantling and re-erection and for the subsequent removal from site, and for the design, fabrication, supply and use of the launching pads at each support, including the replacement of damaged launching pads.

Item	Description	Unit
C13.13.7	**Platforms:**	
C13.13.7.1	Supply platforms (Description of Structure)	number (No)
C13.13.7.2	Re-use (Description of Structure)	number (No)

The unit of measurement shall be the number of access platforms and is equal to the number of permanent and temporary piers.

The tendered amounts shall include full compensation for the design, fabrication, supply and erection, for dismantling and re-erection, for the

subsequent dismantling and removal from site of the access platforms and for any repairs to holes and recesses in the piers required for the support of the platforms.

80 % of the rate will be paid when the platforms are commissioned and the remaining 20 % when they are removed from site and the repairs to the permanent works completed.

Item	Description	Unit
C13.13.8	**Stay system for piers:**	
C13.13.8.1	Pier (description)	number (No.)

The unit of measurement shall be the number of piers/supports required to be stayed during the launching operation.

The tendered rate shall include full compensation for the supply, installation, tensioning, adjusting and subsequent removal of the stays, for the anchorages and the anchorage reinforcing, for any temporary or permanent work required for the installation and for the subsequent repairs to any holes and recesses.

80 % of the amount will be paid when the stay is satisfactorily installed. The remaining 20 % will be paid when the launching operation is complete, the stay is disconnected, repairs completed to the pier and the stay moved to another position or removed from site.

Item	Description	Unit
C13.13.9	**Launching of deck segments:**	
C13.13.9.1	Structure (description) deck segments	number (No)

The unit of measurement shall be the number of deck segments cast and launched regardless of the length of segment being launched.

The tendered rate shall include full compensation for the complete launching of the bridge deck segment, for the appropriate control measures, measurement of pier deflections, the operation and maintenance of the equipment and instruments including the formwork assembly, for all lubricants and any additional costs necessary for the execution of the work as well as for the management of the launching pads at the supports.

90 % of the amount will be paid when the segment is launched. The remaining 10 % will be paid when the concrete formed and unformed surfaces has reached the required standard of finish.

Item	Description	Unit
C13.13.10	**Temporary piers including piles and pilecap:**	
C13.13.10.1	Temporary piers (description)	number (No)

The unit of measurement shall be the number of temporary piers provided. A temporary pier shall include all piles, pile cap, columns and bracing required. Two columns are usually required per temporary pier.

The tendered rate for temporary piers shall include full compensation for all concrete, structural steel, formwork and reinforcement steel and for all other materials, labour, plant and other incidentals required for constructing the temporary piers complete, and for demolition of the temporary piers and temporary pilecaps after use. All works including concrete and reinforcement shall be removed to a minimum depth of 1,5 m below ground level.

80 % of the amount will be paid once the temporary pier is constructed. The remaining 20 % will be paid once the temporary pier is removed.

D13.13 INCREMENTAL LAUNCHING OF BRIDGE DECKS
PART D: GUARANTEES AND COMPLIANCE CERTIFICATES

CONTENTS

D13.13.1 SCOPE

D13.13.2 GENERAL

D13.13.3 PERFORMANCE GUARANTEE REQUIREMENTS

D13.13.4 FUNCTIONAL PERFORMANCE ASSESSMENTS

D13.13.5 VISUALLY ASSESSED PROPERTIES

D13.13.6 INSTRUMENTALLY ASSESSED PROPERTIES

D13.13.7 EVALUATION FOR ACCEPTANCE

D13.13.8 ADDITIONAL PROCEDURES TO BE ADOPTED IN THE EVENT OF FAILURE

D13.13.9 NOTIFICATION OF REMEDIAL WORK

D13.13.10 REMEDIAL WORK

D13.13.1 SCOPE

The scope of this Section covers the following:

- Product conformance specifications
- Warranties for product or element design and installation of proprietary systems
- Performance specifications

Note that the requirements for performance specifications are not limited to that given in Part C only but includes all of the requirements in the Contract Documentation.

D13.13.2 GENERAL

D13.13.2.1 Product conformance specifications

The Contractor shall, within 28 days of entering into the contract with the Employer, submit to the Engineer conformance documentation related to the specifications.

Conformance documentation shall be provided for:

a) Structural steel launching girder

D13.13.3 PERFORMANCE GUARANTEE REQUIREMENTS

D13.13.3.1 Warranties for product or element design and installation of proprietary systems

No additional requirements.

D13.13.3.2 Performance specifications

The Contractor shall, within 28 days of entering into the contract with the Employer, submit to the Engineer conformance documentation related to the specifications.

Performance specifications shall be provided for the following:

a) Incremental launch system: Proven track record.

b) Temporary Bearings.

13.14 SPECIALIST STRUCTURES

CONTENTS

PART A: SPECIFICATIONS

A13.14.1 SCOPE

A13.14.2 DEFINITIONS

A13.14.3 GENERAL

A13.14.4 DESIGN BY CONTRACTOR / PERFORMANCE BASED SYSTEMS

A13.14.5 MATERIALS

A13.14.6 CONSTRUCTION EQUIPMENT

A13.14.7 EXECUTION OF THE WORKS

A13.14.8 WORKMANSHIP

PART B: LABOUR ENHANCEMENT

PART C: MEASUREMENT AND PAYMENT

PART D: GUARANTEES AND COMPLIANCE CERTIFICATES

A13.14 SPECIALIST STRUCTURES

PART A: SPECIFICATIONS

A13.14.1 SCOPE

This Section covers the work related to specialist structures.

A13.14.2 DEFINITIONS

The following definitions shall apply to these specifications:

Jacked structures - includes all structures that are constructed either partially or completely and are then jacked into their final position into or under road embankments.

Cable support systems for structures can range from minor cable support systems for bridges to major cable stayed bridges.

Other specialist bridges including balanced cantilever and other complicated structures.

A13.14.3 GENERAL

The construction of specialist structures shall be carried out in terms of world best practice for the construction of these structures and specialist specifications shall be included in the Contract Documentation which shall replace this Section as applicable.

A13.14.4 DESIGN BY CONTRACTOR / PERFORMANCE BASED SYSTEMS

A13.14.5 MATERIALS

A13.14.6 CONSTRUCTION EQUIPMENT

A13.14.7 EXECUTION OF THE WORKS

A13.14.8 WORKMANSHIP

B13.14 SPECIALIST STRUCTURES
PART B: LABOUR ENHANCEMENT

C13.14 SPECIALIST STRUCTURES
PART C: MEASUREMENT AND PAYMENT

D13.14 SPECIALIST STRUCTURES
PART D: GUARANTEES AND COMPLIANCE CERTIFICATES