CHAPTER 5: JUNCTION LAYOUT

5.1 INTRODUCTION

1 The layout of a road junction or pedestrian crossing and its approaches should be carefully designed to allow the safe and efficient operation of traffic signals. Geometric and other improvements are often required at a junction before signals can be installed.

2 The objectives of improving road geometry at a signalised junction include the following:

(a) to reduce conflict and thus improve safety;

(b) to promote efficient traffic flow; and

(c) to reduce construction and maintenance cost.

3 Installation of traffic signals without due regard to the above requirements may result in an inefficient or unsafe situation, associated with high user cost. It is therefore imperative that appropriate geometric improvements should be carried out as a part of the traffic signal installation project, and be included in the implementation programme and budget.

5.2 GEOMETRIC DESIGN OF SIGNALISED JUNCTIONS

5.2.1 General

1 Geometric design standards of signalised junctions are given in a variety of design manuals. These include the TRH17 and UTG manuals of the Committee of State Road and Urban Transport Authorities (see bibliography). These manuals can be supplemented by manuals from other countries, such as the AUSTROADS (1988) and AASHTO (1995) manuals.

2 The geometric design manuals address general road and junction geometric design standards. The intention of this chapter is not to repeat these standards, but to provide supplementary guidelines applicable to signal controlled junctions.

3 The geometric design of signal controlled junctions differs in a number of important aspects from the design used at priority controlled junctions. It is therefore important that even at locations where signals are not currently warranted, a decision must be made on the possibility of future signalisation. The main differences are:

(a) Operations at priority controlled junctions can be improved by increasing corner radii and by providing tapers, but this creates difficulty in positioning traffic signals and providing for pedestrians. At signalised junctions, smaller corner radii may be required.

(b) At priority controlled junctions, shoulder widths and through lanes are normally maintained through the junction. At signalised junctions, the number of lanes is commonly increased to improve capacity, and the shoulders eliminated to improve signal positioning.

5.2.2 Factors influencing geometric design

1 The geometric design of a signalised junction is influenced by a number of factors, such as traffic volumes, human factors, vehicle factors, topography, and economic considerations.

2 A junction must be able to accommodate peak-hour traffic volumes efficiently and safely. This is particularly important at signalised junctions that carry large volumes of traffic, and where additional lanes may be needed to provide the required capacity to accommodate the traffic.

3 The human factor is a particular important element in the design of signalised junctions. Humans are inclined to act according to habit - they may become confused when surprised, and tend to be inattentive at times. These factors make it essential that uniform and proper design standards should be utilised at junctions.

4 The design of a junction should make provision for the type of vehicle anticipated to use a particular junction. Use can be made of turning templates to establish “swept paths” through a junction.

5 The topography as well as the environment are important factors often restricting the geometric design of a signalised junction. Compromises in design are often required due to topographical and environmental restrictions.

6 The cost of providing high design standards at signalised junctions is often a restricting factor. However, significant improvements can often be achieved by relatively minor low-cost improvements.

5.2.3 Spacing of signalised junctions

1 The spacing of signalised junctions (and pedestrian crossings) on two-way roads is one of the most important factors affecting efficiency and road safety in signalised networks.

2 Optimal co-ordination on two-way roads depends on a large number of factors, and while it is not possible to provide detailed recommendations regarding junction spacing that would optimise co-ordination, a minimum distance of 500 m is generally required. Factors influencing co-ordination include traffic patterns, speeds, cycle length, signal phasing, queue lengths, etc. In general, however, longer cycles and higher speeds require signals to be spaced further apart. Each situation should be investigated depending on particular circumstances.

3 On one-way arterials (not in networks), co-ordination can be achieved relatively easy for any spacing of junctions. The spacing of traffic signals on one-way roads is therefore less of an important factor, except that minimum requirements should be met.

4 The distance at which signals can be spaced apart depends on maximum expected queue lengths. Short block lengths often lead to the blocking of upstream junctions, which have an adverse effect on network operations.

5.2.4 Conflicting manoeuvres at junctions

1 In the design of junctions, consideration must be given to the different types of conflicting traffic manoeuvres that can occur in a junction. These are:
   (a) Diverging manoeuvres that occur when a traffic stream splits into two separate streams.
   (b) Merging manoeuvres that occur when two traffic streams merge into one.
   (c) Weaving manoeuvres that occur when traffic streams cross each other by lane changing.
   (d) Crossing manoeuvres that occur when one traffic stream crosses another at near right angles.
2 Where possible, junction design should eliminate or reduce conflicts, or at least avoid multiple manoeuvres, which combines two or more of the above manoeuvres. Multiple manoeuvres should where possible, be replaced with a series of elemental ones. Such manoeuvres should preferably be separated by at least *two* or *three seconds* of travel time.
3 Diverging, merging and weaving manoeuvres should be designed for low RELATIVE speeds between conflicting traffic streams. This means that the angle of intersection of the streams should be relatively small, and vehicles should preferably be travelling at about the same speeds when the manoeuvres are made. This could mean that acceleration or deceleration lanes may be required to achieve desired operating speeds.
4 Crossing manoeuvres should be made at approximately right angles to minimise driver estimation errors. To achieve this, the angle of intersection between approach roads should preferably be 90 degrees. Angles of down to 70 degrees, however, would also be acceptable. Where possible, geometric improvements should be introduced to achieve such angles.

5.2.5 Sight distance requirements

1 Good junction design requires that proper attention should be given to sight distance requirements. The provision of adequate sight distance is fundamental to safe signal operations.
2 The following sight distances are of importance at traffic signals:
   (a) Stopping sight distance required by vehicles to stop for hazardous objects on the roadway or in the junction. Minimum stopping sight-distances are given in the various geometric design manuals.
   (b) Sight distance required for traffic signal faces as given in Chapter 3 of this manual (Volume 3).
   (c) Sight distance required by right-turning traffic when seeking gaps in an opposing conflicting stream. This sight distance can be established using Figure 2.7: *Shoulder sight distance for stop condition"* given in Volume 1 of the Road Traffic Signs Manual.
3 It is not necessary to provide shoulder sight distance on the approaches to signals that may be out of order since drivers must treat such signals as 3-way or 4-way stop controlled junctions.

5.2.6 Design vehicles

1 The design of a junction should make provision for the types of vehicles expected to use the junction, to carry out turning movements with adequate space for their swept paths.
2 Turning templates are used for the design of junctions. These templates indicate the "swept path envelope" for various angles for turn. Provision should be made to accommodate such swept paths plus a minimum clearance of 600 mm on each side of the path.
3 Some turning templates have been developed for vehicles travelling at crawl speeds to establish absolute minimum design standards. Vehicles turning at such speeds, however, would lead to a deterioration of operations at traffic signals. Templates that provide for vehicles turning at higher speeds should therefore preferably be used.
4 Where provision must be made for particularly difficult turning movements through a junction, care should be taken to check turning paths from all likely positions the junction can be approached from by the design vehicle, and not only one ideal position. This is particularly important where wide approach lanes are provided, but the vehicle must negotiate a narrow path through the junction.

