

5.5 OTHER MARKINGS

5.5.1 Diagonal and chevron markings

5.5.1.1 General

Wide diagonal or chevron markings may be applied to areas of pavement which are not intended for use by moving vehicles.

They define splayed island approaches to obstructions, sealed shoulders, painted islands and medians and areas separating exit ramps from the main freeway traffic lanes (see Clause 5.7.2). They are also used to indicate escape areas, if required.

Diagonal markings are used when all traffic must pass to one side of the marking, and chevron markings when traffic may pass to either side of the marking.

5.5.1.2 Markings on splayed approaches

The markings of splayed approaches to islands or obstructions shall be parallel bars or chevrons as shown in Figure 5.4(a) and (b).

The bars shall be a minimum of 1.0 m wide measured normal to the bar with a gap between bars measured parallel to the road centre line of three to five times the width of the bar.

The angle between the bars or chevrons and the approach line should be 45 degrees maximum. On approaches where the 85th percentile speed is 90 km/h or greater, the angle may be reduced to 30 degrees (i.e. 60 degrees included angle between sides of a chevron).

The outline should be supplemented by raised pavement markers, especially where street lighting is below standard or absent.

5.5.1.3 Diagonal markings on shoulders

If a marking on sections of sealed shoulder is required to discourage vehicular encroachment, it shall comprise bars having a minimum width of 1.0 m measured normal to the marking and between 5 m and 20 m apart, measured parallel to the road centre-line (see Figure 5.5).

5.5.1.4 Painted islands and median strips

Painted islands and median strips shall be defined by outlining areas of pavement with lines. The interior may be either sealed with an aggregate of contrasting colour or texture, or consist of diagonal or chevron markings (see Figures 5.6 (a), (b) and (c)). The outline should be supplemented by raised pavement markers, especially where street lighting is substandard or absent.

Typical uses of painted islands include -

- (a) islands of substandard size in urban areas;
- (b) channelizing islands at rural intersections where operating speeds are high, or road lighting is absent or inadequate;
- (c) narrow medians;
- (d) part-time safety zones; and
- (e) narrow lane separators.

The island may be surrounded by double two-way barrier line if all crossing movements are to be prohibited.

The width and spacing of diagonal markings when used inside painted islands and median strips is shown in Figure 5.6.

5.5.2 Messages on pavements

5.5.2.1 General

Words, numerals and symbols may be marked on pavements to convey guiding, warning or regulatory messages to drivers. They shall be elongated in the direction of traffic movement to make them legible at the maximum distance.

NOTE: The benefit obtainable with increasing elongation diminishes if the distortion ratio exceeds about 8:1.

5.5.2.2 Words and numerals

The length of letters and numerals shall be 2.5 m where the speed limit is up to 80 km/h and 5.0 m at higher speed limits. The shape of letters and numerals shall be as shown in Figure 5.7.

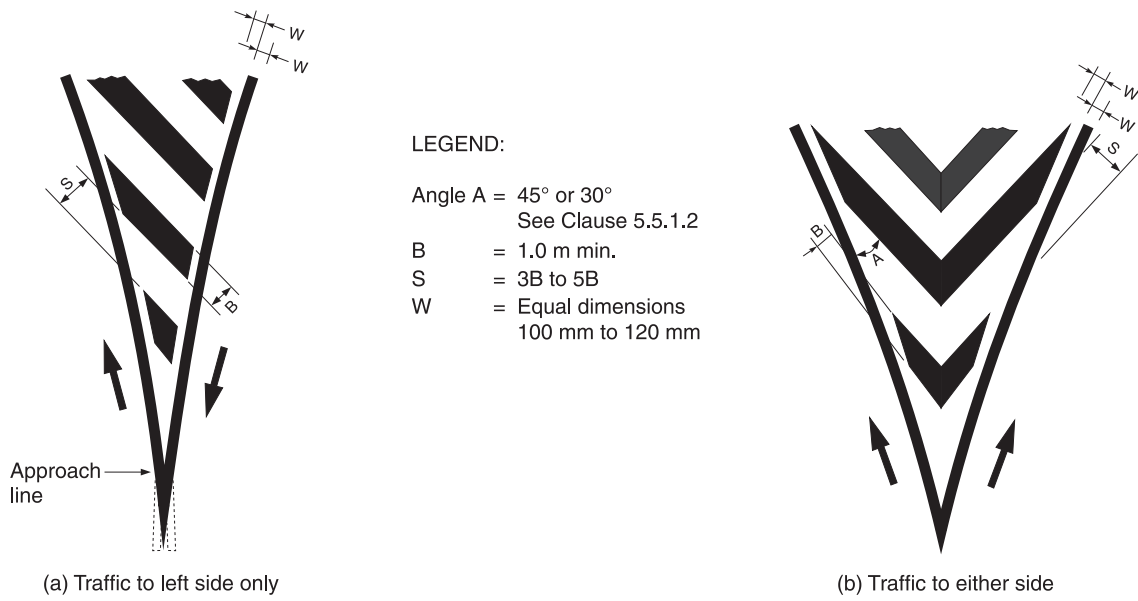


Figure 5.4 SPLAYED APPROACH

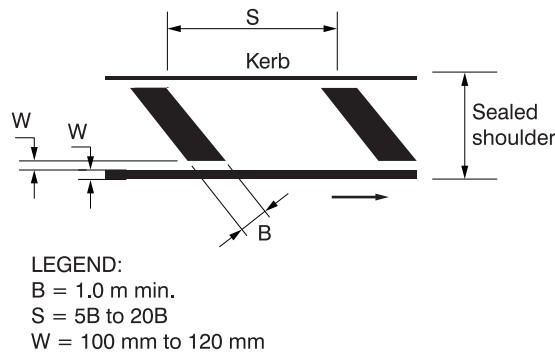


Figure 5.5 SHOULDERS

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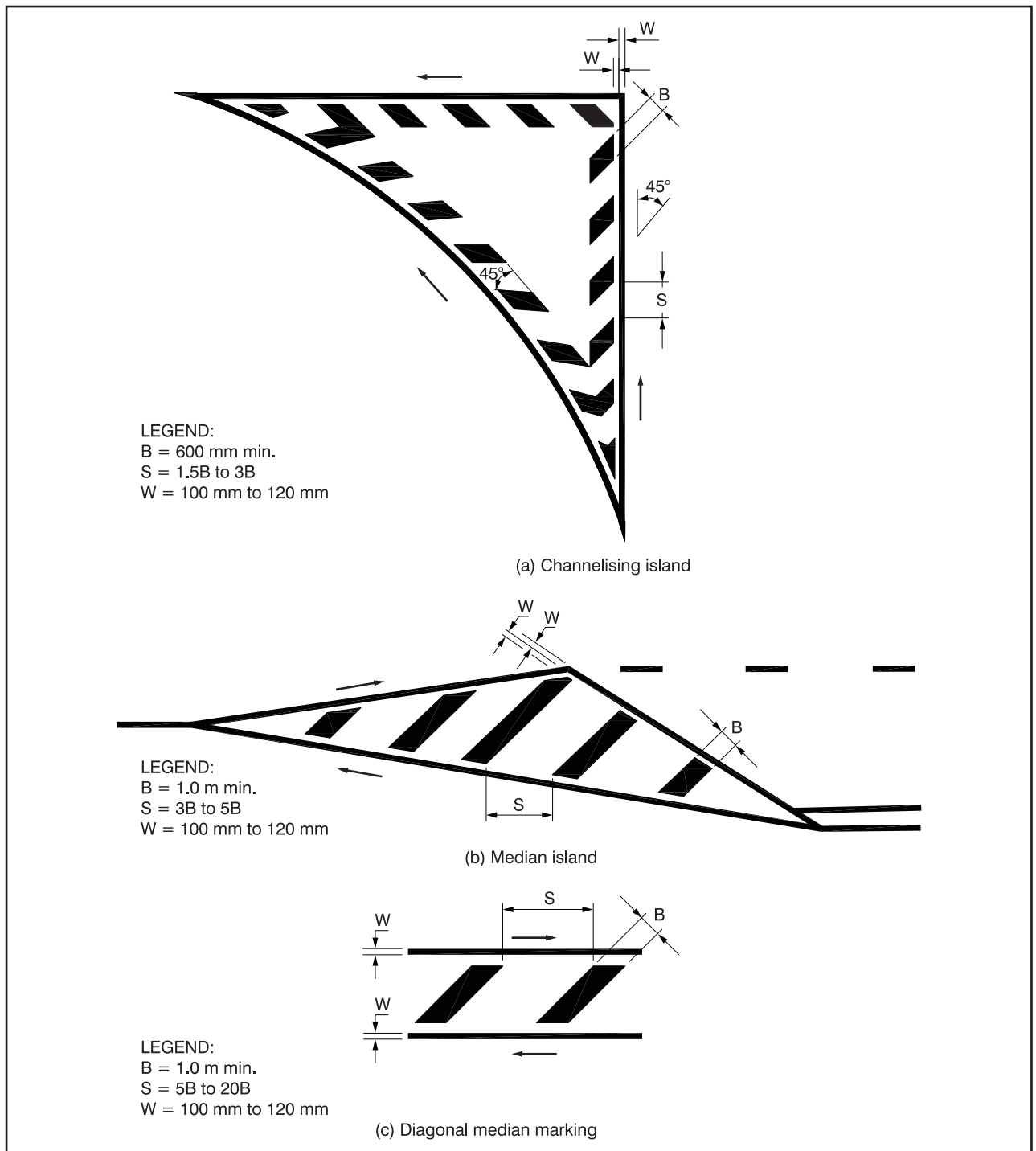


Figure 5.6 PAINTED ISLANDS AND MEDIAN STRIPS

A message should, if possible, be confined to one line. Where two or more lines are required they should be designed as follows:

- Where the 85th percentile speed is greater than 80 km/h, a separation of four times the character height shall be used, and the message arranged to read sequentially, i.e. with the first word nearest to the driver.
- At speeds lower than in Item (a), the separation between lines shall be from one-half to one times the character height and the message arranged to read from top to bottom.

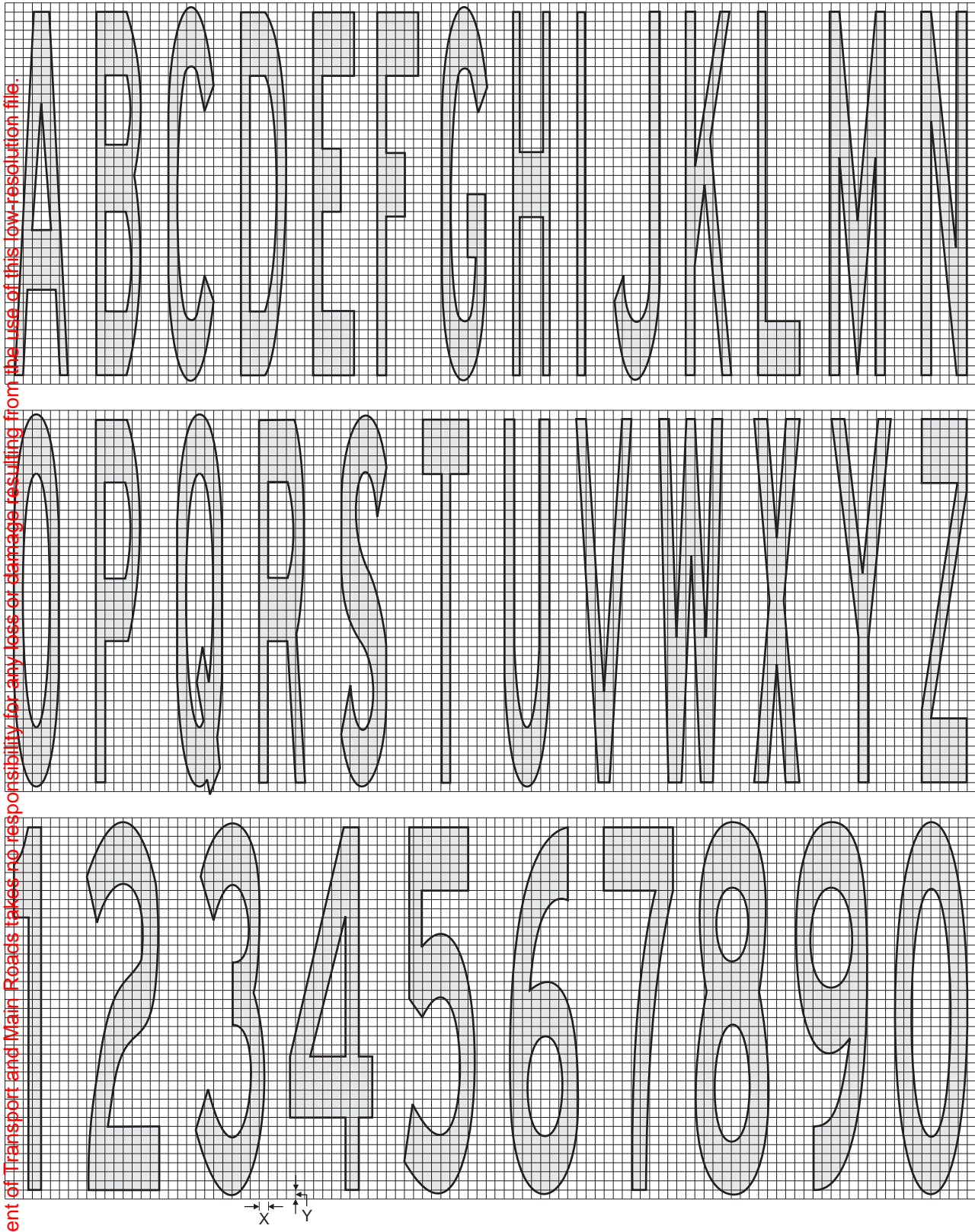
Word messages commonly used on road pavements are as follows:

BUS LANE and BL, TRANSIT LANE and TL - see Part 12

RAIL X - see Part 7

KEEP CLEAR - see Clause 4.5.2.6

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NOTES:
 The grid width X is constant at 100 mm, but the grid height Y may vary as follows:
 Y = 62.5 mm where the speed limit is up to 80 km/h;
 Y = 125 mm at higher speed limits

Figure 5.7 PAVEMENT LETTERS AND NUMERALS

5.5.2.3 Intersection arrows

Intersection pavement arrows give a positive indication of the paths vehicles must follow at intersections. They are legally enforceable. The choice of and need for intersection pavement arrow markings shall be determined as set out in Figure 5.9. This is based on the following requirements:

- (a) Where all the manoeuvres that are permitted by traffic legislation are to be allowed from a marked traffic lane, arrow markings need not be provided.
- (b) If all the manoeuvres that are permitted by traffic legislation are not to be allowed from a marked traffic lane, those manoeuvres which are to be allowed shall be marked with pavement arrows.
- (c) Where any arrow is required in a lane, all manoeuvres that are to be permitted from that lane shall be marked with pavement arrows.
- (d) Notwithstanding the provisions in Item (a) where it is considered desirable for safety or other considerations to mark arrows indicating the legally permitted manoeuvres from that lane, e.g. to emphasize that a turn is not permitted from a lane adjacent to an exclusive right turn lane by marking with a straight ahead arrow, these arrow markings may be provided. However, such markings should be restricted to those found to be necessary after observance of performance in the field.

