# 6 Cross Section

## 6.1 Introduction

### 6.1.1 General

The cross section of a road is a vertical plane at right angles to the road control line. It is viewed in the direction of increasing stationing and shows transverse detail of the various elements that make up the road's structure, sometimes from boundary to boundary. The main purpose of a cross section is to show the variation of elements within the design and their interaction with the natural topography.

The cross section elements should be designed to ensure that the use of the space available within the road reserve is sympathetic to the natural environment and user expectations, while maintaining a balance between construction, maintenance and operating (including crash) costs.

The width and crossfall of traffic lanes and shoulders are based on traffic needs and drainage requirements.

The form of the remainder of the cross section, ie. the batter slopes of fills and cuts, depends on the type of material to be excavated, environmental factors and the importance of the road. The widths and slopes of the various cross section elements may be varied within acceptable limits to achieve a balanced, economical, functional and aesthetic result. Details of acceptable widths and slopes of elements, together with guidelines for selection of the appropriate values are given in this section of the manual.

Some typical cross sections are illustrated in Figure 6.1

### 6.1.2 Important Cross Section Design Factors

The three most important factors that need to be born in mind when using of this section of the Manual are:

- **The Cross Section is Part of the Total Road Design Package**

  The cross section forms only a part of the total road design. Decisions about the dimensions to be used for an individual cross section element are considerably inter-dependent on other design considerations, ie. the shoulder width can only logically be set in relation to the sight distance available due to vertical and horizontal alignments, the pavement surface treatment, adjoining travel lane widths and predicted traffic volumes and composition. A holistic approach must therefore be taken with road design and the cross section needs to be designed in conjunction with all other aspects of the road design, including landscaping.

- **Relative Costs Must Always be Considered**

  For most roadworks the pavement and its wearing surface is the most significant factor in the total cost of the project. It is, however, very important to ensure that the width of pavement is appropriate for the road’s purpose and design requirements. Pavement materials are expensive and small increases in the widths of traffic lanes and shoulders can add significantly to the total cost of the project, even if the percentage increases are relatively small.

  Special care is needed in cases where improvements are being made to roads on existing formations. Adopting dimensions that will require widening of the formation can cause a large increase in the cost of the work. However, once established on a project, marginal increases in dimensions may not represent a significant increase in the total cost. The cost of alternatives should always be examined to ensure that the most cost effective solution is adopted.

- **The Clear Zone is an Essential Part of Cross Section Design**

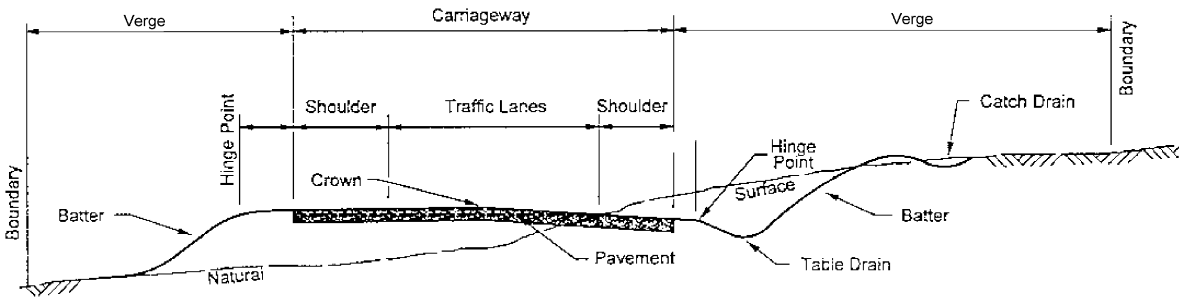
  It is an unfortunate fact that vehicles do sometimes run off the road. Shoulder, verge and batter design must ensure a clear zone which will allow an errant vehicle to traverse this area with minimum damage to itself and occupants. The clear zone concept underlines the fact that a reasonably flat, well compacted and unobstructed road side environment is highly desirable, especially on high speed roads.

  An appropriate speed related clear zone should be provided in urban areas, especially on new construction works. Footpaths will usually provide an adequate clear zone provided utility poles, sign supports and heavy structures are kept to the rear of the footpath, or made frangible, and all planting consists of frangible species. Undergrounding of utility services will assist in keeping the footpath clear of obstructions.