5.2.7 Lane widths

1 Lane widths for straight-through movements at a traffic signal should preferably not be narrower than 3,3 m, although a width of 3,0 m can be resorted to where insistence on the 3,3 m would mean that a right-turn lane cannot be provided. Where there are significant volumes of heavy vehicles, lane widths can be increased to about 3,5 m.
2 Lane widths for left- and right-turn lanes should preferably not be narrower than 3,0 m, although a width of 2,7 m (and even 2,5 m) can be accepted if it would otherwise again mean that a right-turn lane cannot be provided. Where significant volumes of heavy vehicles utilise the turning lanes, the turn lane may be increased to 3,3 m or more.
3 Double and triple turning lanes should be at least 3,3 m and preferably 3,5 m wide on the approach to the junction. Wider widths will be required on the exit side of the junction to accommodate the paths of the turning vehicles. If a median is provided on the exit side, a wider exit width can be achieved by either reducing the width of the median or by setting the median back from the junction.
4 An offset of 0,3 m should preferably be provided between the kerb face and the edge of the roadway.
5 The widths of exit lanes at junctions should be sufficient to accommodate the swept paths of turning vehicles, particularly when double or triple turning lanes are provided, or where only one exit lane is available. Such exit lanes should preferably be at least 3,5 m wide, but a width of between 4,0 m and 4,5 m may be required. Where significant volumes of heavy vehicles turn right, the required widening should be established by means of turning templates.

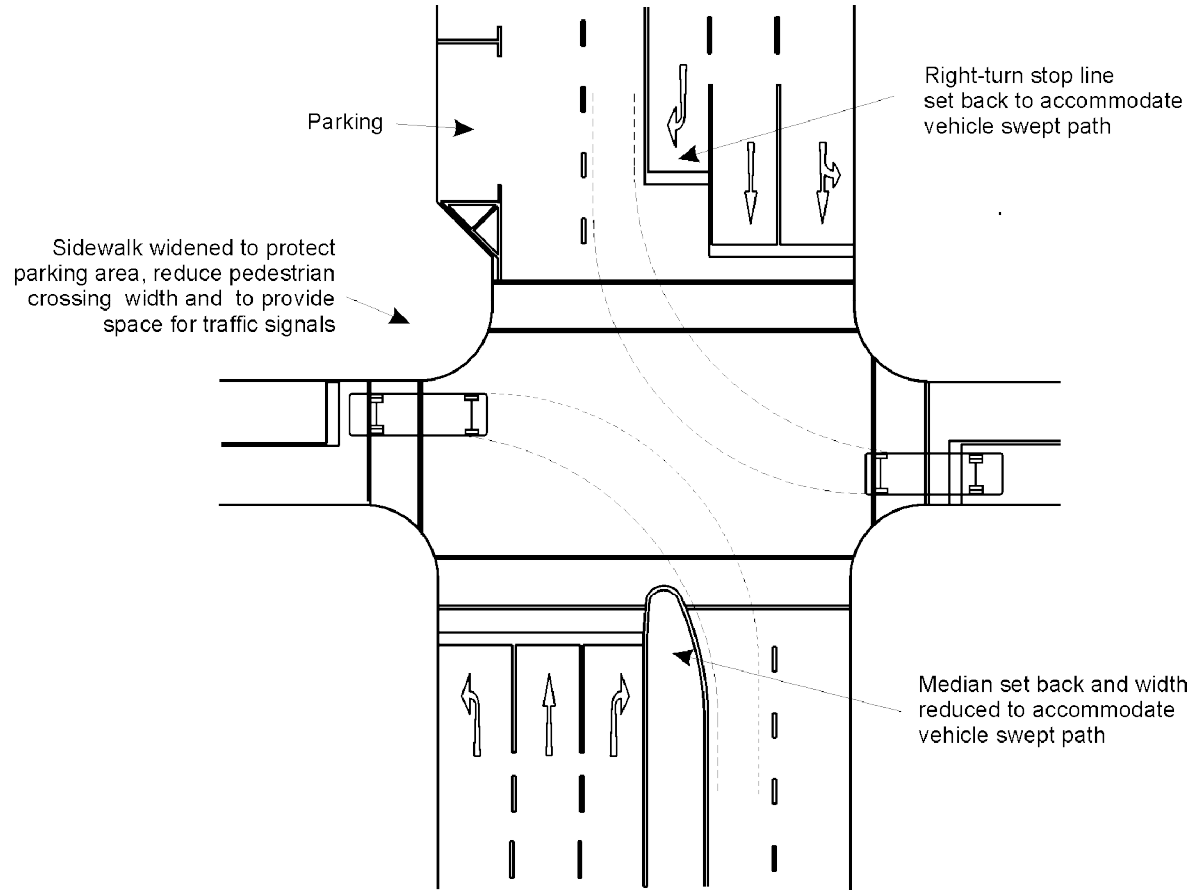


Figure 5.1: Vehicle swept paths through a signalised junction

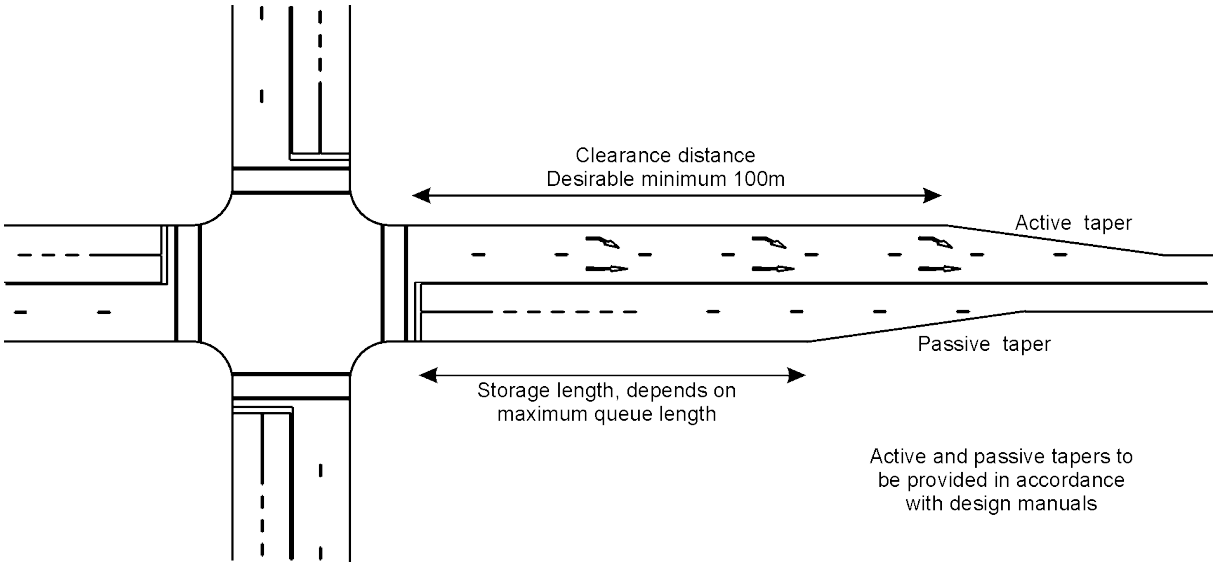


Figure 5.2: Auxiliary through lanes at signalised junctions

6 Where a right-turn movement turns into a two-way road, the stop line on the exit side of the junction can be set back to provide space for the movement. Where a median is provided, the exit lane can be widened by either setting the median back from the junction or by reducing the width of the median locally. The different options are shown in Figure 5.1.

5.2.8 Median widths

1 The width of a median should generally not be less than 1,2 m. This is the minimum requirement to accommodate road traffic signs such as the “keep left” sign.

2 At signalised junctions, however, a width of 1,2 m would not be sufficient to accommodate a traffic signal because of the recommended clearance distance of 0,5 m. Assuming a backboard width of 0,5 m and a clearance distance of 0,5 m on both sides of the backboard, a median width of 1,5 m is required to accommodate a single signal face, while a width of 2,0 m is required to accommodate two signal faces side by side. A minimum median width of 2,0 m is therefore generally recommended near signalised junctions.