Pavement arrows shall be marked in each lane of a multi-lane approach to a roundabout with two or more lanes to indicate the movements permitted from each lane.

If a lane on the approach to an intersection or roundabout is to be designated by means of arrows as above, arrows shall be placed in that lane as follows:

- (i) Arrow nearest a stop or give-way line - 6 m clear distance back from the line.
- (ii) Arrows in a through lane from upstream - at least two additional arrows at a head-to-head spacing of 15 m to 50 m.
- (iii) Arrows in a developed lane at least 36 m long (excluding taper) - at least two additional arrows, the first with its head at the point where the fully developed lane first begins and the second or subsequent arrows equispaced at 15 to 50 m head-to-head between the first and last arrows.
- (iv) Arrows in a developed lane less than 36 m long (excluding taper) - one additional arrow only or in a very short lanes, less than 20 m, no additional arrows, i.e. one arrow only in the lane.
- (v) Provision of a single arrow in accordance with Item (iv) shall comprise the one arrow nearest to the stop or give-way line only, 6 m clear distance back from the line.

At intersections where queues of vehicles are likely to occur, e.g. at traffic signals, pavement arrows should commence sufficiently in advance of the intersection so that waiting vehicles will not obscure them. Where this is not practicable, or where additional information for road users on lane designation (e.g. 'trap' lanes) is required, signs adjacent to or over the appropriate lanes should be installed to supplement the pavement arrows.

Where a turning lane is provided to cater exclusively for U-turns, and it is essential to distinguish it from a right turning lane before or after, the U-turn arrow may be used. If the distinction is not needed, a right turn arrow will usually be sufficient.

Where two separate successive turns in the same direction may be made from a single turning lane, the sequential turns arrow may be used in advance of the first turn. The use of this marking is the exception, rather than the rule.

Standard designs for pavement arrows shall be as shown in Figures 5.10 and 5.11. They are elongated similarly to letters or numerals in order to increase their recognition distance.

5.5.2.4 Lane change arrows

Lane change arrows shall be provided at lane reductions (merges) typically as illustrated in Figures 4.16, 4.18 and 4.20 in all situations where a lane change rather than a zip-merge is provided for, see Clause 4.7.2 and Figure 4.16.

Lane change arrows shall conform to the designs in Figure 5.12, the urban type to be used where the 85th percentile speed is 80 km/h or less, and the rural type where it is more than 80 km/h.

Three arrows shall be used in each case. They shall be equispaced between the advance merge sign and the start of the lane change taper.

Lane change arrows shall not be used in the zip-merge case described in Clause 4.7.2(a).

5.5.2.5 Expressway exit lane arrows

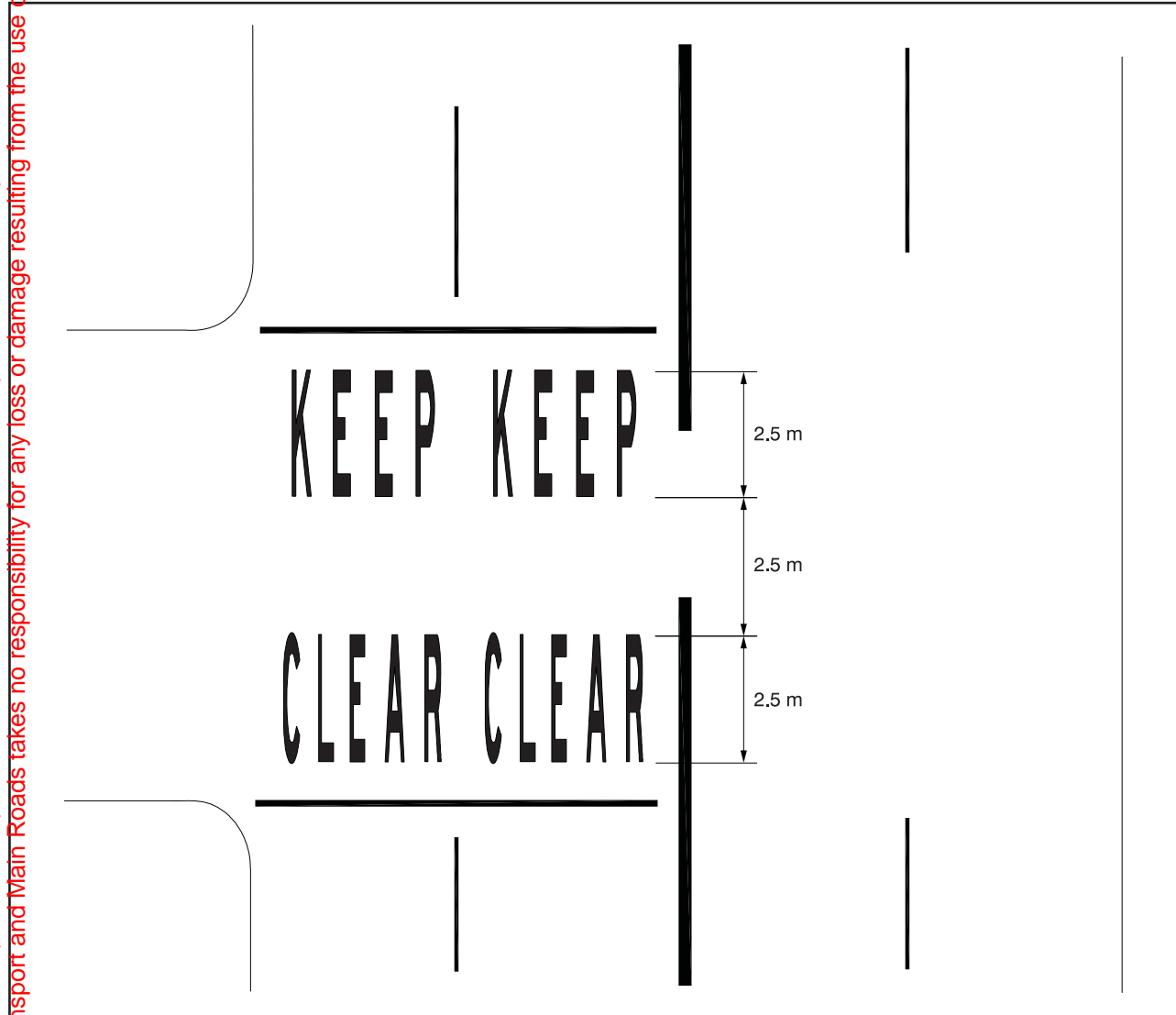
The use of the exit lane arrows shown in Figure 5.13 is specified in Clause 5.7.3. Their use is further illustrated in Figure 3.4.

5.5.2.6 Keep clear marking

A keep clear marking as shown in Figure 4.8 when used to control the blocking of entrances and exits at side streets or property access points by queued traffic, shall only be used in the following situations:

- (a) To allow emergency vehicle access from its depot or station.
- (b) Where a blockage would create a safety problem elsewhere in the system, e.g. vehicles stopping to turn right into a driveway causing a blockage at a nearby intersection.

The marking shall not be used primarily for the purpose of facilitating access/egress to a side street or driveway.



NOTE: A single message covering two lanes may be adequate. The words may be made wider to suit.

Figure 5.8 KEEP CLEAR MARKING

5.5.3 Kerb markings

Kerbs of medians and traffic islands may be marked white and reflectorised if added visibility is required.

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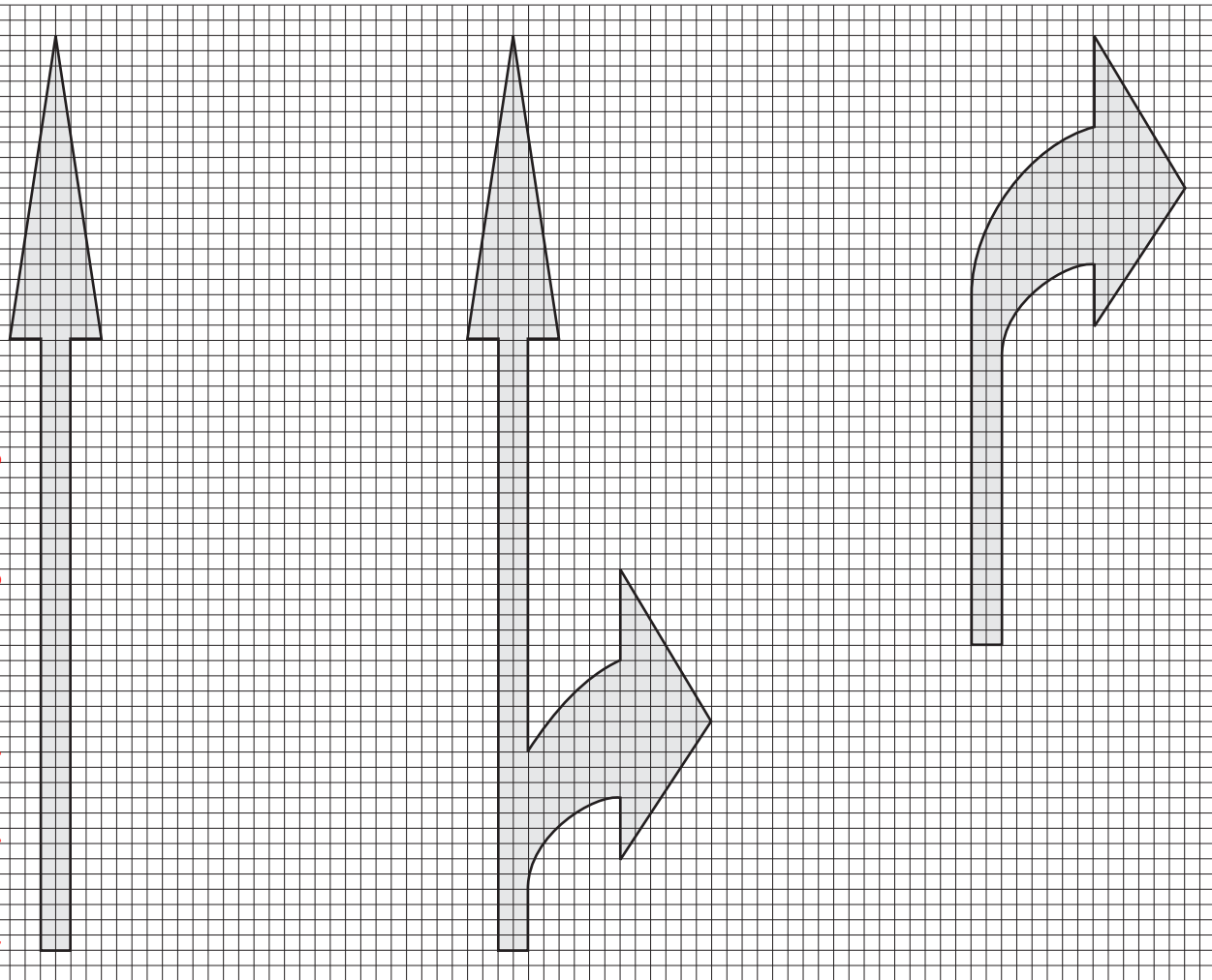
No	Description of requirements	Two lane	Three lane	Four lane
1	Legal manoeuvres if lane unmarked			
2	Legal manoeuvres if left lane only marked			
3	Legal manoeuvres if right lane only marked			
4	Markings for two exclusive left turn lanes			
5	Markings for two exclusive right turn lanes			
6	Markings for shared left turn and through from lane adjacent to left turn lane			
7	Markings for shared right turn and through from lane adjacent to right turn lane			
8	Markings for shared left turn and through from lane adjacent to two exclusive left turn lanes	NOT APPLICABLE		
9	Markings for shared right turn and through from lane adjacent to two exclusive right turn lanes	NOT APPLICABLE		
10	Markings to indicate left turn prohibition (signing also required, see Clause 2.8.2)			
11	Markings to indicate right turn prohibition (signing also required, see Clause 2.8.2)			

NOTES:

- 1 Full lines indicate arrows to be marked.
- 2 Dotted lines indicate manoeuvres which are permitted by regulations but which need not be marked.
- 3 On some intersection approaches, it may be necessary to combine two or more of the marking methods shown.