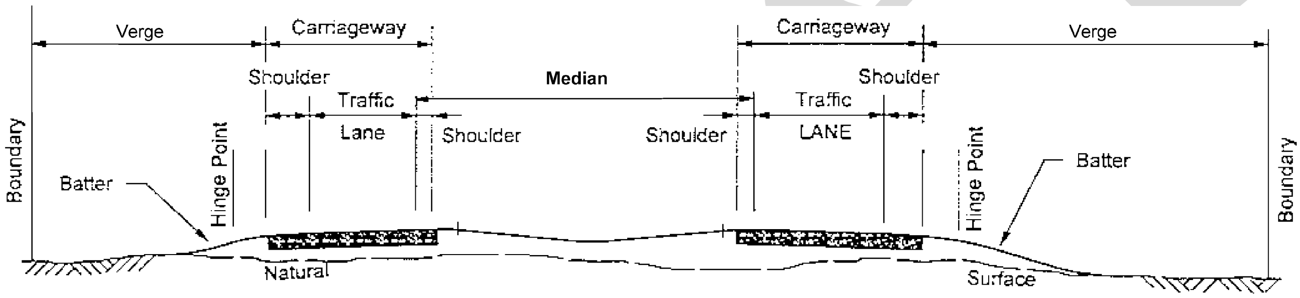
### 6.1.3 The Road Reserve

The road reserve is measured between the property boundaries on each side of the road. It must be of sufficient width to accommodate the ultimate planned traffic lanes, a median when necessary, shoulders, footpaths, public utilities, drains, and the space necessary for the cut and batter slopes, including any extra clearances necessary adjacent to high cut batters to prevent possible future erosion affecting adjacent properties.

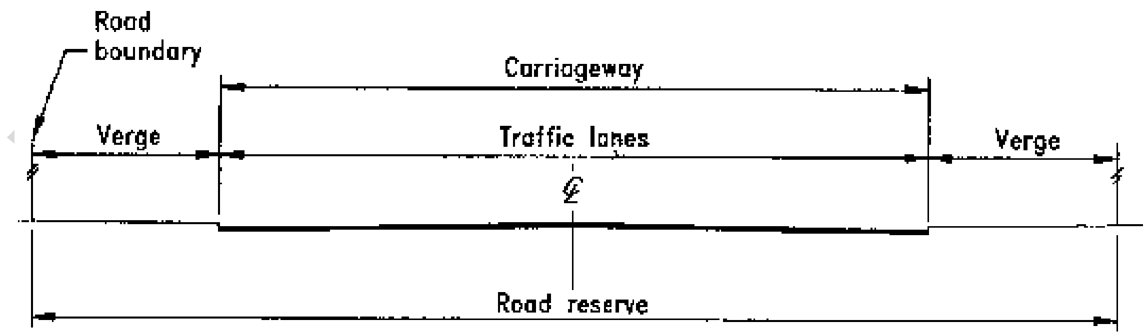
A wide road reserve will permit the construction of gentle slopes which result in greater safety for motorists and enables easier and more economical maintenance.



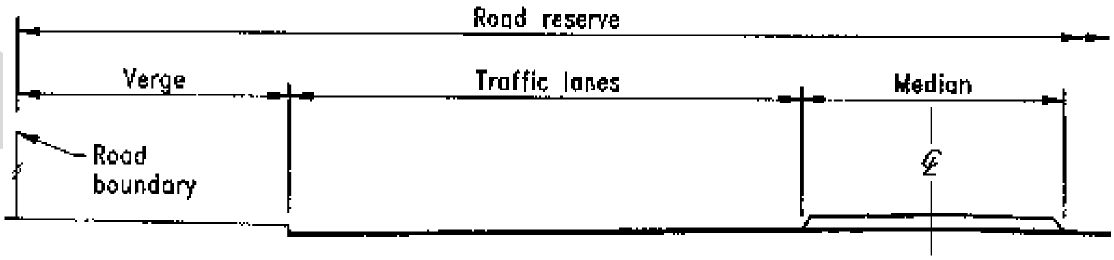

**(a): Two-lane Two-way Rural Road**




**(b): Dual Carriageway Rural Road**




**(c): Two-lane Urban Road**




**(d) Dual Carriageway Urban Road** ***(½ section only - second one-way carriageway and adjacent verge are not shown)***

**Figure 6.1: Typical Cross Sections**

***(More extensive cross section details are shown in Section 6.11)***

### 6.1.4 Cross Section Determination

The Flow Chart shown in Figure 6.2 details a procedure to help determine the most appropriate cross section to be used. References to other relevant sections of the Manual are given for assistance.