3 On narrow medians, where insistence on the 0,5 m clearance would mean that signal faces cannot be provided on the median, the lateral clearance can be reduced to an absolute minimum of 0,1m, but only if the camber or crossfall of the roadway falls away from the median. In such a case, it would be possible to install two signal faces on a 1,2 m wide median.

4 A minimum median width of 2,0 m is desirable where it is necessary to accommodate pedestrians or pedal cyclists. Wider medians may be required where large volumes of pedestrians must be accommodated.

5.2.9 Junction corners

1 Corner kerb turn radii at signal controlled junctions of between 8 and 10 m are normally desirable, but radii as small as 6 m and as large as 12 m can be used. Corner radii below 8 m lead to left-turning vehicles making wider turns, and encroachment onto adjacent lanes. Radii above 10 m, on the other hand, lead to an increase in turning speeds that could affect the safety of pedestrians. The larger radii also create problems with the positioning of traffic signals.

2 At locations where significant volumes of heavy vehicles use the junction, the above corner turn radii could be inadequate. In such cases, slipways may be required to accommodate left-turn movements.

3 Where parking is provided, it is preferable to widen the sidewalk area at the corner of the junction, as shown in Figure 5.1. Such widening serves to protect the parking area and it allows for the closer positioning of traffic signal faces to the roadway. Another advantage is that it reduces the clearance time required by pedestrians to cross the junction.

4 Barrier or semi-mountable kerbs should be used on the corners of signalised junctions to prevent parking on the corners. Provision should also be made for recessed pedestrian ramps at the corners.

5.3 AUXILIARY LANES

5.3.1 Auxiliary through lanes

1 Auxiliary through lanes are sometimes provided at signalised junctions to improve capacity. An example of a junction with such lanes is shown in Figure 5.2.

2 The length of the auxiliary through lane on the approach to a junction depends on the amount of storage required to accommodate the queue length waiting at the traffic signal. The auxiliary through lanes should be terminated well clear of the junction, desirably 100 m minimum beyond the junction (excluding the taper).

3 Adequate active and passive taper rates should be provided in accordance with standards provided in design manuals. Care must be exercised with the location of the merging (active) taper to ensure that there is sufficient sight distance for the approaching driver to perceive the merge and have adequate time for relative speed adjustment and gap selection for merging.

5.3.2 Left-turn auxiliary lanes

1 The left-turn does not have the same impact on the safe and efficient operation of a signalise junction as the right-turn movement (except where left-turning movements are hampered by high volumes of pedestrians). This, however, does not mean that left-turn auxiliary lanes are not required. In many instances, it may be possible to improve signal operations and safety significantly by introducing left-turn lanes.

2 Left-turn lanes have the advantage that decelerating turning traffic is removed from the through lanes, thus improving operations on such lanes. It could also be more cost effective to add a left-turn lane than to increase the number of through lanes.

3 A left-turn lane can be of particular advantage when a left-turn phase can be provided when the right-turn movement from the left is given a separate phase. At many T-junctions, there is an opportunity to provide such a left-turn phase, and the provision of a left-turn lane can often be more readily justified at such junctions (except when pedestrian signals are required to accommodate pedestrians).

4 Left-turning lanes are most effective when significant volumes of traffic turn left, the traffic signal has insufficient capacity to handle peak-hour traffic (due to pedestrians), and the provision of a left-turn lane would be the most cost-effective solution to increase the capacity of the junction.

5.3.3 Right-turn auxiliary lanes

1 The right-turn movement is of particular importance at signalised (and also other) junctions. Even one vehicle wanting to turn right at a junction, and having to wait because of limited gaps in the opposing flow, will impede other traffic and could create unsafe operating conditions. Exclusive right-turn lanes at a traffic signal will be warranted at most locations where signals are warranted.

2 Right-turn lanes not only contribute to improved capacity, but also have a significant safety benefit. In many cases, right turn lanes can be warranted based on their **safety** benefits alone, rather than the capacity improvements that can be achieved. Relatively few right-turn vehicles can cause severe disruptions that could lead to accidents, although sufficient capacity may be available at a junction.

3 The need for right-turn lanes to improve safety depends on the speed on a road as well as the probability of conflicts between the right-turn and other traffic travelling in the same direction. On high-speed roads, a right-turn lane will be justified, even if very low volumes of traffic turn right. On roads with low operating speeds, a higher degree of conflict can be accepted.

4 In general, right-turn lanes should be provided at all traffic signals, except where operating speeds are low (50 km/h or less) or where very few conflicts occur between right-turn and other traffic movements (either because of low volumes of right-turners or low volumes of opposing traffic movements). A cost-benefit analysis can be undertaken in which the benefits accruing from the provision of a right-turn lane can be compared with the cost of providing such a lane.

5 Right-turn lanes can also be justified on **capacity** grounds. A capacity analysis would indicate whether such lanes are required. Where right-turn traffic volumes exceed 300 vehicles in the peak hour, provision of a double right-turn lane may be considered. Triple right-turn lanes can also be considered, but normally only on one-way streets and on the side approaches of T-junctions.

5.3.4 Design of right-turn lanes

1 Right-turn lanes can be introduced by utilising a number of different methods, as shown in Figure 5.3. In the north-south direction, the approach lanes are narrowed to accommodate the right-turn lanes and the lanes delineated by using road markings. The turning lanes in the east-west direction are provided inside a constructed median.

2 Two methods of delineating right-turn lanes by means of road markings are shown in Figure 5.3. From the north, a painted island is utilised to provide greater protection to right-turn movements. From the south, no such island is provided and WM2 CONTINUITY LINES are used to demarcate the turning lane.

3 The painted island design has the advantage that it is significantly more visible than the second design, particularly at night. However, in urban areas where street lighting is provided and speeds are relatively low, the design without the island is adequate. This design has the advantage that the S-type of manoeuvre required to make a right-turn associated with a painted island, is eliminated.

4 When traffic signal face S1R is used (in combination with traffic signal arrow sign ST2) to control a right-turn movement, separate right-turn lanes must be provided. Such lanes should be separated from other lanes by a WM2 CONTINUITY LINE, a RM5 PAINTED ISLAND or a constructed island.

5 In the design of right-turn lanes, it is important that sufficient sight distance should be provided to avoid the possibility of head-on conflict. The sight-distance of right-turning vehicles is often obstructed by a queue of right-turning vehicles in the opposite direction. Two examples of this problem are shown in Figures 5.4 and 5.5. Possible methods of addressing these problems are discussed.

5.3.5 Double and triple right-turn lanes

1 Double or triple left and right-turn lanes can be provided at junctions provided that there is adequate space on both the approach to, and exit from, the junction. The capacity for turning traffic can be significantly improved by providing such lanes (triple right-turn lanes would normally only be considered on one-way streets and on the side legs of T-junctions).

2 For the right-turn movement, the provision of double or triple turn lanes can impair lines of sight. Protected-only right-turn phases should therefore be considered when such lanes are used.

3 It is strongly recommended that use should be made of guide lines through the junction when double or triple lanes are provided. Such lines are needed to discourage encroachment between the turning lanes and to reduce the possibility of sideswipe accidents between vehicles.

4 The guide lines should allow for the largest type of vehicle anticipated to make the right-turn movement. Turning templates are used to establish the turning paths of two or three heavy vehicles turning right at the same time.