Figure 5.9 USE OF INTERSECTION PAVEMENT ARROWS

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(a) Straight ahead

(b) Combination - straight ahead and turn

(c) Exclusive turn

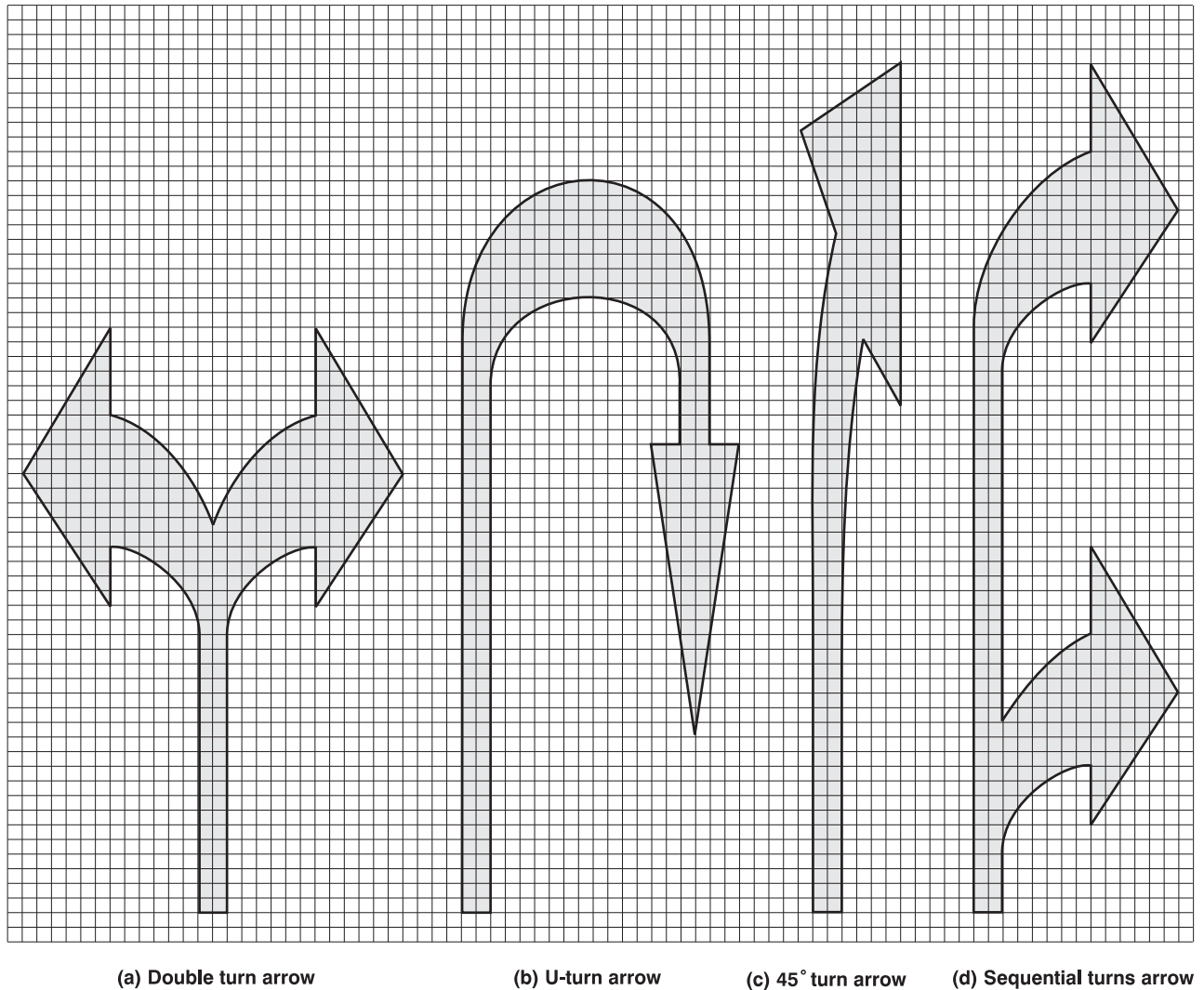
NOTES:

Minimum length of arrow:

- (a) Straight ahead arrow and combined arrow = 6 m.
- (b) Turn arrow = 4 m.

The width of grid squares is constant at 100 mm. The height of the grid squares is 100 mm minimum.

Figure 5.10 INTERSECTION PAVEMENT ARROWS – COMMON TYPES



NOTES:

- 1 Minimum length of arrow:
 - (a) Double turn arrow = 4 m.
 - (b) U-turn arrow = 5 m.
 - (c) Sequential turns and 45° turn arrows = 6 m.
- 2 The width of grid squares is constant at 100 mm. The height of the grid squares is 100 mm minimum.

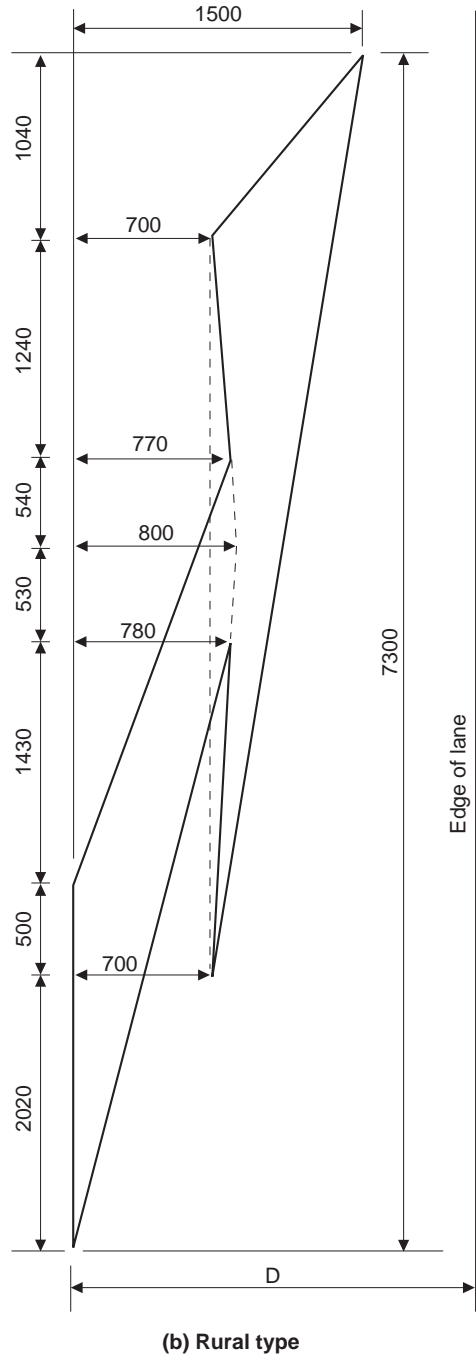
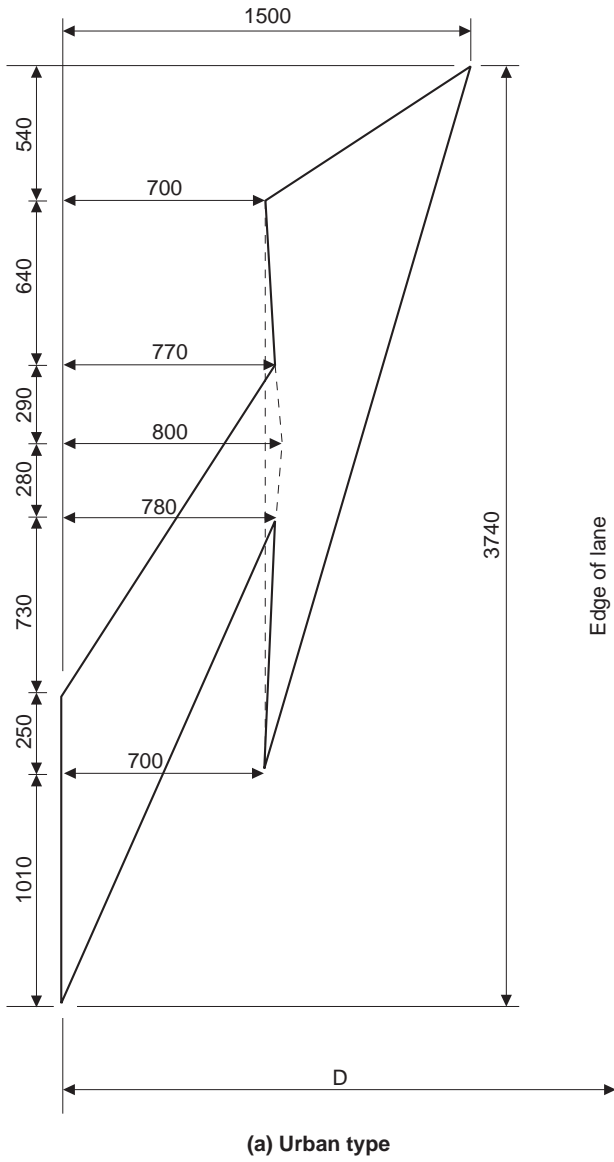
Figure 5.11 INTERSECTION PAVEMENT ARROWS – SPECIAL TYPES

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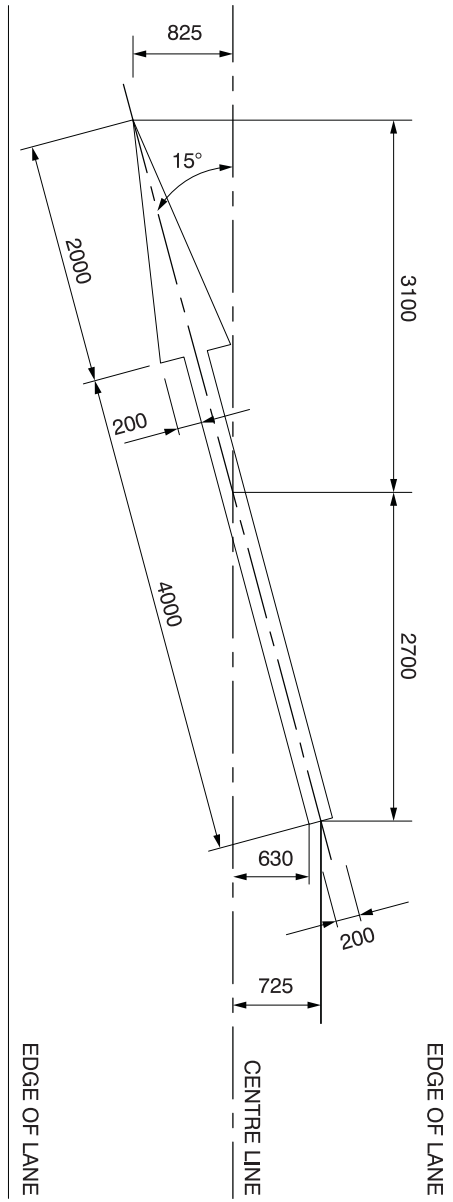
NOTES:

Dimension D should be approximately 0.6 times the width of the lane.

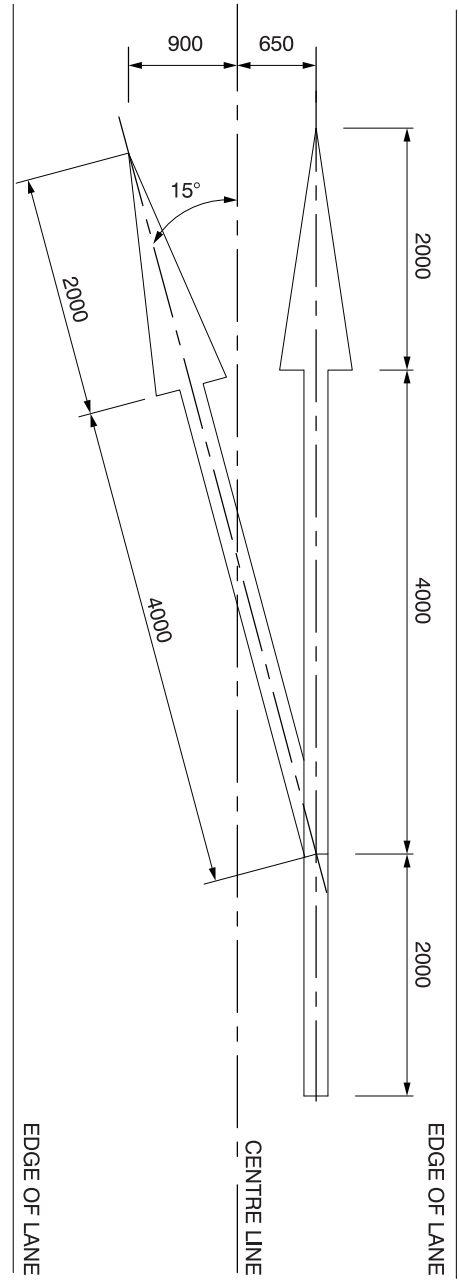
When installing arrows it is recommended that the head be laid first.

DIMENSIONS IN MILLIMETRES

Figure 5.12 MERGE PAVEMENT ARROWS



(a) Exclusive (trap) lane



(b) Shared through and exit lane

DIMENSIONS IN MILLIMETRES

Figure 5.13 EXPRESSWAY EXIT LANE ARROWS

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5.6 RAISED PAVEMENT MARKERS

5.6.1 General

Raised pavement markers are of the following types:

- (a) Retroreflective raised pavement markers (RRPM), see Clause 5.6.2.
- (b) Non-retroreflective raised pavement markers (NRPM), see Clause 5.6.3.
- (c) Internally illuminated pavement markers, see Clause 5.6.4.

Symbols used on plans to represent raised pavement markers are given in Table 5.4.

