CHAPTER 20: DETECTORS

20.1 INTRODUCTION

1 Detectors are used extensively at traffic signals to detect the presence of vehicles or pedestrians with the purpose of either adjusting signal timings or providing signal phases.

2 A traffic detector will generally comprise:

(a) A detection device, e.g. an inductive loop in the roadway.

(b) An electronic detector unit to serve the input provided by the detection device.

(c) A feeder cable connecting (a) and (b).

3 The detector unit is usually located in the controller cabinet and the unit interfaces electrically with the controller to provide the inputs required by the controller.

20.2 PEDESTRIAN PUSH BUTTONS

1 Pedestrian push buttons can be provided to call pedestrian phases. They are strictly speaking not detectors, as they respond only to action on the part of the pedestrian in pushing the button.

2 The push button unit itself must be intrinsically safe electrically and should only be used to complete a low voltage electrical circuit. The push button should be resistant against vandalism, and the button plunger should be designed to minimise the risk of jamming by foreign objects, moisture or corrosion.

3 The push button can incorporate a mechanism for providing tactile and audible "feedback" to visually impaired pedestrians (see Chapter 17 of this manual).

4 Push button units should be coloured yellow and provided with a black walking-man symbol.

20.3 VEHICLE DETECTORS

1 A wide range of vehicle detecting devices has been developed for use at traffic signals. These include the following:

(a) Ultrasonic detectors, which depend upon the reflection of sound waves from the vehicle.

(b) Infrared detectors, which depend upon the reflection of infrared light from the vehicle.

(c) Microwave detectors, which depend upon the reflection of very high frequency electromagnetic waves from a vehicle.

(d) Magnetometers, which depend upon the change in a magnetic field produced by the metal of a vehicle. These detectors are installed below the road surface.

(e) Inductive loop detectors, which depend upon the change in an inductive field produced by the metal of a vehicle.

2 The inductive loop detector is currently the most widely used method for the detection of vehicles in modern traffic control systems.

20.4 DETECTOR OPERATION

1 Modern traffic detectors can provide a variety of functions and can be operated in various modes, irrespective of the means used for the detection of traffic.

2 There are two fundamental modes in which detectors can operate:

(a) Passage (Pulse) detection - used to indicate that a vehicle has crossed a detector. No indication is given of the time the vehicle has spent while crossing the detector and the pulse is of very short duration. The signal received from the detector is therefore basically a binary "yes" or "no" code. Any extension of green commences when a vehicle reaches the detector.

(b) Presence detection - used to indicate that a vehicle is present on a detector. The vehicle is detected for the duration of time it spends on the detector. Any extension of green commences after the vehicle has departed from the detector.

3 The majority of detection systems operate in presence mode rather than passage mode. Vehicle-actuated systems in particular require the presence mode. A call is registered, and green is extended, while the presence of a vehicle is detected in such presence mode. Extension detectors will extend a green signal for a short time period when the presence of a vehicle is no longer detected.

4 Detectors may also be provided with either latching (locking) or non-latching (non-locking) detector memory circuits. A non-latching detector permits a waiting call to be dropped as soon as a vehicle leaves the detection area. A latching detector, however, will hold the call until it has been satisfied by the provision of green, even if the vehicle leaves the detection area.

5 The latching and non-latching circuits can be used for purposes such as improving the capabilities of stop line calling detectors. The locking circuit can, for instance, be used to prevent dropping of calls by vehicles that cross and stop beyond the stop line call detector. On the other hand, this facility will place demands for vehicles that clear the junction, resulting in unnecessary false calls for a green signal. It may therefore be beneficial to address this problem by providing a longer stop line detector and locating the detector in such a position that it will cover the majority of positions where vehicles will stop.

6 In addition to the above functions, most modern vehicle detectors are able to ignore the continued presence of a vehicle beyond a predetermined interval. This is to avoid (illegally) parked vehicles continually calling phases that are not legitimately required.