5.3.6 Length of right-turn lanes

1 Standards for the lengths of right-turn lanes are given in the design manuals. These lengths are normally determined based on the expected 95^{th} percentile queue length in the peak hour. The lengths should be checked against the queue in the adjacent through lane and the longer queue used to ensure that turning vehicles are not blocked from entering the turn lane.

2 On high-speed roads where expressway type conditions are required, an appropriate deceleration length may be added to the storage length requirement to ensure optimum and safe traffic flow. At traffic signals, it is generally more important to provide the storage space than a deceleration length.

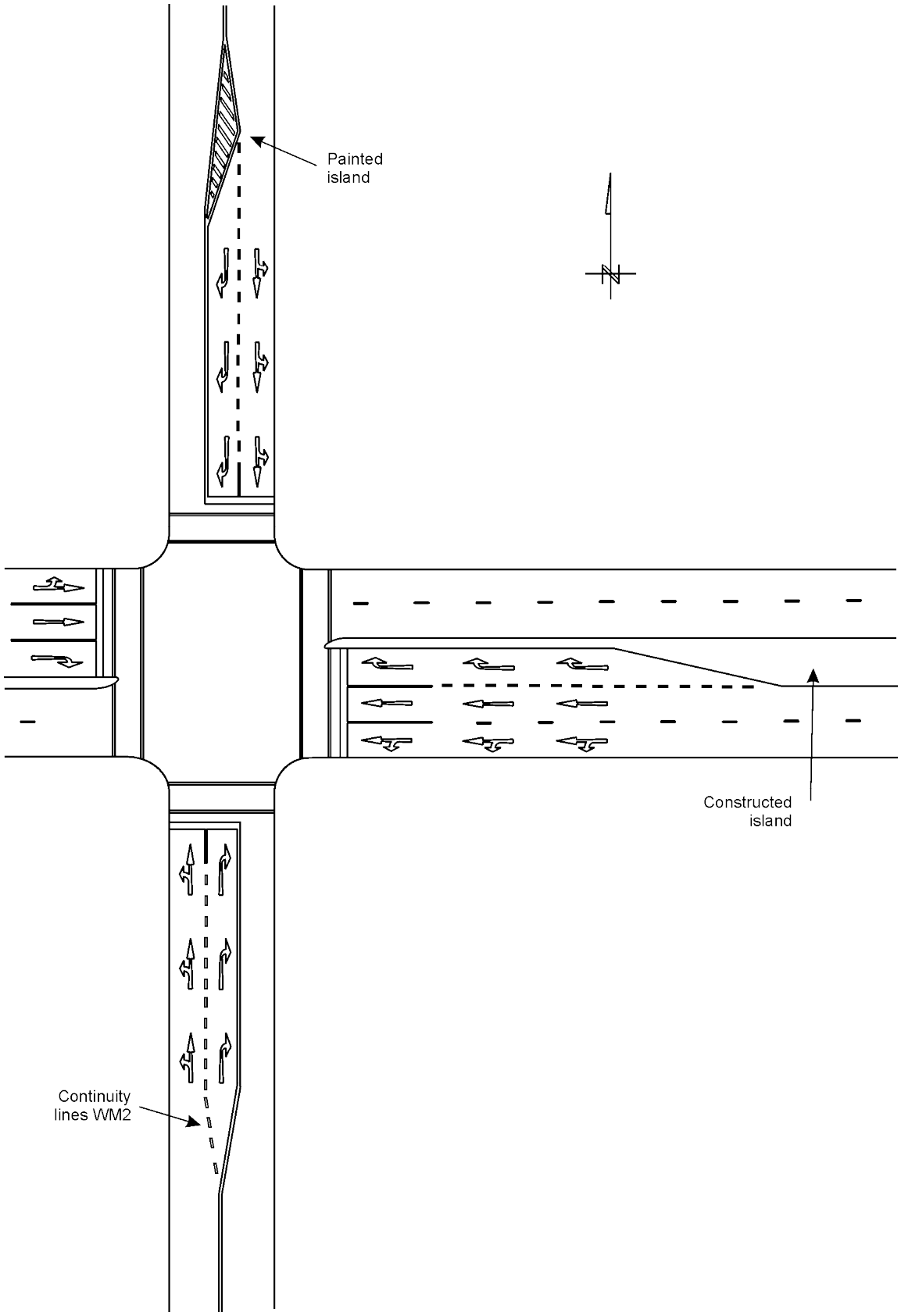
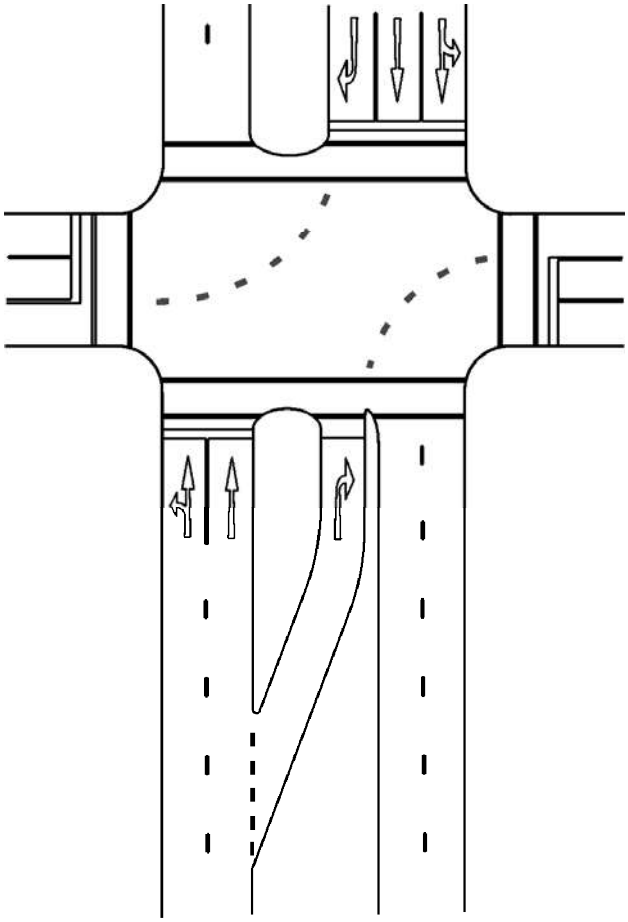
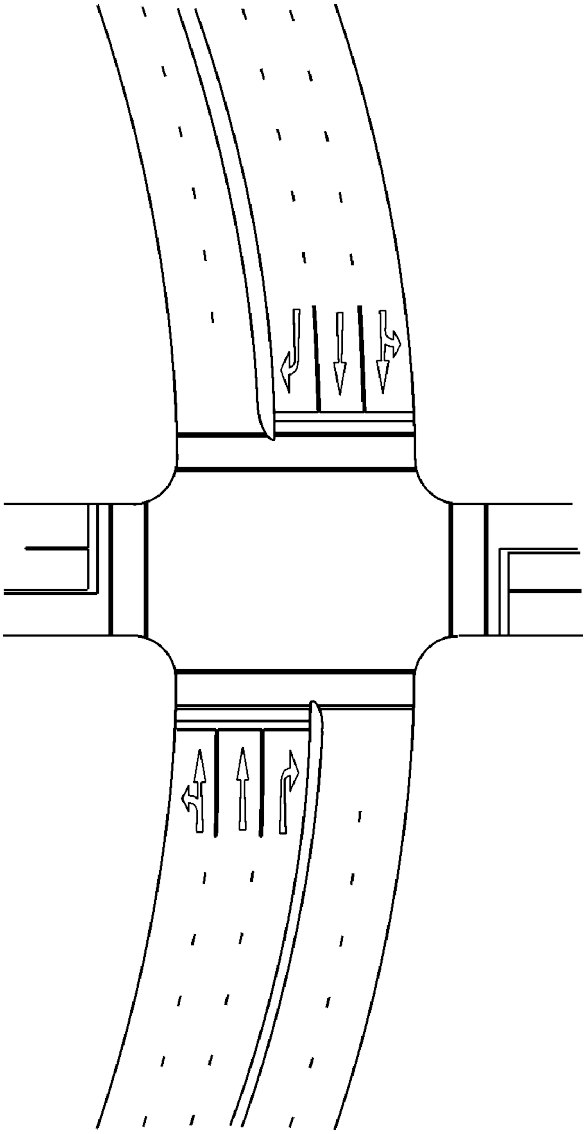