5.6.2 Retroreflective raised pavement markers (RRPM)

RRPMs are used to augment painted lines, stripes and chevrons when it is deemed necessary or desirable to improve their visual properties. As devices which are considered to be at same level as the road surface RRPMs are intended to be trafficable when placed within a painted island or median strip.

RRPMs generally provide more effective and durable pavement markings than painted lines because -

- (i) they are not generally obscured at night under wet conditions;
- (ii) they provide an audible and tactile signal when traversed by vehicle wheels; and
- (iii) they are conspicuous in all conditions.

Physical and performance requirements for pavement markers are specified in AS 1906.3.

In deciding whether to use markers, the following factors should be taken into account:

- (i) Operational effectiveness.
- (ii) Ease of installation.
- (iii) Self-cleansing properties under traffic.
- (iv) Effects of noise in or near residential areas.

The colour specified for RRPMs in various usages is shown in Table 5.3.

RRPMs shall not be displayed towards oncoming traffic on the right-hand edge lines on undivided roads.

5.6.3 Non-retroreflective raised pavement markers (NRPMs)

NRPMs shall be white. Their use in moving traffic situations is confined to lane guidance through intersections, see Clause 5.6.5.4.

5.6.4 Internally illuminated

The application of internally illuminated raised pavement markers in respect of colour, positioning and spacing shall be the same as for RRPMs. If used in a continuously operating mode they shall also have retroreflective elements meeting the photometric requirements of AS 1906.3. If used in a switching mode they shall not be retroreflective. The markers shall not be used in a flashing mode.

NOTE: Users should satisfy themselves that the photometric performance of the selfilluminating feature of such devices is adequate for their purposes.








Table 5.3 COLOUR OF RETROREFLECTIVE RAISED PAVEMENT MARKERS TO AUGMENT PAINTED LINES

Application	RRPM colour
Dividing lines	Yellow
Lane lines	White
Right hand edge line, divided road and one-way road	Yellow
Left hand edge line, divided road and one-way road	Red
Left hand edge line, 2-way road	Red
Small* channelizing island outline, painted or raised – all sides	White
Median island outline, painted or raised – all sides	Yellow
Roadway diverge outline, including expressway exit nose, and approach end of large island	
- left† side	Yellow
- right† side	Red
Step-out markings at expressway exit ramps	Green

* A small island should generally be regarded as one with no side, including approach and departure markings, longer than 12 metres.

† Left or right when viewed in the direction of travel.

Table 5.4 SYMBOLS FOR RAISED PAVEMENT MARKERS

Marker or term	Symbol
Non-retroreflective raised pavement marker	
Retroreflective raised pavement marker:	
Unidirectional – White	
- Yellow	
- Red	
- Green	
Bidirectional – White	
- Yellow	

5.6.5 Application of raised pavement markers

5.6.5.1 Positioning of markers

Markers are generally located in gaps in the painted broken lines. The gap for placing markers should be sufficient to accommodate a margin for error in remarking operations.

For applications with continuous lines such as barrier lines and traffic islands, the marker shall be placed 25 mm to 50 mm from the line as shown in Figure 5.14.

On sharp curves, RRPMS augmenting painted edge lines, lane lines and painted median/island approaches shall be orientated so that the full retro-reflective effect is realized on approach. This is achieved by aiming the reflective face in the direction of approaching traffic rather than tangentially to the curve.

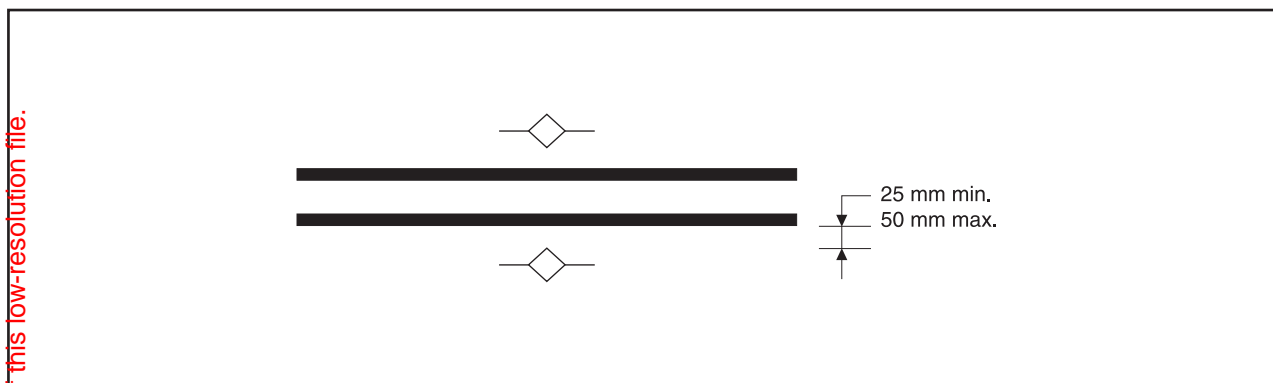


Figure 5.14 LATERAL PLACEMENT OF RRPMS

5.6.5.2 Augmenting painted lines

The use of RRPMS in augmenting pavement markings shall be as illustrated in Figures 5.15 to 5.26. The positioning of RRPMS in relation to the painted lines, is specified in Clause 5.6.5.1.

The normal spacing between RRPMS, dimension N shown on the following treatment diagrams, is the distance indicated in Table 5.5 for the particular situation.

Table 4.5 NORMAL SPACING (N) BETWEEN RRPMS

Situation	Dimension N, m
Unlit roads generally, lane lines and dividing lines	24
Substandard curves or curves 400 m radius or less	12
Dividing (barrier) lines on approaches to median ends	
Roads with street lighting meeting AS 1158.1.1 (except that 24 m spacing for lane lines may be sufficient in many cases)	
Short length of special purpose dividing or lane line, exit lines at roundabouts	
Dividing lines on all multilane undivided roads	4 min, 12 max*
Lines outlining traffic islands, median and separator ends, and other devices	
Markers on edge lines including outlines of painted median strips and separators	24 preferred, 36 max
Dividing and lane lines on intersection approaches (minimum – one and marker at each end of the line)	12

* Shown on Figures 4.22 to 4.24 and 4.26 at the preferred dimension, 6 m.

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(a) Lane lines

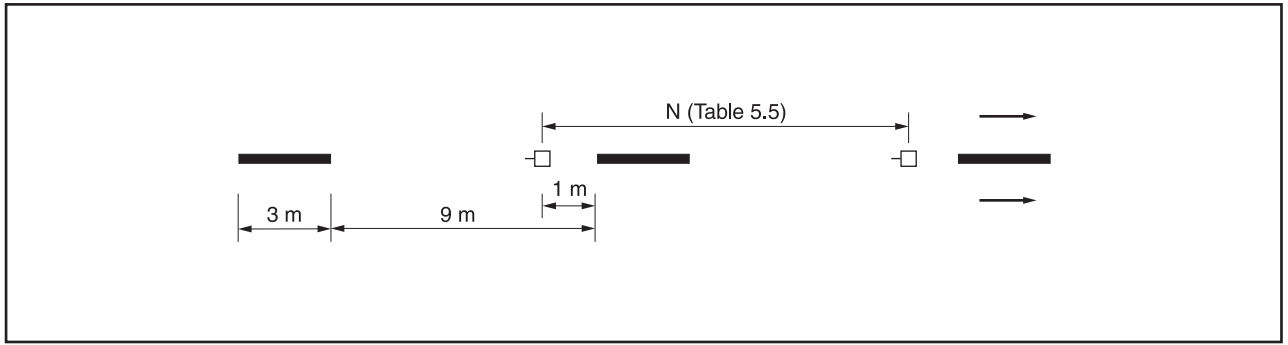


Figure 5.15 BROKEN LANE LINES

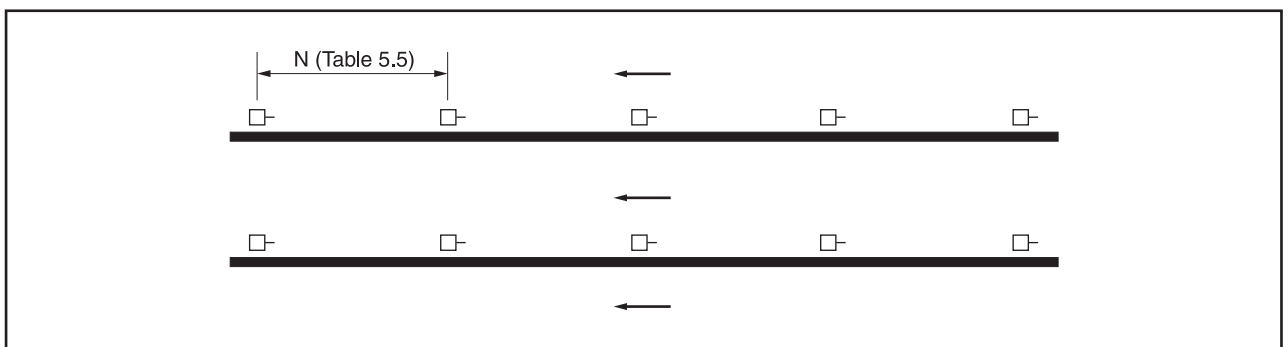


Figure 5.16 CONTINUOUS LANE LINES

(b) Dividing lines

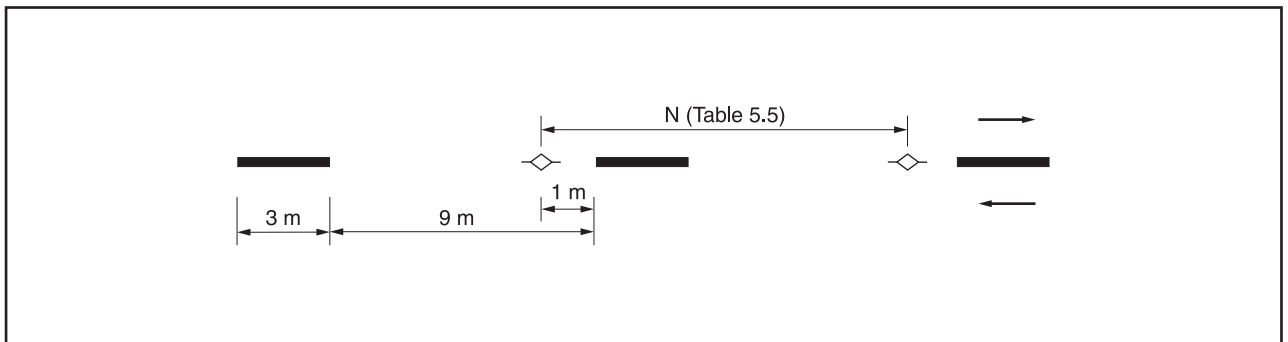


Figure 5.17 BROKEN DIVIDING LINE

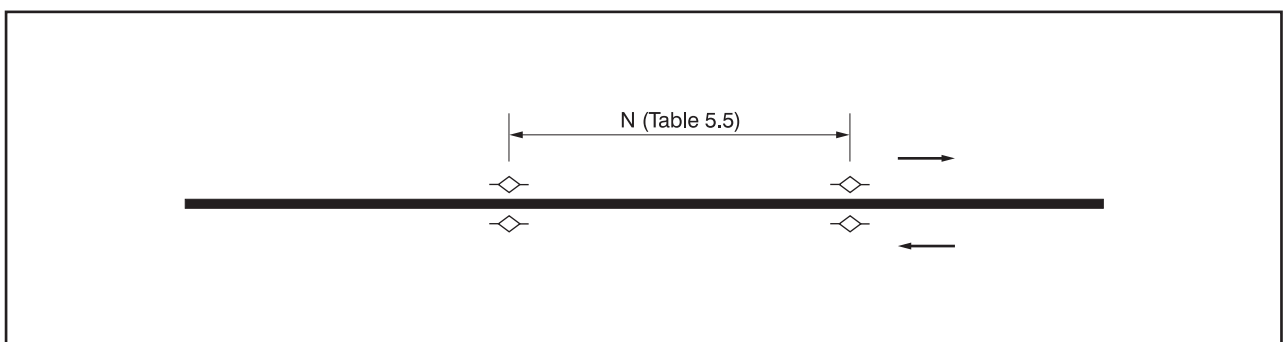


Figure 5.18 CONTINUOUS DIVIDING LINE

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(c) Barrier lines

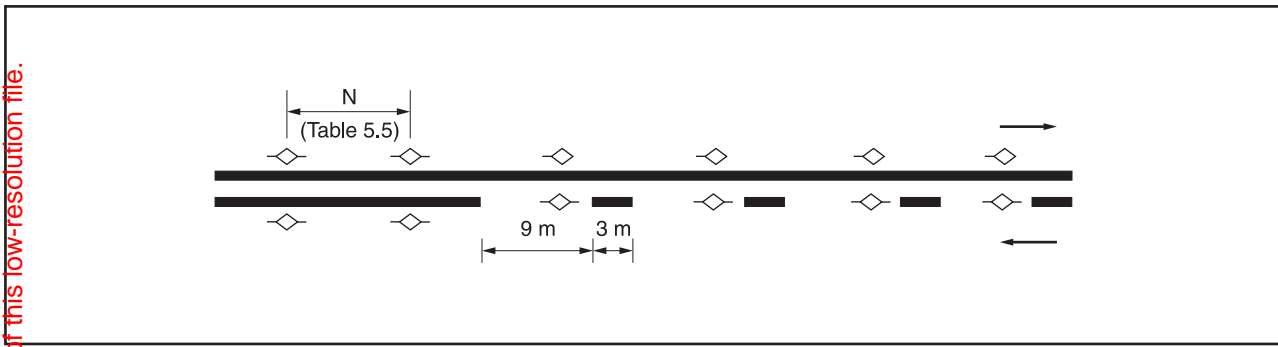


Figure 5.19 BARRIER LINES

(d) Edge lines

Except on single lane roadways, e.g. freeway ramps, RRPMs shall not be used to supplement edge lines unless they are also used, at the same location, to supplement dividing, barrier or lane lines (see Figure 5.20). They should not generally be used on edge lines where the shoulder is not sealed as they are likely to be removed or covered in grading operations, but if used they should be placed inside the edge line. Provision of RRPMs on edge lines on rural roads is optional but important in locations subject to fog or other adverse visibility conditions, or at points of special hazard, e.g. approaches to bridges with sub-standard shoulder width (see Figure 5.21).