20.5 INDUCTIVE LOOP DETECTORS

20.5.1 General

1 Inductive loop detectors are the most widely used method of detecting vehicles, mainly as a result of their relatively low installation cost. However, when loop detectors are not properly installed and maintained, they could be prone to high rates of failure.

2 The inductive loop consists of one or more turns of wire placed in a slot cut into the street surface. The loop works on the principle that an electromagnetic field is generated by an electrical current passing through the loop. Any ferrous metal object passing through the field will disturb the field, and this disturbance can be sensed by the electronic detection unit.

20.5.2 Loop shapes and sizes

1 Inductive loops have been used in a variety of shapes and sizes. Preference is normally given to small size loops rather than large loops due to improved sensitivity and the lower cost of maintaining smaller loops. Often a number of small loops will be installed rather than one large loop.

2 Most loops are in the shape of a rectangle, diamond or parallelogram, as shown in Figure 20.1. The rectangular corners of the different shapes result in “hot spots” where the electromagnetic fields overlap, which are very effective in detecting vehicles. The efficiency of the loop can also be improved by orientating the loop 45 degrees to the kerb, as with the diamond and parallelogram shapes.

3 The increased efficiency of the diamond and parallelogram shaped loops is more important at higher speeds. These loops are therefore recommended when it is necessary to detect vehicles travelling at speed.

4 The rectangular shaped loop is recommended for the detection of stopped vehicles. The diamond and parallelogram shapes may be more effective in terms of sensitivity, but some areas of the roadway will not be covered by these loops. It is thus possible, for example, that stopped motorcycles will not be detected. The greater efficiency of these loops is also not really required when vehicles are stopped. The most effective shape for the detection of stopped vehicles is therefore the rectangular form.

5 A skewed stop line detector is shown in the right-most lane in Figure 20.1. Such detectors are required to prevent false calls being placed by right-turn vehicles from the crossing street encroaching on the wrong side of the road (but only where median islands are not provided).

6 In order to reduce false calls being placed by vehicles straddling two lanes, the edge of a loop should not be closer than 0,6 m from the lane line. Such spacing will also reduce the incidence of cross-talk between two adjacent loops.

20.5.3 Detector loop and unit requirements

1 The operations of loop detectors can be affected by a variety of factors, such as the ambient conditions. Loop detectors should therefore be self-tuning, allowing them to adjust to such conditions, and even to the presence of a parked vehicle within the detection area.

2 Particular care must be taken in providing protection against lightning surges. Detector loop input terminals should be electrically isolated.

3 A variety of loop wires are used, some more costly than others. The wire should be of a high quality and tough and be resistant to abrasion, heat and moisture. Even when wires have been manufactured according to specifications, it is good practice to pre-test the wire isolation by submerging the wire in water and testing the wire for electrical leaks (a few bends should be made in the wire before it is tested). The wire isolation should also be tested for resistance to heat that may be generated by the slot sealant.

4 The number of turns of wire should be calculated according to the recommendations of the manufacturer of the detection unit. The number of turns depend on the size of the loop and the type of vehicles to be detected.

5 The loop wire is installed in a slot, cut into the road surface as shown in Figure 20.2. The slot is cut sufficiently deep to accommodate the wire, filling material and the slot sealant. The wire should lay on a bed of suitable material (e.g. silicon sand) to prevent possible damage from an uneven surface. The wire should also be covered by some suitable material (such as silicon sand or a neoprene cord) to reduce the possibility of damage due to heat generated by the slot sealant while curing. Some sealant materials may also induce unwanted stresses in the loop wire after it has cured.

6 The slot sealant should be of good quality. It must be flexible to allow for possible movement in and thermal expansion of the pavement, but at the same time be tough enough to withstand vehicle tyre abrasion and the possible penetration of debris which could damage the loop wire. It must also be able to withstand the corrosive effects of road salts, fuel, and other fluids found on road surfaces. The sealant must also be able to adhere properly to both concrete and asphalt road surfaces, preferably without a primer.