Figure 5.3: Provision of right-turn lanes at a signalised junction



In this figure, sight distance is obstructed due to the provision of a very wide median and the queue of right-turning vehicles forming in the opposite direction. A possible geometric improvement that can be considered at such a junction is to provide the right-turn lane in the median, as indicated in the figure.

Figure 5.4: Restricted sight distance for right-turning traffic due to a very wide median



In this figure, sight distance is obstructed due to the horizontal curve on the road and the queue of right turning vehicles forming in the opposite direction. A possible remedy for this problem is to provide a protected-only right-turn phase. Note that this problem only occurs in the one direction (bottom-to-top) and not in both directions.

Figure 5.5: Restricted sight distance for right-turning traffic due to a horizontal curve (bottom-to-top direction)

3 In establishing the required right-turn storage lengths, it is important that attention be given to future requirements. This means that traffic volumes and patterns must be predicted for the design year. As with the geometric design of other elements of a junction, the length of the turning lane should be designed to accommodate such design year traffic volumes.

4 As a minimum, provision should be made for storage space for at least two vehicles in the right-turn lane (about 12m). However, it is more desirable to provide a storage space for at least five vehicles (about 30 m). Typically, storage spaces vary between 30 to 60 m, depending on right-turn volumes.

5.3.7 Slipways

1 A slipway is a roadway that passes to the left (or in the case of one-way systems, to the right) of the main junction without intersecting the main junction. Slipways can be controlled or free-flow as shown in Figure 5.6.

2 Slipways at signalised junctions, may be required under the following circumstances:

(a) When provision has to be made for large turning vehicles, and the corner turn radius cannot be increased to accommodate such vehicles.

(b) At skew junctions where the normal treatment would lead to a large junction.

(c) Where improved operations and capacity are required for the turning movement.

3 **Controlled slipways** are controlled by a traffic signal or a yield or stop sign. The following are a number of considerations that should be taken into account:

(a) YIELD control should only be used when adequate shoulder sight distance is available. STOP control is otherwise used. Such sight distance is required to allow drivers to view straight-through vehicles from the right as well as vehicles turning right from the opposite approach.

(b) The angle of entry of a controlled slipway should not be less than 70 degrees relative to the crossroad (with the stop line angled at a maximum of 20 degrees). A sharper angle not only increases driver discomfort, but also leads to speeding, which could result in unsafe operating conditions.

(c) The controlled slipway is treated as a separate junction operating independently of the main signalised junction. This creates no problem when a slipway is yield or stop controlled. Signalised slipways, however, have the problem that signals are normally not provided on the main road and that potential conflicts must therefore be prevented at the main junction. **All conflicting movements at the main junction, including the right-turn movement from the opposite direction, must face a red light signal while the slipway receives a green signal.** This would require the provision of a protected-only right-turn phase for right-turning traffic from the opposite approach.

4 **Free-flow slipways** allow for free-flow turning movements at relatively high speed. The following are a number of important considerations in the design of such slipways.

(a) The radius adopted for the slipway should preferably allow for a relatively high operating speed.

(b) Due to the high operating speeds, free-flow slipways are only appropriate when there are very low volumes of pedestrians.

(c) An acceleration lane of sufficient length should be provided on the exit side of the slipway.

(d) The slipway design should prevent vehicles making wide turns directly onto the crossing road. A short median can be provided on the exit side of the slipway to direct vehicles onto the acceleration lane.

5 Free-flow slipways can improve operations significantly when they are properly designed using appropriate design standards (and there are no or few pedestrians).

6 Yield (or stop) sign controlled slipways have the advantage that turning traffic movements do not have to stop at the traffic signal.

7 Signal controlled slipways have the following disadvantages:

(a) The opportunity for gap acceptance is not available.

(b) Right-turning movements on the main junction must be prohibited when the slipway receives a green light signal.

(c) Although the saturation flow of the left-turn movement at a traffic signal can be slightly increased by providing a signalised slipway, it does not mean that the capacity of the junction can be increased. In many instances, capacity could in fact be reduced, particularly if additional signal phases must be introduced to accommodate opposing right-turn movements.

8 Signalisation of slipways may be required on double or triple lane slipways due to possible sight distance problems. It is, however, important to reiterate that such signalisation should only be provided when a permanent protected-only right-turn phase is provided on the opposite approach at the main junction.