RRPMs should generally be placed outside the painted line to prolong their effective life and to increase the apparent lane width.

NOTE: The preferred spacing on edge lines is 24 m and the maximum, 36 m (see Table 5.5).

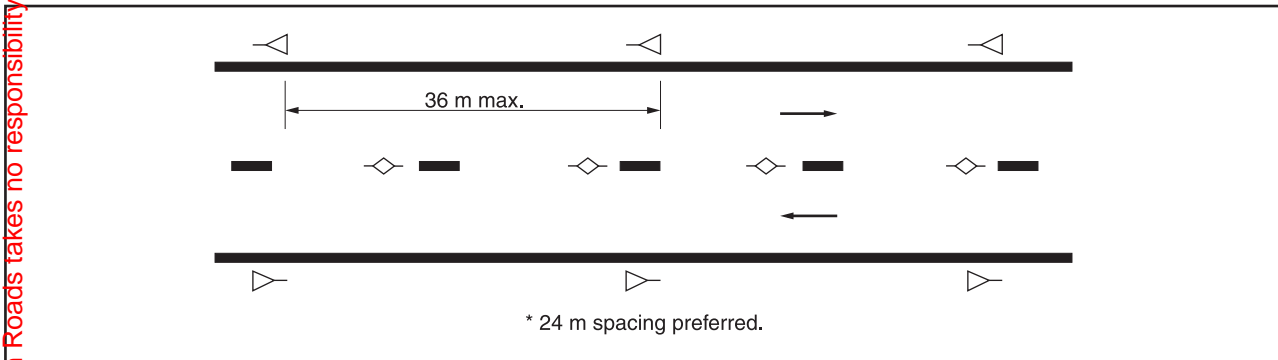
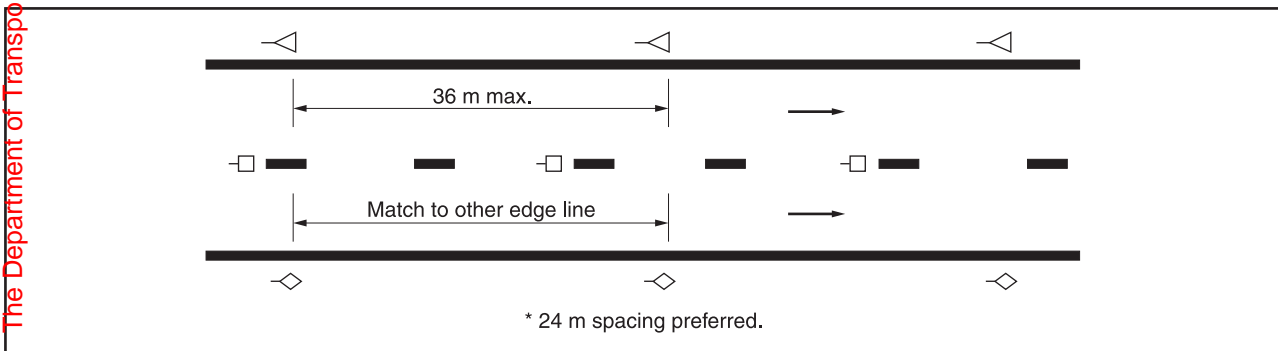


Figure 5.20 EDGE LINES ON A TWO-LANE TWO-WAY ROAD



NOTE: RRPMs are only used on rural divided roads as indicated in Clauses 5.6.5.2(d).

Figure 5.21 EDGE LINES ON A MULTILANE ONE-WAY ROADWAY

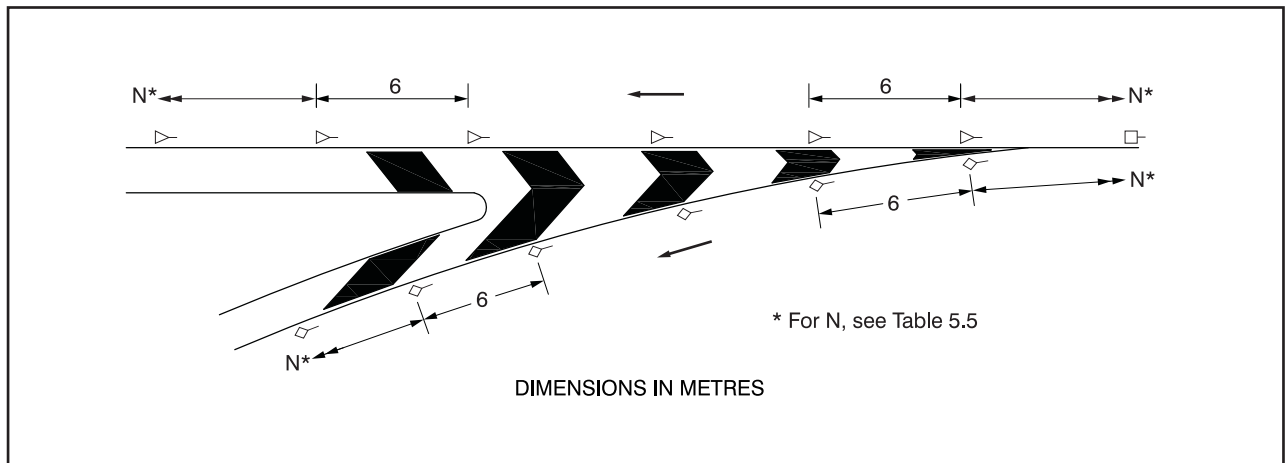
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(e) *Continuity lines*

RRPMs should not be used on continuity lines, as they may inhibit rather than encourage the correct lane-changing manoeuvre. However they may be required if the line is on a curve or is of excessive length such as along a weaving section, and extra delineation of the lane-change area is needed. The spacing in this case shall be 24 m.

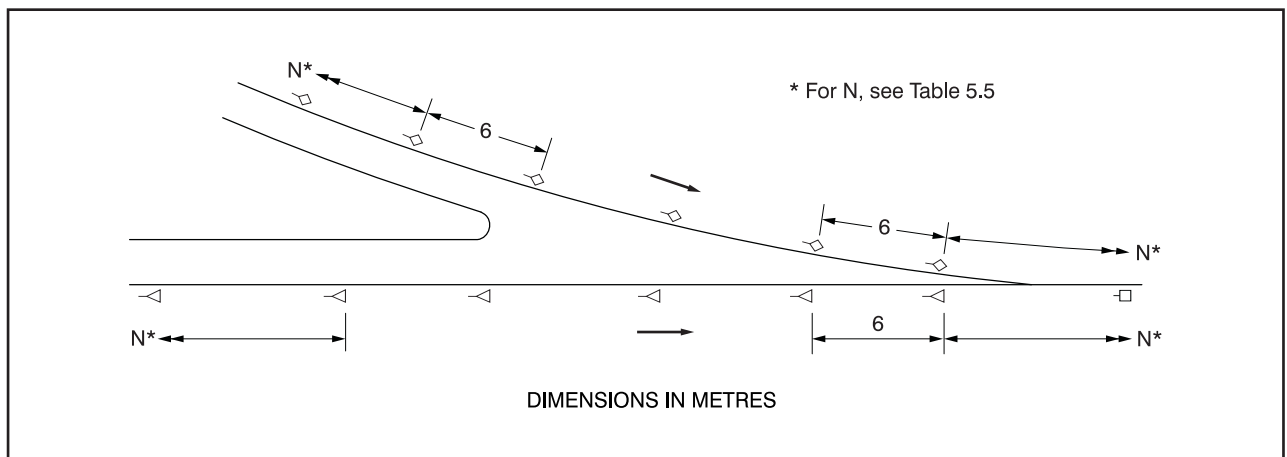
(f) *Traffic islands, medians and other devices*

The configurations shown are intended to illustrate the use of RRPMs only and should not be taken as a guide to the lengths or sizes of the facilities described.



NOTE: Spacing shown is indicative only.

Figure 5.22 LARGE RAISED OR UNPAVED TRAFFIC ISLAND WITH DIVERGING TRAFFIC

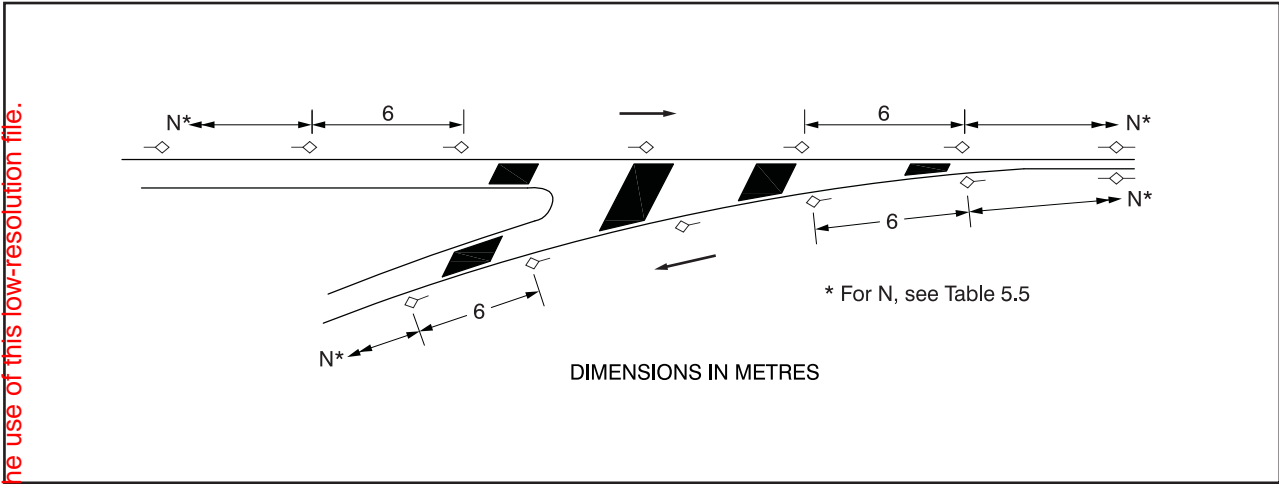


NOTE: Spacing shown is indicative only.