7 In order to prevent breakage or cracking of the insulation, the loop wire should not be bent to form sharp corners, or even right angles. All corners of the loops should be cut across to reduce the angle of bending, as shown in Figure 20.1.

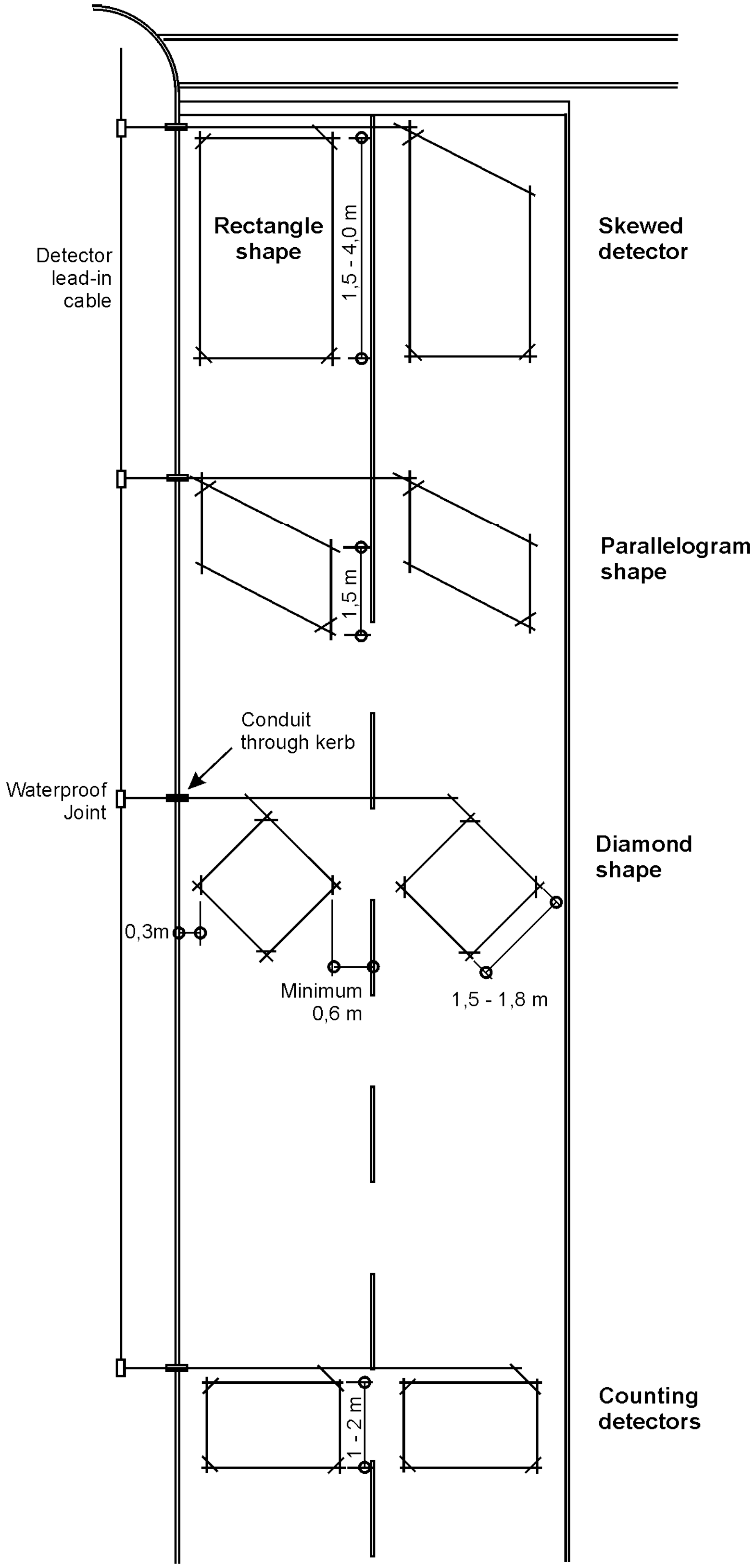

Figure 20.1: Inductive loop shapes and sizes

20.5.4 Loop installation procedure

1 Loops need to be properly and carefully installed to ensure trouble-free operation. The most common causes of failure are breakage of the wire or breakdown of the insulation, causing ingress of water and variations in resistance to earth and induction.

2 Great care should be given to ensuring that the slot is cut properly. The cut must be done at an even depth, particularly at corners where the cut must continue slightly beyond the end of the loop to accommodate the circular shape of the saw.

3 Slots should be cut in the road surface, using a diamond saw of suitable width. The slot should be free from any sharp edges that could damage the loop wire insulation and should be clean and dry before laying the loop. The use of compressed air to blow debris from the slot is highly recommended.

4 The wire should be laid in the slot without the application of undue pressure or force. Wire should not be pushed into the slot with a screwdriver or any other sharp instrument.

5 The loop wires and wire tails from the loop should be one continuous length of wire and joints should not be permitted. The wire tails are joined to the detector lead-in cable (DLC) and the joint should be encapsulated in a waterproof resin compound.