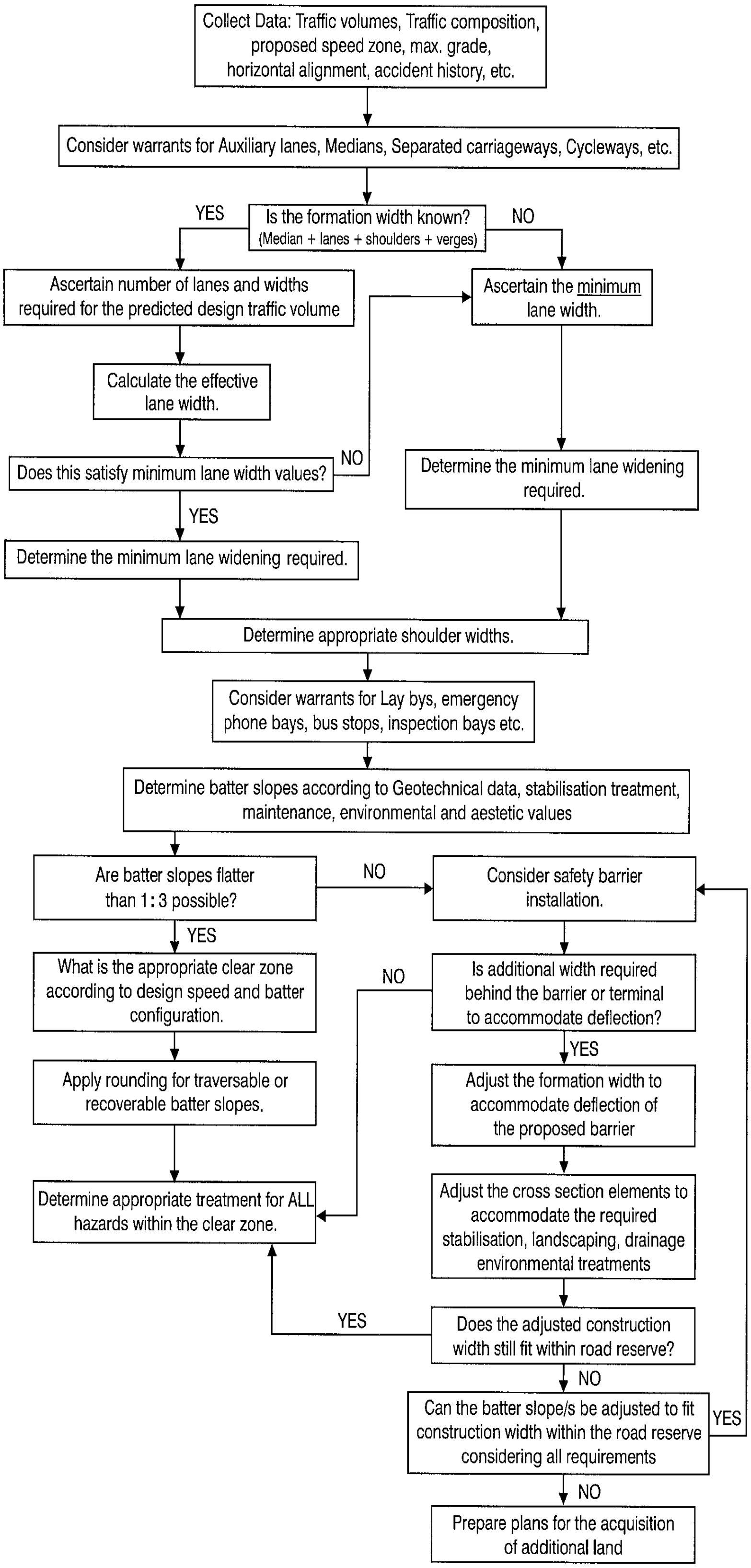



**Figure 6.2: Cross Section Determination Flow Chart**

### 6.1.3 Minimum Seal Widths for State Highways

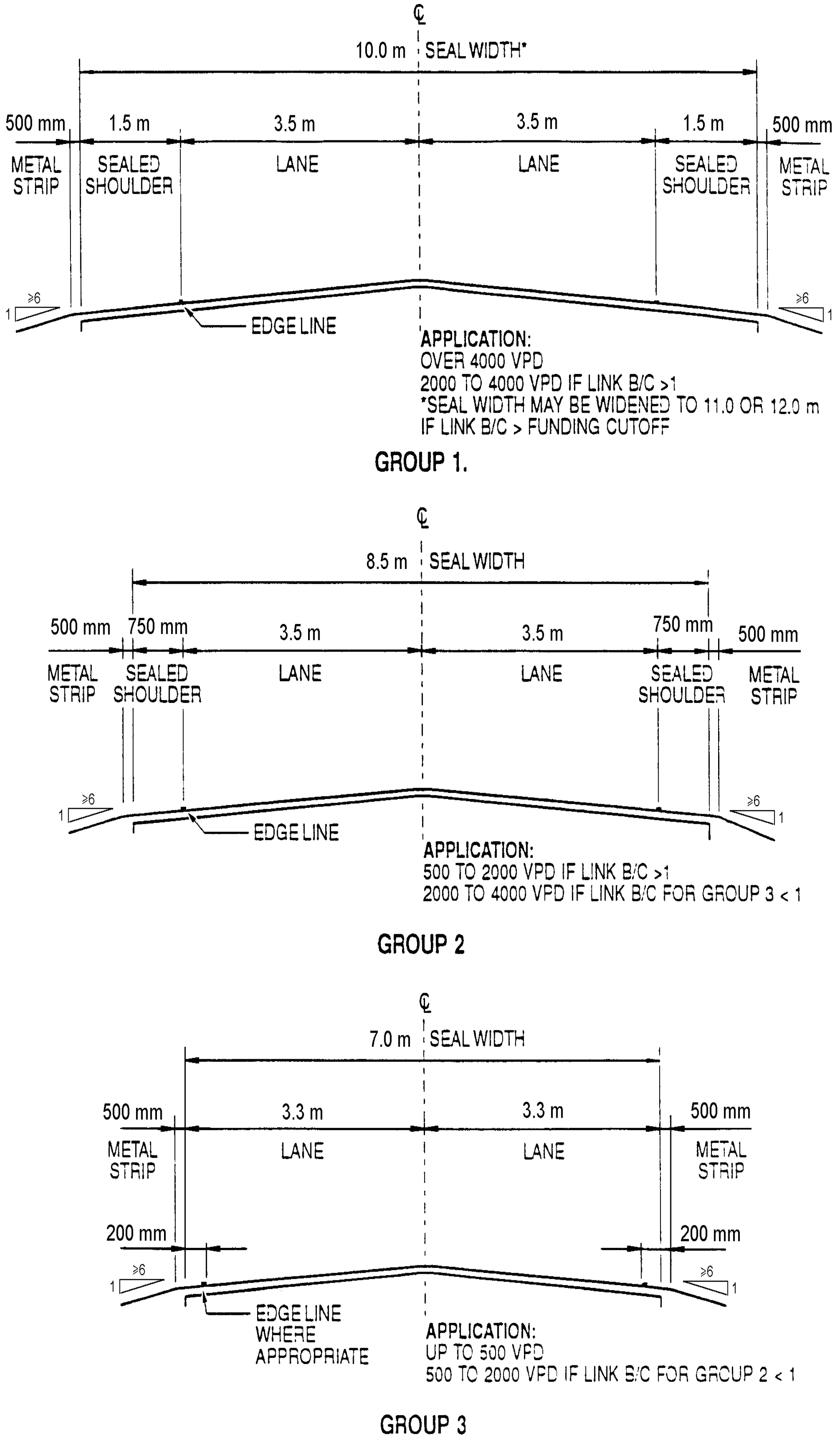



**Figure 6.3: Minimum State Highway Sealed Widths**

## 6.2 Traffic Lanes

### 6.2.1 General

A traffic lane is that part of a roadway reserved for the normal one way movement of a single stream of vehicles. Traffic lanes provide a variety of functions important to the overall efficient function of the road hierarchy, such as:

- through road,
- special - bus, transit, etc.,
- auxiliary (turning or overtaking),
- parking,
- cycling.