Figure 5.23 LARGE RAISED OR UNPAVED TRAFFIC ISLAND WITH SUBSEQUENT MERGE

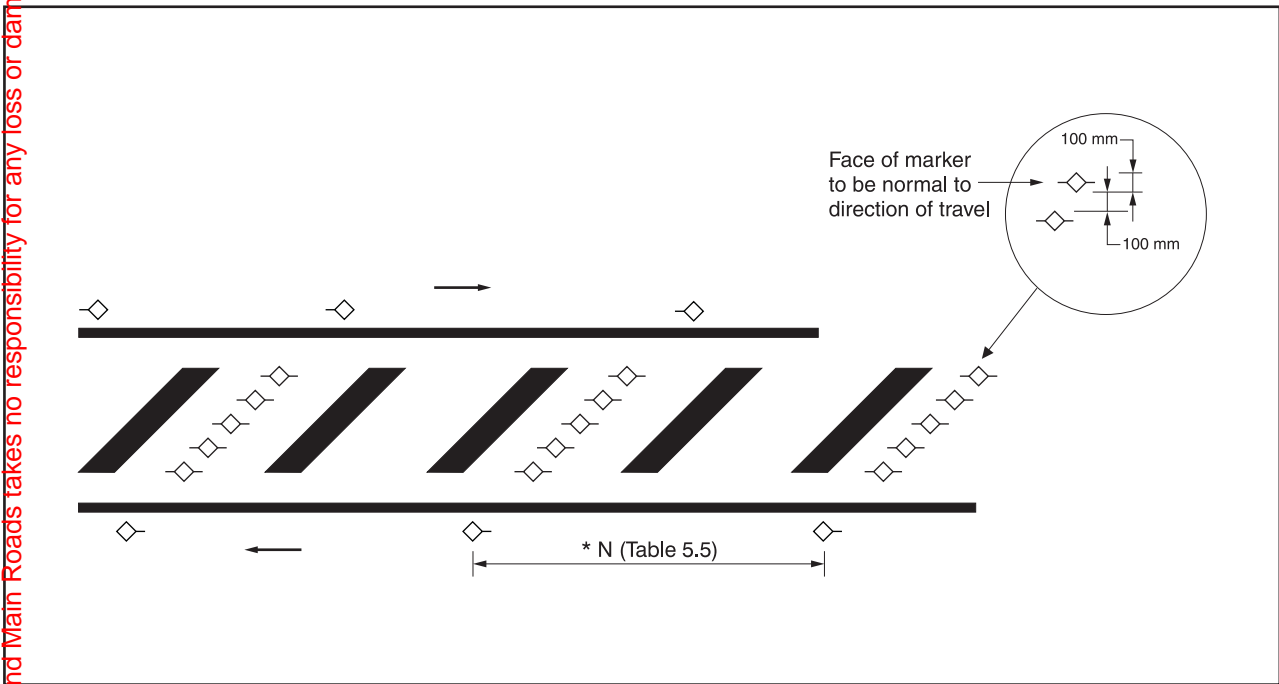
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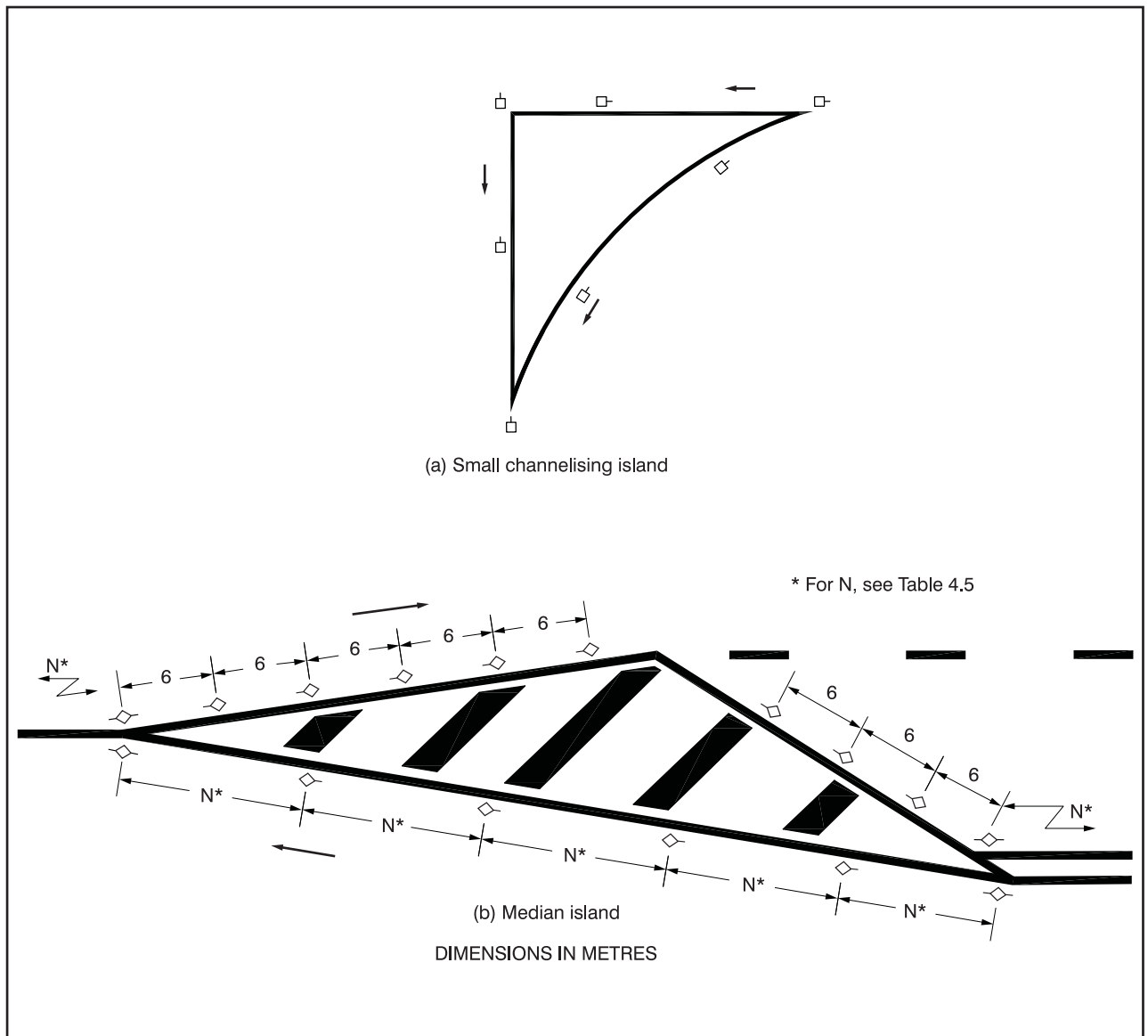
NOTE: Spacing shown is indicative only.

Figure 5.24 APPROACH TO (OR DEPARTURE FROM) MEDIAN ISLAND (TWO-WAY FLOW)



NOTE: Diagonal rows of RRPMs within the marked median are intended to be additional to the RRPMs on the outlines.

Figure 5.25 PAINTED MEDIAN STRIPS



NOTES:

- 1 For small islands, a minimum of two RRPMs should be visible on any one edge.
- 2 The spacing may be adjusted to allow even gaps between RRPMs.

Figure 5.26 PAINTED ISLANDS**5.6.5.4 Lane guidance through intersections**

A treatment of the type illustrated in Figure 5.27 comprising the placement of NRPMs within an intersection to guide non-turning traffic may be considered where it is apparent that such traffic would have difficulty in finding the correct lane on the departure side. The treatment is normally applicable only to wide signalised intersections on multilane roads. Typical situations where the treatment may be required are:

- (a) lanes on opposite sides of the intersection offset by half a lane width or more, e.g. the north-south leg of Figure 5.27;
- (b) drivers required to steer a curved course through the intersection, e.g. the east-west leg of Figure 5.27;
- (c) highly skewed intersections where the travel distance within the intersection is excessive; or
- (d) other features such as tram lines or adverse vertical geometry which may make the course difficult to follow.

Where applied, the treatment shall be completed for all through lanes on all legs even though the problem may exist for one intersecting road only. Markers should normally be omitted from within the area bounded by turn lines when these are marked, but may be required if inadequate, confusing or incorrect guidance would result, for example, where a curved path is to be followed.

It is essential that these treatments be maintained at a high level so that confusing patterns will not be created by an excessive number of missing markers. The expected high cost of maintenance should be taken into account when considering the need for treatment.

As an alternative to NRPMs, short dashes of thermoplastic material may be used, provided they are at least as visible as NRPMs under all viewing conditions.

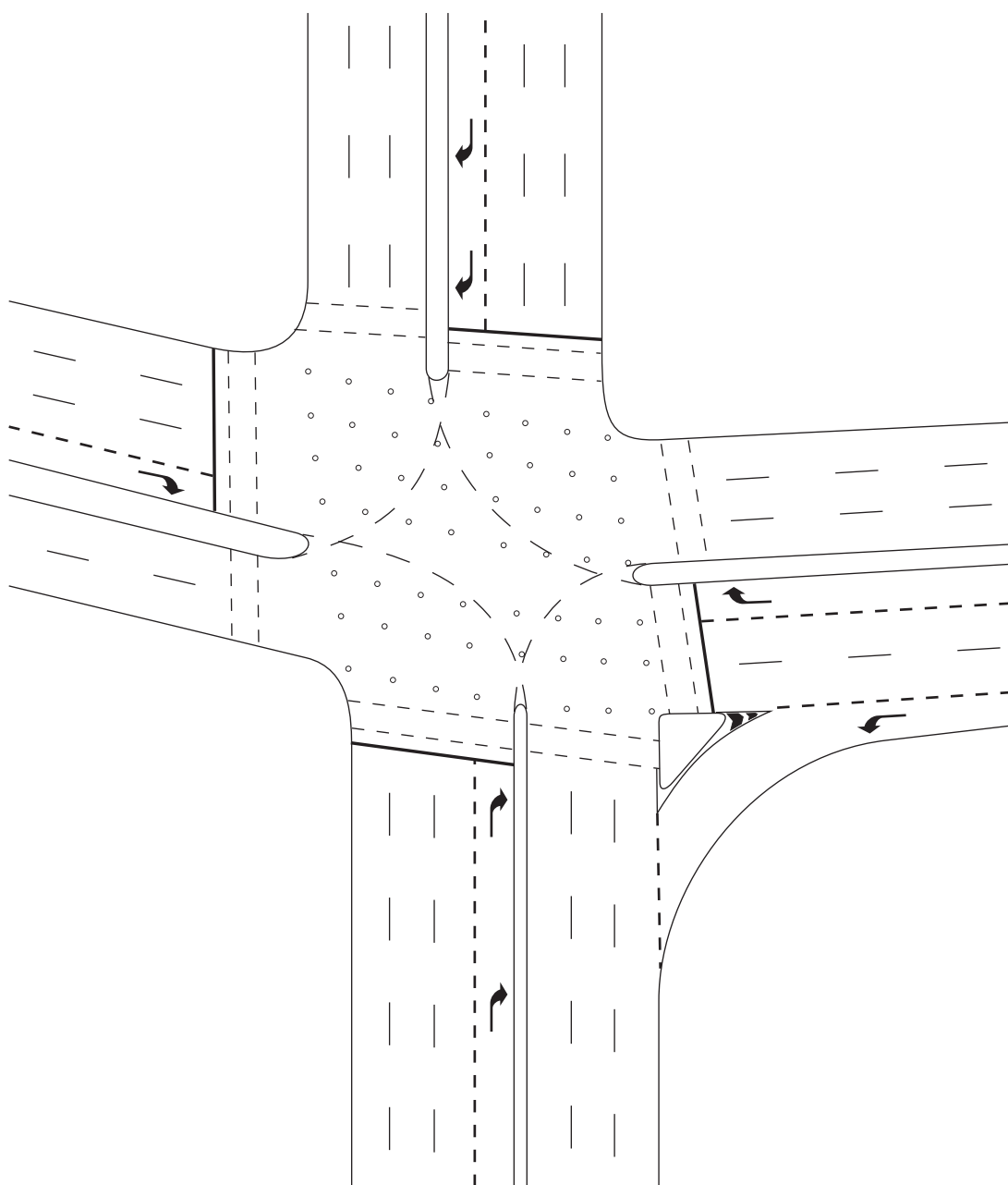


Figure 5.27 LANE GUIDANCE THROUGH INTERSECTIONS USING NRPMs

5.7 PAVEMENT MARKINGS AT ENTRANCE AND EXIT RAMPS

5.7.1 Entrance and exit ramp layouts

Examples of pavement markings at single lane entrances and exits are shown in Section 3, Figure 3.3 and at two lane exits in Figure 3.4.

5.7.2 Exit ramp nose marking

Exit ramp nose marking is illustrated in Figure 5.28.

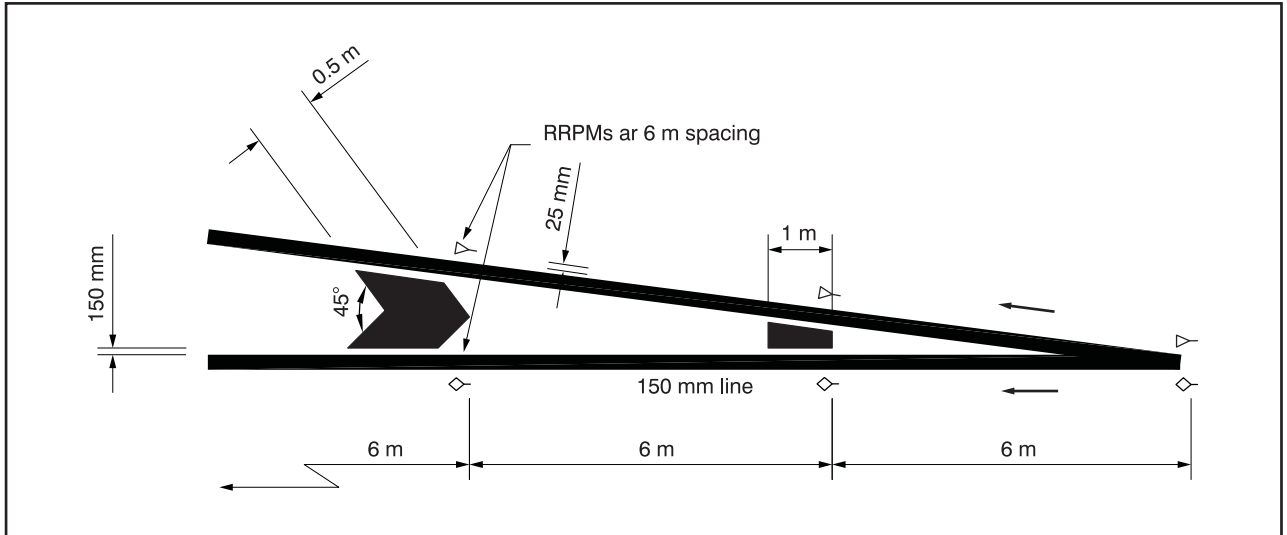


Figure 5.28 EXIT RAMP NOSE MARKING

5.7.3 Expressway exit lane arrows

Expressway exit lane arrows shall be used on main expressway roadways where there is a 'trap' lane which is one from which all traffic must exit. Because the indicated movement is such a small angular divergence from the through path, the use of conventional turn arrows is not recommended. Use of slightly inclined straight ahead arrows as illustrated in Figure 5.29 is preferred. The shape of these arrows is specified in Clause 5.5.2.5.

Where arrows are used in the trap lane, a combination arrow shall be placed in the next lane to the right, adjacent to each trap lane arrow, indicating that the second lane is a shared exit and through lane. The recommended spacing is 50 m head to head.

NOTE: For best visual effect the arrow inclination should not exceed 15°.