6 If there is a kerb, a hole must be drilled through or below the kerb and a conduit provided for the wire tails.

7 Loops at the same position from the stop line and connected to the same detector unit can be electrically connected in series (subject to a maximum limit that can be accommodated by the electronic circuit).

20.5.5 Prefabricated loops

1 Prefabricated loops can be used on roads that are subject to settlement or movement. The loops are prefabricated in a workshop and are installed as a single unit.

2 Various methods can be used for constructing such loops. These include the following:

(a) Installing loop wires in a 12 mm PVC conduit or pipe. All joints are sealed watertight.

(b) Encapsulating the loop wires in fibreglass. The loop is prefabricated on a frame and then wrapped with fibreglass fabric and treated with resin.

(c) Installing loop wires in a precast concrete slab of about 1,2 m square and 200 mm deep. An oversize hole is made in the pavement and the precast slab is installed with concrete backfill.

3 The slot for the prefabricated loop is made by making two saw cuts and chiselling out material between the two cuts.

20.6 BIBLIOGRAPHY

1 Institute of Transportation Engineers, 1997, Traffic detector handbook, Washington DC.

2 Institute of Transportation Engineers, 1985, Traffic detector field manual, Washington DC.

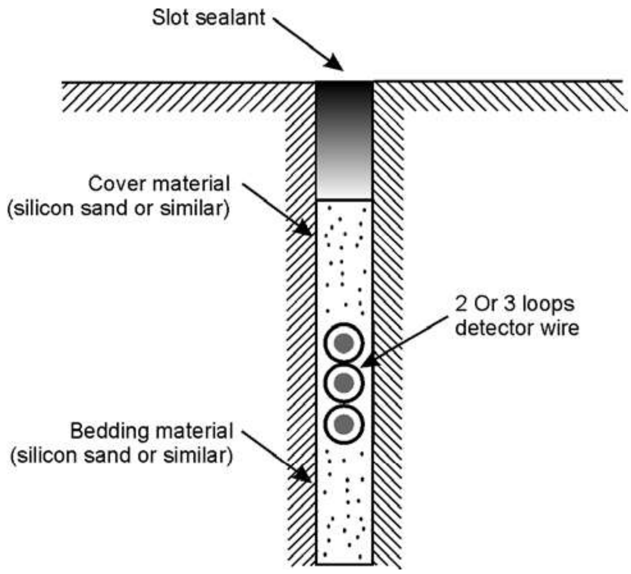

Figure 20.2: Inductive loop wire slot cut into the road surface