Traffic lane width is normally determined after consideration of the road's annual average daily traffic (AADT) and peak hour traffic volumes, where relevant. Vehicle dimensions and the combination of speed and traffic volume should also be taken into account.

Lane width and road surface condition have a substantial influence on the safety and comfort of road users. In rural areas the additional costs incurred in providing wider lanes can be partially offset by the reduction in long term pavement maintenance costs resulting from heavy vehicle wear in the vicinity of the pavement edge on narrow lane roads.

Narrow lanes also force vehicles to travel laterally closer to one another than their drivers are normally comfortable with, particularly at higher travel speeds.

Drivers also tend to reduce their travel speed, or shift closer to the centre of the lane/road, or both, when they perceive a hazardous object is too close to either the nearside or offside of their vehicle. The most common driver reaction to this type of hazard is, however, a movement of their vehicle away from the hazard. The offset of a fixed hazard from the edge of the traffic lane beyond which this reaction is not observed is termed the *'Shy Line'*. The shy line is normally taken as the distance from the edge of the traffic lane to the outer edge of shoulder, or the distance shown in Table 6.1, whichever is the greater.

| Design or $85^{th}$ Percentile Speed (km/h) | Shy Line Offset (m) | |
|---|---|---|
| | Nearside (Left) | Offside (Right) |
| ≤ 70 | 1.5 | 1.0 |
| 80 | 2.0 | 1.0 |
| 90 | 2.5 | 1.5 |
| ≥ 100 | 3.0 | 2.0 |

**Table 6.1: Shy Line Offsets**

Reductions in lane width reduces the lateral clearance between vehicles and also to fixed obstacles. This leads to reduced travel speed and lane capacity and Tables 6.2 and 6.3 show the reduction in lane capacity caused by a fixed hazard close to the road.

| Clearance to fixed obstacle close to the road | Lane Capacity (% of 3.5m lane capacity) | | | |
|---|---|---|---|---|
| | 3.5 m lane | 3.3 m lane | 3.0 m lane | 2.7 m lane |
| 1.8 | 100 | 93 | 84 | 70 |
| 1.2 | 92 | 85 | 77 | 65 |
| 0.6 | 81 | 75 | 68 | 57 |
| 0.0 | 70 | 65 | 58 | 49 |

**Table 6.2: Two-lane Two-way Road Lane Capacity**

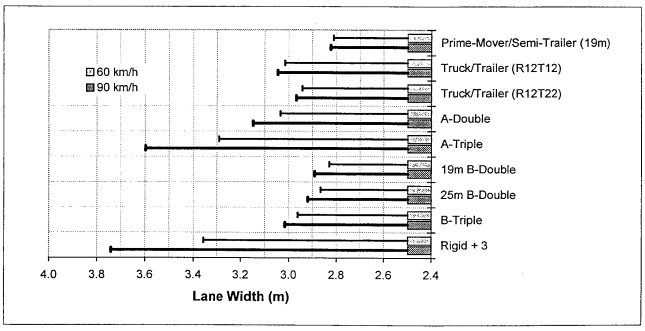
| Clearance to fixed obstacle close to the road | Lane Capacity (% of 3.5m lane capacity) | | | |
|---|---|---|---|---|
| | 3.5 m lane | 3.3 m lane | 3.0 m lane | 2.7 m lane |
| 1.8 | 100 | 95 | 89 | 77 |
| 1.2 | 98 | 94 | 88 | 76 |
| 0.6 | 95 | 92 | 86 | 75 |
| 0.0 | 88 | 85 | 80 | 70 |

**Table 6.3: Four-lane Dual Carriageway Road Lane Capacity**

***NOTES:***

1. ***The width of a lane adjacent to a kerb excludes the width of the channel (if any).***
2. ***The legal width limit of heavy commercial vehicles is 2.5 m and the majority of heavy vehicles are built to this maximum width. An additional width of 200 mm is needed on each side of these vehicles to accommodate their wing mirrors.***

ARRB Transport Research was commissioned to develop minimum estimated lane width requirements for various heavy vehicles. Data from this study is shown in the histogram below.