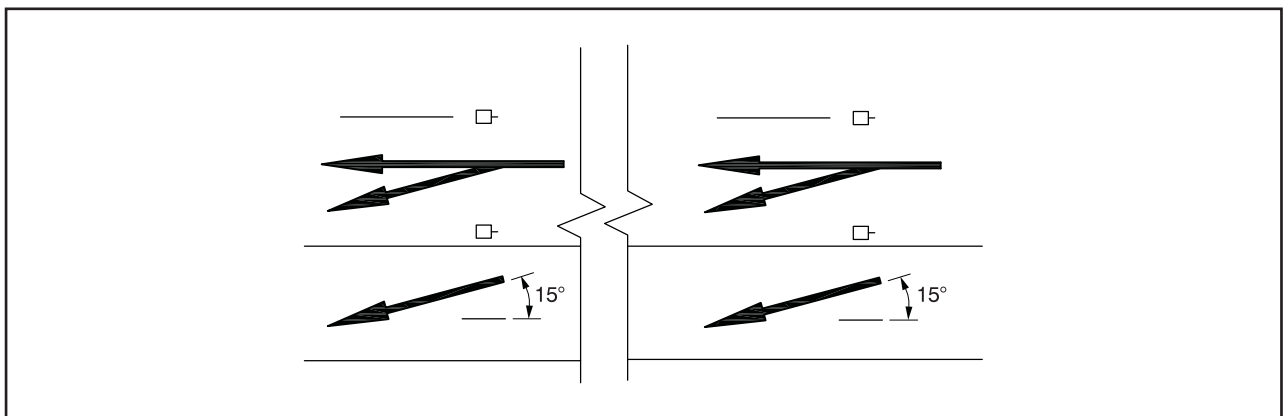


Figure 5.29 EXPRESSWAY EXIT LANE ARROWS IN A 'TRAP' LANE AND AN ADJACENT 'OPTIONAL' LANE

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5.7.4 Exit ramp marking

The marking shown in Figure 5.30 is the normal exit ramp marking. To delineate the approach to and entrance of an off-ramp, green uni-directional RRPMS are used in association with the edge line.

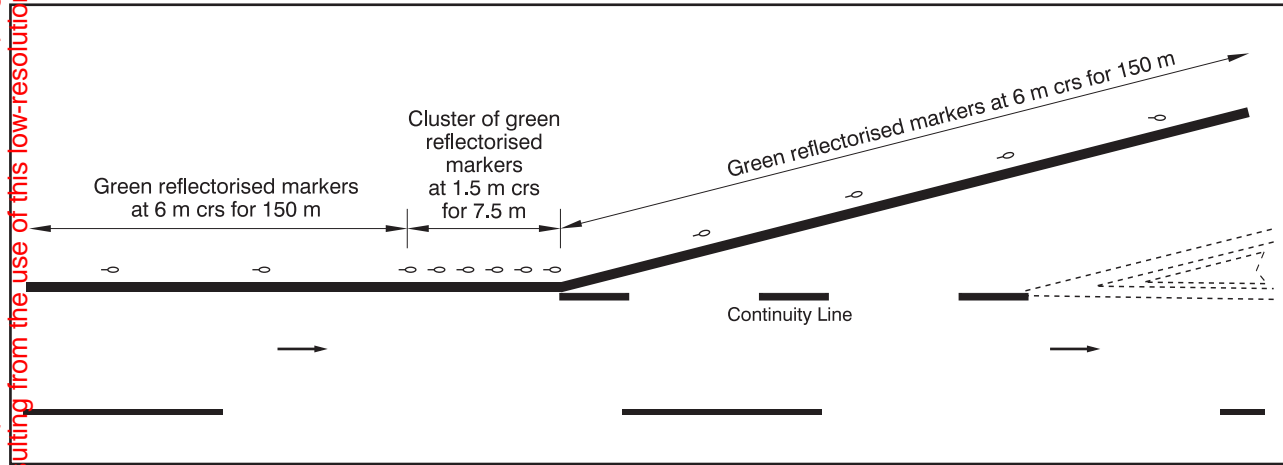


Figure 5.30 MARKING AT AN EXIT RAMP

5.7.5 'Step-out' marking

The step-out marking shown in Figure 5.31 is used as illustrated in Figure 3.3 as an alternative to the normal exit ramp marking if visibility to the pavement along the ramp taper is poor (e.g. at a crest or left hand curve) or there is evidence of drivers inadvertently taking the exit. Green RRPMS may be used with step-out markings as illustrated.

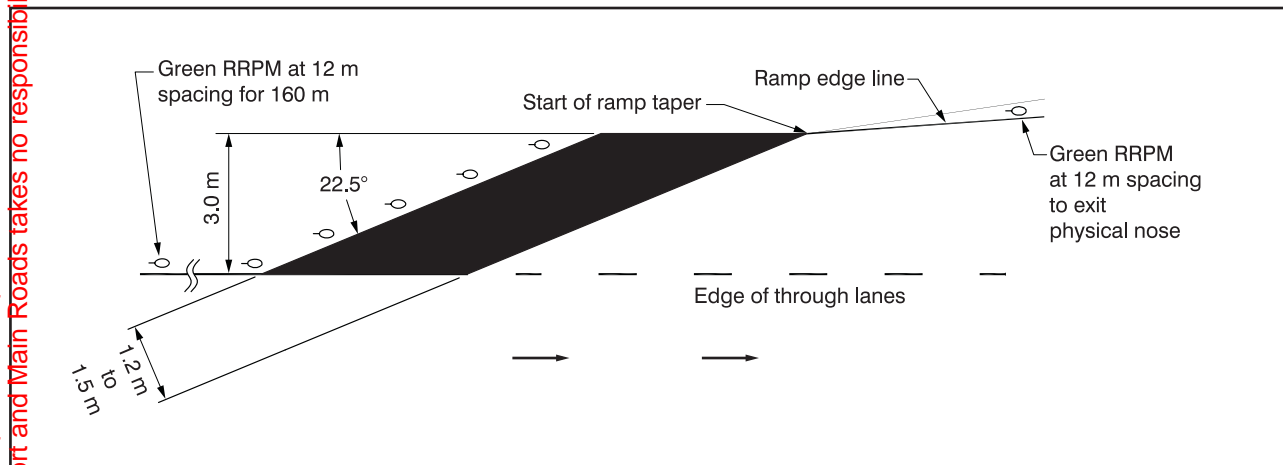


Figure 5.31 STEP-OUT MARKING AT AN EXIT RAMP

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APPENDIX A

USE OF FLASHING LIGHTS WITH WARNING SIGNS

Warning signs which, because of the extreme severity of the hazard to which they refer or lack of adequate sight distance to the hazard, or a combination of the two, need to attract special attention, may be augmented with flashing lights.

Assemblies typically comprise a diamond shaped warning sign on a yellow rectangular background, with two alternately flashing yellow lights located above the sign, generally as illustrated in Figure A1(b). Any supplementary plate in the W8 series normally used in conjunction with the particular sign, may be added as appropriate.



Figure A1 EXAMPLES OF WARNING SIGNS WITH FLASHING LIGHTS

The lights should each meet the relevant requirements of AS 2144 for 200 mm diameter traffic signal lanterns. The recommended flash rate of each light is 40 to 60 flashes per minute with an on-time of 40 to 60%.

APPENDIX B

DETERMINATION OF LETTER SIZES FOR SIGNS

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D1 SCOPE

This Appendix sets out a method of determining the size of letters to be used on signs requiring individual design.

D2 PROCEDURE

Determine the capital letter sizes using the following equation*:

$$H = 0.14 NV + 11.4S \dots\dots\dots .B1$$

where

H = capital letter height in millimetres, including height of initial capitals used with lower case letters

N = number of words on the sign

V = approach speed in kilometres per hour

S = lateral offset of the sign in metres, measured from the centre of the sign to the centre of the traffic lane

The formula applies to words made up of *Series E Mod. capitals and lower case letters*, e.g. on direction signs, on *side-mounted* signs in *rural* areas. For other conditions the formula should be modified as follows:

- (a) For other letter Series *increase H* by the following factors:
Series C – 50%, Series D – 25%, Series E – 7%.
- (b) For signs in urban areas *increase H* by 25% (conspicuousness adjustment for urban environments).
- (c) For overhead signs, S used in formula should be vertical offset of centre of sign from driver’s eye height *multiplied by 2*.

where an overhead sign is at the side of the road and more than 3 m from the edge of the pavement, it may be necessary to calculate the equivalent lateral distance S_{EL} from the formula:

$$S_{EL} = (S_L^2 + 4S_V^2)^{1/2} \dots\dots\dots .B2$$

where

S_L = lateral offset of the sign in metres, as for Equation D1

S_V = vertical distance of the centre of the sign above the driver’s eye in metres, (distance above road surface, minus 1.2 m)

The value S_{EL} is then substituted for S in Equation D1.

To facilitate sign design and manufacture it will usually be necessary to adopt the standard letter size given in AS 1744, nearest to the size calculated.

* The derivation of this equation is given in Austroads, Guide to Traffic Engineering Practice, Part 8: *Traffic Control Devices*.

APPENDIX C

DETERMINATION OF ADVISORY SPEEDS ON HORIZONTAL CURVES

C1 SCOPE

This Appendix describes methods to be used for the determination of advisory speeds on horizontal curves using either the ball bank indicator method or by using other means, e.g. Vericom data.

C2 PRINCIPLE

The advisory speed for a curve is obtained by measuring the centripetal force exerted on a vehicle when travelling around the curve at a particular speed, and from that information, determining the travel speed at which the centripetal force would be at a predetermined acceptable maximum.

NOTE: Advisory speed signing is not permitted on unsealed roads only (see Clause 4.4.6.1).

C3 BALL BANK INDICATOR METHOD

C3.1 Equipment

The ball bank indicator in its original form comprises a sealed cylindrical glass tube curved into the arc of a circle and placed against a scale graduated in degrees of curvature of the tube, see Figure C1. The tube is filled with a damping liquid and contains a moving metal ball. The tube is mounted transversely in a medium size car or station wagon on or near the dashboard and in a perpendicular plane. As the vehicle is driven around a curve the centripetal force acting on the vehicle is measured in degrees of deflection of the ball, left or right, from the centre or zero position. This measurement is known conventionally as the 'ball bank' angle.

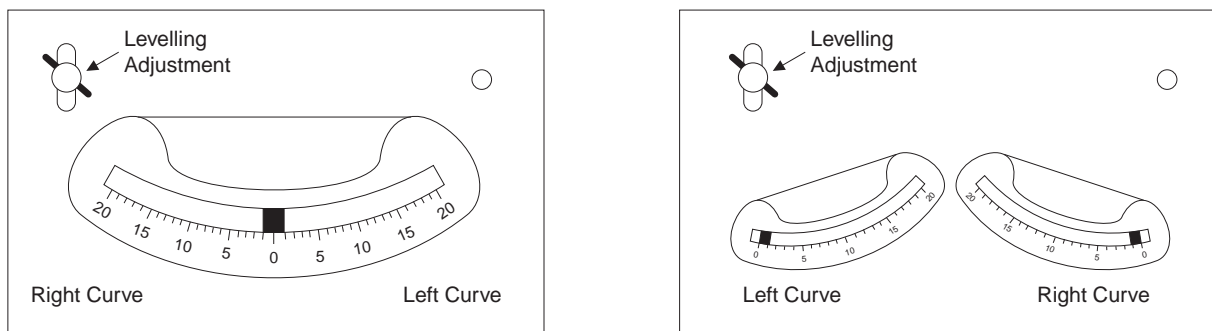


Figure C1 BALL BANK INDICATOR

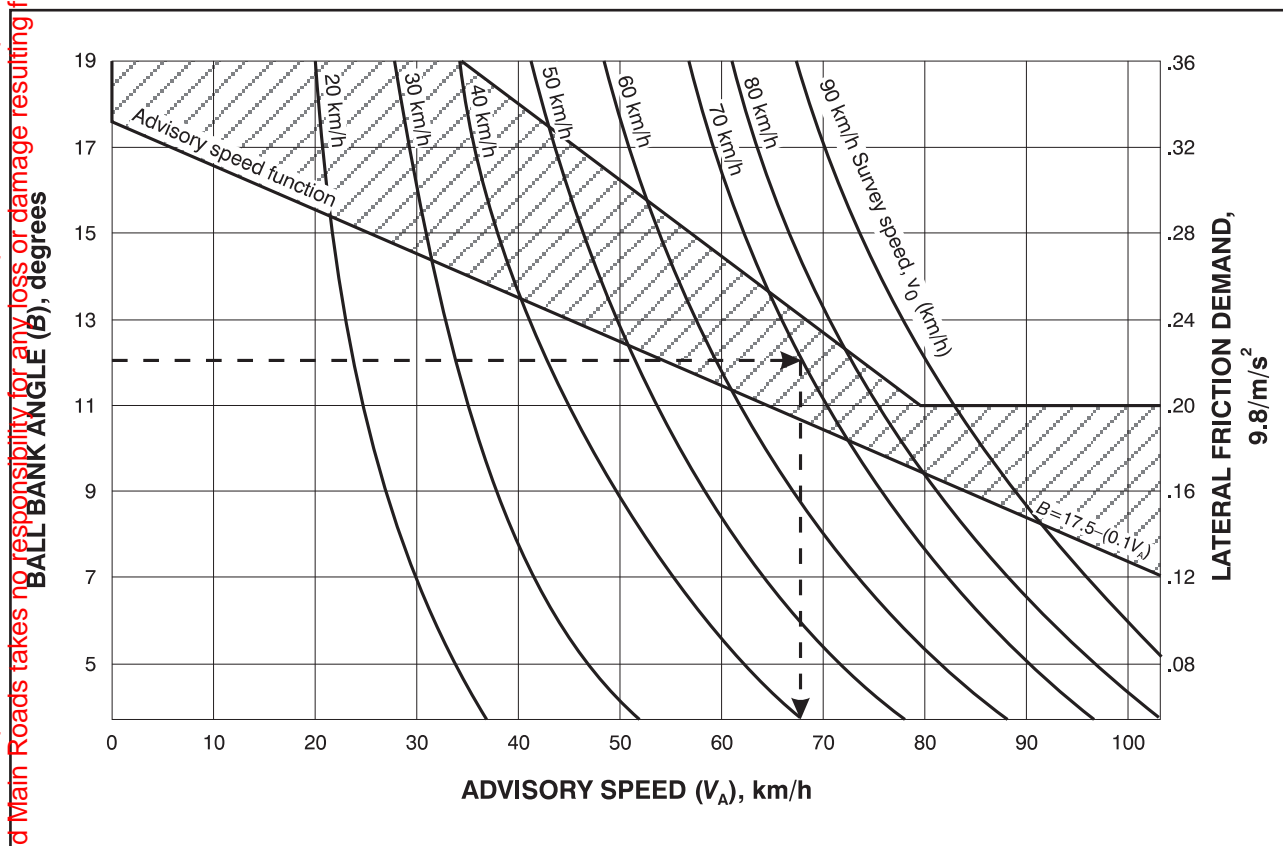
Devices capable of measuring the ball bank angle by other means including indirect means and including those capable of automatic recording and analysis of results will meet the requirements of this Standard. Instruments should be capable of providing a ball bank angle reading accurate to ± 0.5 degrees.