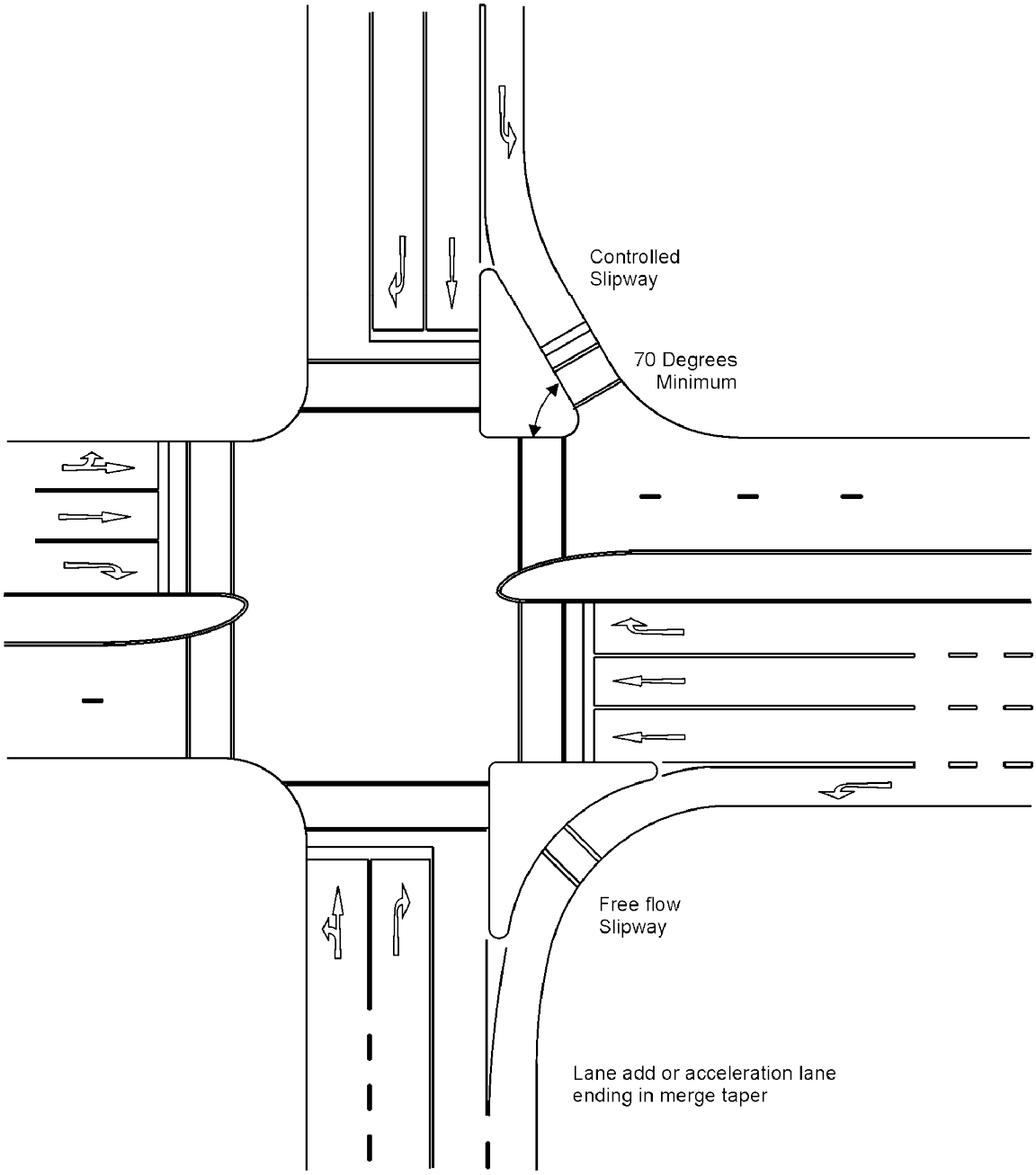


Figure 5.6: Free-flow and controlled slipways at a signalised junction

5.4 ROAD SIGNS

1 The National Road Traffic Regulations allow for the use of various road signs at traffic signals. There are, however, a limited number of road signs that may be used in conjunction with a traffic signal. These signs are the following (these signs have also been listed in Chapter 3 of this manual):
   (a) a street name sign;
   (b) a direction route marker sign;
   (c) information signs IN14, IN15 and pedestrian and pedal cyclist signs relating to the function of the traffic signal;
   (d) a one-way roadway sign;
   (e) a no-entry sign;
   (f) a left-turn prohibited, right-turn prohibited or a U-turn prohibited sign;
   (g) a proceed straight through only, proceed left only, or proceed right only sign;
   (h) a pedestrian prohibited sign R218; or
   (i) a traffic signal arrow sign ST1 to ST5;
   The above signs may be mounted on the same post, cantilever or gantry as that of the traffic signal.
2 Other signs may not be used in conjunction with a traffic signal, even if the signal is out of order (except where the signals have been masked out). These include the STOP sign R1, YIELD sign R2 and the RIGHT-OF-WAY sign IN7. A slipway at a signalised junction, however, may be STOP or YIELD sign controlled.
3 The PEDESTRIAN PROHIBITED SIGN R218 is used to prohibit pedestrians from proceeding beyond the sign. The sign must be posted on the near side of the junction, in the direction to which it is applicable (and in both directions of the crossing).
4 The following information signs related to the operation of traffic signals, may be used at signals:
   (a) Where signal timings are co-ordinated for a fixed speed, information sign IN14 may be displayed on the relevant exit from a junction.
   (b) Where a traffic signal has three or more vehicular signal phases, information sign IN15 may be located directly below a signal face.
   (c) Pedestrian and pedal cyclist information signs.
5 The TRAFFIC SIGNAL AHEAD SIGN W301 may be used to warn a road user of the presence of a traffic signal. This sign should be displayed in advance of:
   (a) Any *new* traffic signal installation. The sign may be removed after a period of three months.
   (b) Any approach where the approach speed is 70 km/h or more, or where the signal is not visible within 180 m of the junction.
   (c) A *remotely located* junction or mid-block pedestrian crossing.
6 A TEMPORARY TRAFFIC SIGNAL AHEAD SIGN TW301 may be used in advance of any traffic signal that is used temporary at roadworks.
7 The TRAFFIC SIGNAL OUT OF ORDER SIGN TW412 may be used to warn a road user that the traffic signals ahead are out of order. If a TRAFFIC SIGNAL AHEAD SIGN W301 is located in advance of the traffic signal, the temporary warning sign TW412 may be placed over the W301 sign for the period the signal is out of order.
8 The PEDESTRIAN CROSSING SIGN W306 may be used to warn a road user of the presence of a mid-block pedestrian crossing ahead. The sign should be displayed not less than 90 m or not more than 180 m in advance of the crossing.

5.5 ROAD MARKINGS

5.5.1 Range of road markings

1 Signalisation is applied to a wide range of road junctions. As the traffic handling characteristics of a junction become more complex, so the need for clear and unambiguous road markings becomes greater. Road safety at, and the efficiency of, a junction can be greatly affected by the way in which the approaches to it, and the areas shared by conflicting traffic movements are marked.
2 Details related to road markings are given in Chapter 7 of Volume 1 of the Road Traffic Signs Manual. The various types of road markings and their dimensions are summarised in Table 5.1.
3 The minimum road markings required at a signalised junction or crossing includes the stop line (RTM1), pedestrian crossing lines (RTM3) and the no-overtaking line (RM1). Additional road markings will be required at more complex junctions.
4 Figure 5.7 shows road markings for typical signalised approaches to junctions. Figure 5.8 shows typical guide lines through a junction.

5.5.2 Pedestrian crossing lines

1 Pedestrian crossing lines (RTM2) are used to indicate the position where pedestrians (or pedal cyclists) may cross at a junction or a mid-block crossing. Block pedestrian crossing markings (RTM4) may also be used instead of the crossing lines at both junctions and mid-block crossings, particularly in locations where pedestrian volumes are high.
2 Pedestrian crossing lines (or block pedestrian crossing markings):
   (a) SHOULD as a general rule be provided at all traffic signal controlled junctions, even if the junction is used by no pedestrians (except where pedestrians are specifically prohibited);
   (b) MAY be provided without pedestrian or pedal cyclist signals being installed at a junction;
   (c) SHALL be provided where pedestrian signals are installed at junctions or crossings; and
   (d) SHALL NOT be provided when PEDESTRIAN PROHIBITED R218 signs have been posted.
3 Pedestrian crossing lines not only mark crossing positions for pedestrians, but can serve to improve the visibility of the junction and to assist drivers in recognising and identifying a junction as being signal controlled.

5.5.3 Regulatory road markings

1 The RTM1 STOP LINE imposes a mandatory requirement upon drivers of vehicles, when combined with a red light signal, that they shall stop their vehicles immediately behind such line.

2 The RTM2 YIELD LINE imposes a mandatory requirement upon drivers of vehicles that they shall yield right of way at the point marked by the line to all traffic, including pedestrians.

3 The RTM3 PEDESTRIAN CROSSING LINE imposes a mandatory requirement that drivers of vehicles shall yield right of way to a pedestrian who is crossing the roadway (or to a pedestrian waiting to cross the roadway), provided that pedestrians are crossing in accordance with the traffic light signals. It also imposes a mandatory requirement that pedestrians shall only cross the roadway within the area demarcated by the markings.

4 The RTM4 BLOCK PEDESTRIAN CROSSING imposes a mandatory requirement similar to that of the RTM3 pedestrian crossing line.

5 The RM1 NO-OVERTAKING LINE imposes a mandatory requirement that drivers of vehicles shall not drive on the right side of the line, or that any part of a vehicle crosses the line (except when the vehicle must gain direct access to any adjacent property, or to pass a stationary obstruction). At a junction or crossing, no-overtaking lines are used between two opposing directions of travel.

6 The RM3 CHANNELISING (STACKING) LINE imposes the mandatory requirement that drivers shall not drive a vehicle in such a manner that it, or any part of it, crosses such a marking. These lines are used between lanes of vehicles travelling in the same direction. The channelising line should be preceded by EXTRA DENSITY GM1 LANE LINES.

7 The RM4.1 LEFT EDGE LINE (YELLOW) is used to demarcate the left-hand edge of the travel way.

8 The RM4.2 RIGHT EDGE LINE (WHITE) is used to demarcate the right-hand edge of a travel way.

9 The RM5 PAINTED ISLAND MARKING imposes the mandatory requirement that drivers shall not drive a vehicle in such a manner that it, or any part of it, crosses such a marking.

10 The RM8 MANDATORY DIRECTION ARROWS (YELLOW) impose a mandatory requirement that drivers of vehicles may proceed only in the direction indicated by the arrows. The arrows SHALL be preceded by at least one and preferably two direction arrow ahead WM7 markings. The arrows may NOT be used to indicate an increase in the number of lanes ahead – BIFURCATION ARROWS GM3 must be used for this purpose.

11 The RM10 BOX JUNCTION marking imposes a mandatory requirement that drivers of vehicles shall not enter the box marked area within a junction if they are not able to leave such area due to stationary vehicles ahead of them.

12 The RM11 ZIG ZAG ZONE LINE imposes a mandatory requirement that drivers shall not park or stop in the area marked by the line except to yield right of way to pedestrians on a pedestrian crossing.

13 The RM12 NO-STOPPING LINE (RED) imposes a mandatory requirement that drivers of vehicles shall not stop their vehicles adjacent to such line (except in compliance to a regulatory sign or traffic signal).

5.5.4 Warning road markings

1 The WM2 CONTINUITY LINE is used to warn drivers that if they drive to the left (or right) of such line that they will shortly deviate from the through roadway.

2 The WM3 DIVIDING LINE is used to warn drivers that vehicles travelling on the other side of the line are travelling in the opposite direction (and if they wish to cross such line, they must wait until it is safe to do so).

3 The WM5 YIELD CONTROL AHEAD is a triangular shaped road marking used to warn drivers of a YIELD sign R2 ahead.

4 The WM6 LANE REDUCTION ARROWS are used to warn drivers that a lane on a multi-lane road ends some distance ahead, either from the left or the right, or from both left and right. The markings should be repeated at least once, but preferably three times, as shown in Figure 5.2.

5 The WM7 MANDATORY DIRECTION ARROW AHEAD warning markings are used to warn drivers that a MANDATORY DIRECTION ARROW marking RM8 is ahead which will require the driver to proceed only in the direction indicated by the arrow. At least one WM7 arrow shall precede an RM8 arrow marking (except when the RM8 arrow is in a recessed turn lane that is less than 25 m in length). The arrows may NOT be used to indicate an increase in the number of lanes ahead – BIFURCATION ARROWS GM3 must be used for this purpose.

5.5.5 Guidance road markings

1 The GM1 LANE LINES are used to demarcate traffic lanes for vehicles travelling in the SAME direction. STANDARD DENSITY LANE LINES are normally used on road links. At junctions, EXTRA DENSITY LANE lines should precede CHANNELISING (STACKING) LINES over a distance of at least 18 m (24 m in rural areas).

2 The GM2 GUIDE LINES are used to provide guidance through a junction. The lines may also be used to provide guidance to pedestrians when a formal pedestrian crossing is not warranted. YIELD LINES RTM2 may be incorporated to advise drivers of the likely need to yield within a turning movement.

3 The GM3 BIFURCATION ARROWS are used to indicate an increase in the number of lanes ahead. Mandatory direction arrows WM7 may not be used for this purpose.

4 The GM4 INFORMATION ARROWS are used to indicate the direction of travel permitted in a particular lane. The arrows can be useful at very wide junctions to indicate exit paths. The arrows can also be useful to indicate the exit direction of one-way streets at junctions.

Table 5.1: SUMMARY OF ROAD MARKINGS FOR SIGNALISED JUNCTIONS AND CROSSINGS					
Marking number	**Description**	**Urban areas**		Rural areas	
		Width	Length	Width	Length
Regulatory road markings					
RTM1 (white) [1,2]	STOP Line	300 mm Min	Full approach	500 mm Min	Full approach
RTM2 (white) [1,3]	YIELD line	300 mm Min	600 mm Line 300 mm Gap	500 mm Min	1000 mm Line 500 mm Gap
RTM3 (white) [2,3]	Pedestrian crossing line	100 mm Min [4]	Full roadway	100 mm Min [4]	Full roadway
RTM4 (white)	Block pedestrian crossing	[4]	600 mm Block 600 mm Gap	[4]	600 mm Block 600 mm Gap
RM1 (white)	No-overtaking line	100 mm Min	9 m Minimum 18 m Preferred 27 m Multi-lane	100 mm Min	12 m Minimum 24 to 60 m Preferred
RM3 (white)	Channelising/ Stacking line	100 mm Min Same as GM1 or WM2	9 m Minimum 18 m Preferred 27 m Multi-lane	100 mm Min Same as GM1 or WM2	12 m Minimum 24 m Preferred 60 m High speed
RM4.1 (yellow)	Left edge line	100 mm Min		100 mm Min	
RM4.2 (white)	Right edge line	100 mm Min		100 mm Min	
RM5 (yellow with white borders)	Painted island marking	100 mm White boundary lines 150 mm to 1 000 mm Yellow lines sloped at 30/60 degrees or 200 mm to 600 mm Continuous yellow line between two white lines			
RM8 (yellow)	Mandatory direction arrows	Approximately 1 m in advance of stop line.			
RM10 (yellow)	Box junction	100 mm Min		100 mm Min	
RM11 (white)	Zig Zag Zone	100 mm Min	2,0 m Line 150 mm Gap 30 m length	100 mm Min	2,0 m Line 150 mm Gap 30 m length
RM12 (red)	No-stopping line	100/150 mm Min		100/150 mm Min	
Warning road markings					
WM2 (white) [5]	Continuity line	200 mm Min	1,5 m Line 1,5/3,0/7,5m gap	200 mm Min	2 m Line 2/4/6 m Gap
WM3 (white)	Dividing line	100 mm Min	3,0 m Line 6,0 m Gap	100 mm Min	4,0 m Line 8,0 m Gap
WM5 (white)	Yield control ahead				
WM6 (white)	Lane reduction arrows				
WM7 (white)	Mandatory direction arrow ahead				
Guidance road markings					
GM1 (white) [5]	Lane lines	100 mm Min	1,5 m Line 1,5/3,0/7,5m gap	100 mm Min	2 m Line 2/4/6 m Gap
GM2 (white)	Guide lines	100 mm Min	0,5 m Line 1,5 m Gap	100 mm Min	0,5 m Line 1,5 m Gap
GM3 (white)	Bifurcation arrows				
GM4 (white)	Information arrows				

NOTES
[1] Stop line not less than 1,2 m and not more than 15 m in advance of continuation of edge of the crossing roadway.
[2] Stop line minimum 1,0 m in advance of pedestrian crossing lines (3,0 m at pedestrian crossings).
[3] Yield line minimum 3,0 m in advance of pedestrian crossing lines minimum (preferably 6,0 m).
[4] Pedestrian crossing width – 2,4 m Minimum; 3,0 m Preferred minimum; 5,0 m Preferred maximum.
[5] Continuity and Lane lines available as extra, standard and reduced density lines, depending on gap size.