C3.2 Procedure

The following survey procedure relates to the original ball bank indicator as described in Paragraph C3.1. Steps may be omitted as appropriate depending on the facility for automatic recording and analysis provided by the instrument used.

- Calibrate the vehicle speedometer by driving the vehicle at constant speed over an accurately measured distance and noting the variation between indicated and true speed. Repeat this step three to four times at approximately equal increments of speed so as to provide coverage of the range of speeds likely to be used in the survey. Calibration to ± 1 km/h will be adequate for this survey.
- Level the instrument by parking the vehicle on a flat surface with driver and observers aboard and adjusting the ball to the zero mark. Turn the vehicle through 180° and if the ball is no longer at zero, reset the ball to a point equal to half the error.

- (c) Survey the curve by driving the survey vehicle at a constant speed around the curve as nearly parallel to the road centre-line as possible. For convenience in using the graph in Figure C2, drive at a speed as near as possible to a multiple of 10 km/h. Drive on the correct side of the road avoiding sudden steering corrections while in the curve. Record the ball bank reading, B (degrees) and the speedometer reading V (km/h) in the central untransitioned portion of the curve. Both instruments should be steady at this point with the ball at or near its maximum deflection for the curve.
 - (d) Adjust the indicated speed according to the variation found in Step (a) to determine the true speed, V_O and plot the ball-bank angle against the speed on Figure C2.
 - (e) If the plotted point does not lie within the shaded band in Figure C2, repeat Steps (c) and (d) at 10 km/h increments or decrements until the plotted point lies within that band. Read off the advisory speed V_A at that point.
- Where the road has two or more lanes in one direction, measure the advisory speed for each lane separately and report the lowest value.



NOTES:

The example shows an observed reading of 12 degrees at a survey speed of 70 km/h. The advisory speed is 66 km/h.

The graph is based on the matching of ball bank angle to advisory speed as shown in the following Table:

Ball bank angle degrees	8.0	8.5	9.0	9.5	10.0	10.5	11.0	11.5	12.0	12.5	13.0	13.5	14.0	14.5	15.0
Advisory speed km/h	95	90	85	80	75	70	65	60	55	50	45	40	35	30	25

Figure C2 DETERMINATION OF ADVISORY SPEED ON A HORIZONTAL CURVE FROM BALL BANK INDICATOR READING AND LATERAL ACCELERATION INSTRUMENT

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C4 ELECTRONIC ACCELEROMETER METHOD

C4.1 Equipment (Vericom 4000)

Accelerometers can accurately measure the lateral inertial force generated by a vehicle travelling through a horizontal curve. The measured unit output is a function of the acceleration of gravity (9.81 m/s^2). The accelerometer (Vericom 4000) is mounted centrally to the longitudinal axis of the test vehicle on the windscreen (using the mounting system supplied by the manufacturer, as depicted in Figure C3).



Figure C3

C4.2 Set Up Procedure

The following set up and levelling procedure applies to the Vericom 4000 model accelerometer instrument. It is recommended the instrument be calibrated before each test activity as outlined in the device instruction manual.

- (a) The test vehicle should be parked on a level surface with driver and operator in the vehicle. A digital smart level may be utilised to check the vehicle setup platform.
- (b) The accelerometer instrument has a lateral and longitudinal axis bubble level that can be used to achieve appropriate pre test level accuracy.
- (c) The preferred levelling method is to utilise the active digital instrument display.
 1. **Important** - the instrument zeroing setting must be **turned off** to conduct a valid test.
 2. Through the tools key select the monitor mode in G-Force and do not save to memory for the levelling procedure. The resulting tri axis (Gx, Gy and Gz) active screen display allows manual adjustment to level the instrument.
 3. Ensure the Gy and Gx active display is as close to a zero display as possible. Levelling accuracy sensitivity of **less than 1% (Gy = 0.01)** display is considered adequate for a valid test survey.

C4.3 Test Survey Procedure

The test survey procedure relates to the Vericom 4000 model accelerometer instrument. If a different model electronic accelerometer is used, the test run procedure may require modification for that particular instrument.

- (a) The GPS system supplied by the instrument manufacturer should be connected in accordance with the instruction manual and utilised for each survey to ensure test run speed recording.
- (b) The curve survey methodology should replicate the ball bank procedure in terms of test speed multiples and direction.

C4.4 Survey Data Analysis

The software provided with the instrument (Profile 4) is used to graph the data collected for each survey test run (refer to Figure C4). The following procedure should be used to ensure consistent lateral acceleration Gy interpretation.

- a) Select Gy as the vertical graph axis display and GPS speed as the secondary graph unit display.
- b) Select the chart average cursors and move them to span the nominated curve apex with a recommended general minimum data set spread of 2 seconds. This process smoothes out short duration road roughness data noise and irregular driver steer input data peaks, similar to the fluid inside a conventional ball bank device.
- c) When analysing same direction but different speed curve survey runs, the recommended data comparison is to align the travelled curve apex distance. Early curve entry and late curve exit transition data should not be included in the data set spread.

An example of a like for like curve apex travel distance data set comparison is as follows:

1. First curve run at 50 km/h with a selected 2.5 second data set = 35 m
2. Second curve run at 60 km/h with a 2.1 second data set = 35 m
3. Third curve run at 40 km/h with a 3.1 second data spread = 35 m

The software generated lateral friction demand number is a smoothed peak average of the lateral acceleration experienced by the test vehicle at the test speed, through an equivalent curve apex travel distance. A negative Gy value represents a left curve and a positive Gy value indicates a right curve.

The interpreted lateral friction demand value is applied to the ball bank curve advisory speed chart to deduce the appropriate curve advisory speed value, inline with the conventional ball bank procedure.

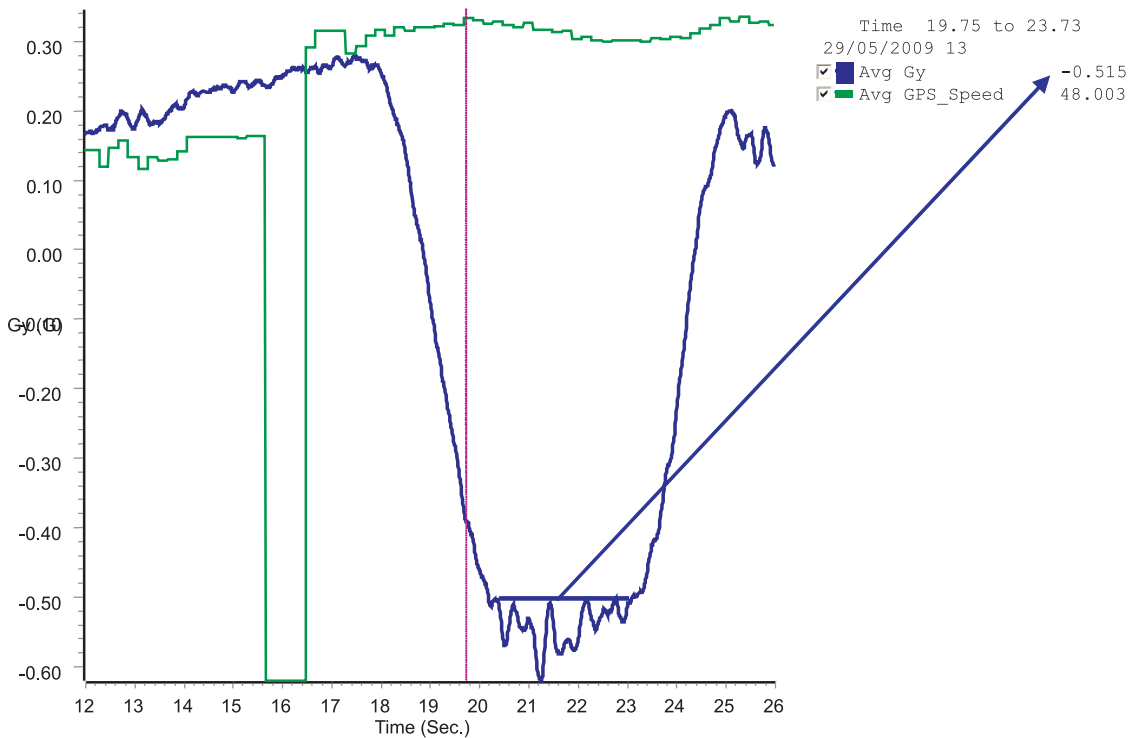


Figure C4 PROFILE 4 CURVE SURVEY DATA GRAPH DISPLAY

C5 ADVISORY SPEED ADJUSTMENT

To determine the advisory speed to be shown on Advisory Speed signs, the speed obtained from the above methods shall be adjusted, as necessary, to a multiple of 10 km/h by rounding four units up or five units down.

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C6 REPORT

The advisory speed to be shown on Advisory Speed signs shall be reported for each curve measured, for each direction of travel, and where more than one advisory speed was measured in a particular direction, the adjusted speed corresponding to the lowest measured value.

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APPENDIX D

DETERMINATION OF ADVISORY SPEEDS ON VERTICAL CURVES

D1 SCOPE

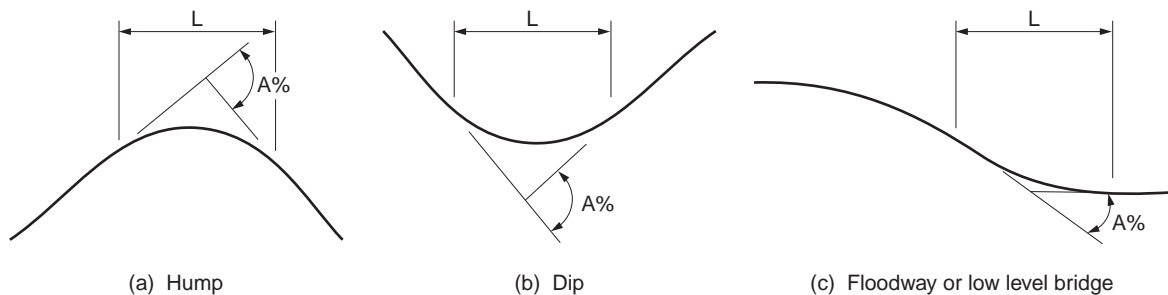
This Appendix describes a method which may be used for determining the advisory speed on sharp vertical curves, i.e. at dips and humps.

D2 PRINCIPLE

The advisory speed is first estimated from measurements of the length of the curve and the total grade change. It is then checked by driving over the curve at the estimated speed.

D3 METHOD

Referring to Figure D1, proceed as follows:



LEGEND:

L = length of hump or dip, in metres

A = total grade change, percent

Figure D1 HUMP AND DIP MEASUREMENTS

- (a) Measure the horizontal length L (metres) of the vertical curve.
- (b) Measure the grade (percent) at each end of the vertical curve.
- (c) Calculate the total algebraic grade change, A (percent), and hence find the ratio A/L .
- (d) From Table D1, find an initial estimate for the advisory speed to the nearest 1 km/h. The Table is based on a maximum tolerable vertical acceleration of 0.1 g (approximately 1 m/sec/sec).
- (e) Drive over the vertical curve in a passenger car of common make, at least twice in each direction at the estimated speed.
- (f) Assess the suitability of the test speed on the basis of suspension bottoming, handling and passenger comfort.
- (g) If the estimated speed is unsatisfactory, increase or decrease the test speed by 10 km/h as required and repeat Steps (e) and (f).

NOTE: In addition to geometry of the vertical curve, factors which affect advisory speed include pavement surface condition, horizontal alignment and, in a dip, the likelihood of encountering water or drift sand.

TABLE D1 ESTIMATION OF ADVISORY SPEED ON A VERTICAL CURVE

A/L	Advisory speed km/h
< 0.15	N/A
0.15-0.16	95
0.16-0.17	90
0.18-0.19	85
0.20-0.22	80
0.23-0.26	75
0.27-0.30	70
0.31-0.35	65
0.36-0.42	60
0.43-0.51	55
0.52-0.63	50
0.64-0.80	45
0.81-1.05	40
1.06-1.42	35
>1.42	30

- (h) To obtain the advisory speed to be shown on signs, adjust the speed to a multiple of 10 km/h by rounding four up or five down.

APPENDIX E

SIGNS FOR WILDLIFE AWARENESS

(Informative)

This Appendix specifies warning signs for wildlife only for those kinds of animal that would constitute, by virtue of their size, an injury risk to occupants of motor vehicles and motor cycles if struck on the road, e.g. kangaroos and wandering stock.

The efficacy of signs of the type specified in Clause 5.11.2.7 in preventing the road kill of small animals considered doubtful.

Signs aimed at creating a general awareness of wildlife in an area such as those shown below are suggested as a more meaningful approach to the problem of protecting small animals. It is envisaged that these signs could be displayed up to two at any one location.



FIGURE E1 WILDLIFE AWARENESS SIGNS

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