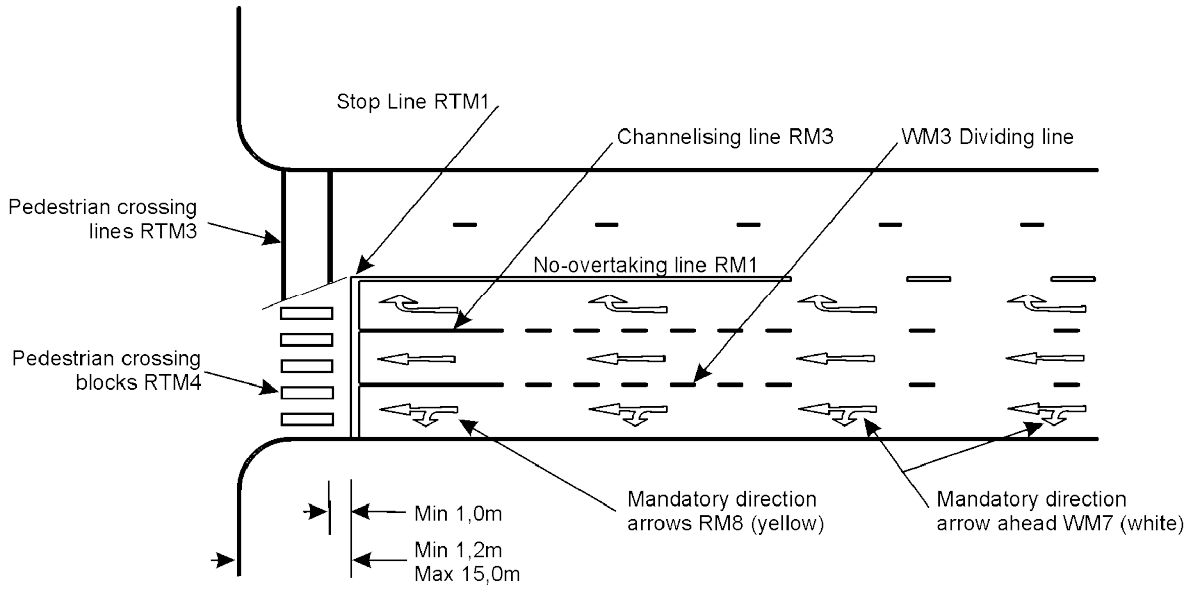


Figure 5.7: Road junction with pedestrian crossing markings

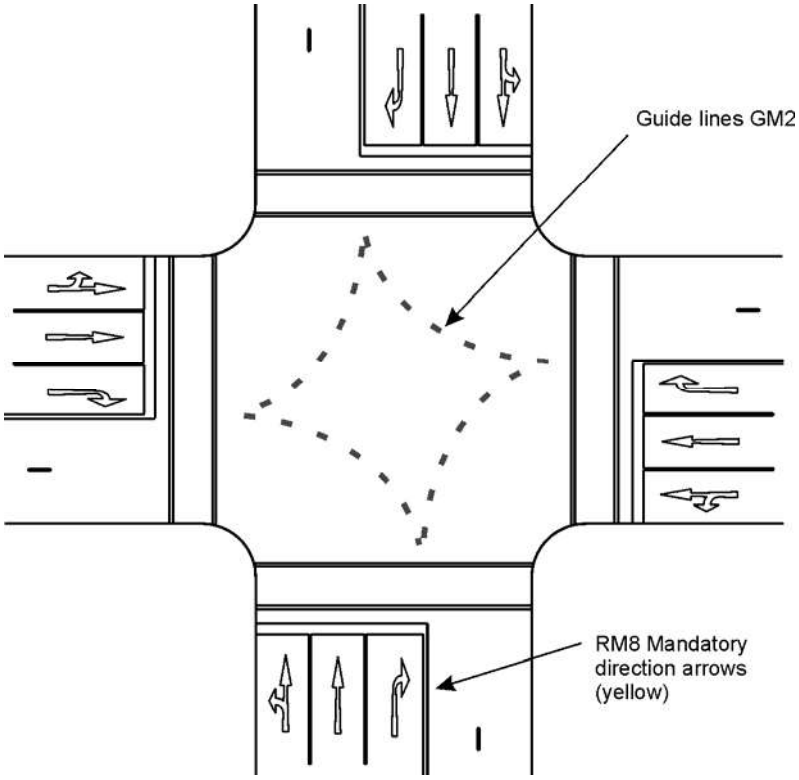


Figure 5.8: Guide lines through a junction

5.6 ROAD LIGHTING

1 The provision of road lighting at signalised junctions and mid-block pedestrian crossings will promote safe operations at night. Adequate lighting will contribute to increased visibility, thereby increasing driver awareness of the signals as well as possible conflicts within the junction. Lighting enhances traffic safety by illuminating hazardous objects or situations so that the driver can respond readily and safely.

2 Lighting can reduce the number of accidents at night to about a third of that occurring during the day. Reduction factors such as this can be used in cost-benefit analyses in which the benefits accruing from lighting can be compared with the cost of providing such lighting.

3 In addition to its safety benefits, the provision of road lighting can also contribute to reducing crime levels.

4 At junctions, road lighting is particularly justified when a significant number of pedestrians cross the junction or crossing at night. Such junctions would normally be located near developments that have a large component of recreational land use. This includes sporting venues, cinemas, popular restaurants, resorts, etc.

5 Lighting is also required at complex junctions with islands and other obstructions, or where significant volumes of vehicles turn right at night.

6 An important principle in the provision of road lighting is that a uniform level of brightness should be provided over the full junction or crossing. Drivers may not discern objects when brightness is allowed to vary. Care should also be taken to ensure that all important features are illuminated, including kerbs and pedestrian crossings.

7 A further important aspect related to the introduction of lighting at remotely located junctions, is the time required by drivers to visually adapt to changes in lighting levels. The problem mainly occurs when drivers leave the illuminated area. To address this problem, the level of lighting at the junction should be kept relatively low. Alternatively, the level of lighting can be gradually reduced.

8 High mast lighting is often used at remotely located junctions. This method of lighting has several advantages. These include the following:

(a) High mast lighting covers a greater area of the junction, including areas adjacent to the roadway. Drivers can therefore relate to the entire junction complex.

(b) Fewer poles located farther away from the edge of the pavement reduce the probability of collisions with the poles.

(c) Transition lighting is more easily achieved because of the gradual reduction of light levels at higher mounting heights.

The disadvantage of high mast lighting is that additional energy is required to illuminate areas other than the roadway itself.

5.7 BIBLIOGRAPHY

1 AUSTROADS, 1988, Part 5- Intersections at Grade, Australia.

2 AASHTO (American Association of State Highway and Transportation Officials), 1995, A policy on Geometric Design of Highways and Streets, Washington, USA.

3 Committee of Urban Transport Authorities, 1986, UTG1 Guidelines for the geometric design of urban arterial roads, Pretoria,

4 Committee of Urban Transport Authorities, 1989, UTG7 Geometric design of urban local residential streets, Pretoria,

5 Committee of Urban Transport Authorities, 1988, UTG5 Geometric design of urban collector roads, Pretoria,

6 Committee of Urban Transport Authorities, 1990, UTG10 Guidelines for the geometric design of commercial and industrial local streets, Pretoria,

7 Committee of State Road Authorities, 1988, TRH 17, Geometric design of rural roads, Pretoria,