A clearance component is not included in these estimated vehicle path lane widths. Typically, 0.5 m needs to be added to give a lane width sufficient for efficient traffic operations.

These minimum vehicle path widths are for a straight, level road with an average NAASRA roughness of 120 counts/km, a crossfall of 4.5% and two test speeds. This particular combination is regarded as too extreme for typical design conditions, but no other data is available at present. Also, a different set of test conditions would need to be considered for roads with other than straight travel paths. However, the research suggests that, in a speed environment of 90 km/h, most of New Zealand's legal size heavy vehicles could comfortably operate on roads that have an effective lane width of 3.5 m. State highway lane widths should therefore conform to the following general standards:

- The desirable minimum width of a traffic lane is 3.5 m. Auxiliary lanes should also conform to this width.
- On kerbed urban arterial roads the width of the left-hand lane should be increased to 4.5 m, to accommodate cyclists.
- Single one-way traffic lanes, such as freeway ramps, should be at least 4.5 m wide, to allow traffic to pass a stationary parked, or broken down, vehicle.

In some situations, such as restricted road reserve width, the Highway Standards and Strategy Manager may approve a departure from these standards. In these situations the lane widths should be reduced by increments of 0.1 m until an acceptable solution, or 3.0 m, ie. the minimum state highway lane width, is reached.

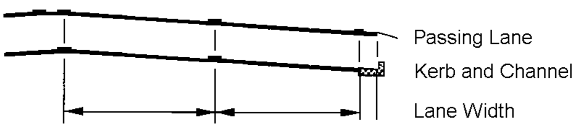



**Figure 6.4: Lane Width Notation**

### 6.2.2 Two-Lane Two-Way Rural Roads

The minimum traffic lane width for a two-lane two-way rural state highway should be determined from Table 6.4. Where the AADT lies near to a boundary between groups the use of the higher value must be carefully considered.

Where the design speed in mountainous terrain exceeds 80 km/h, or 100 km/h in undulating terrain, or where there is a high percentage of heavy vehicles (20% for 500 AADT and 5% for 2000 AADT), a lane width of 3.5 m is desirable.

### 6.2.3 Multilane Rural Roads, Expressways and Motorways

The minimum traffic lane width for multilane rural roads, expressways and motorways is 3.5 m.

Desirably, any rural road consisting of four lanes or more should have a central median to separate the opposing traffic flows.

| Effective Width of TwoTraffic Lanes (m) | Anticipated AADT at Opening | | |
|---|---|---|---|
| | Low Future Growth (< 3%) | Reasonable Future Growth (3 - 6%) | High Future Growth (> 6%) |
| 6.6 | up to 700 | up to 500 | up to 300 |
| 6.5 | 700 - 1700 | 500 - 1200 | 300 - 900 |
| 7.0 * | over 1700 | over 1200 | over 900 |

*** *Where local conditions dictate widths in excess of 7.0 m may be considered***

**Table 6.4: Traffic Lane Width Guidelines for Two-lane Two-way Roads**

### 6.2.4 Urban Roads

The desirable state highway traffic lane width in urban areas is 3.5 m. Where the road reserve width is restricted, lane width(s) may, with Standards and Strategy Manager approval, be reduced.

The differing functions and uses of each lane must be taken into account when *'squeezing'* an extra lane from an existing or partially widened road formation, or fitting the required number of lanes into the space available, is necessary. Lane widths must be allocated on an equitable basis in these situations and the widths varied in 0.1 m increments from the desired 3.5 m to a minimum of 3.0 m, with the following provisions:

- **On Straight Alignments:** 3.l m is the minimum width for a kerbside lane. All other lanes must be at least 3.0 m wide.
- **On Curved Alignments:** Widening in accordance with Table 6.5 must be applied.

| Normal Lane Width (m) | Radius (m) | Widening (m per lane) |
|---|---|---|
| 3.5 | 60 - 100 | 0.6 |
| | 100 - 150 | 0.3 |
| 3.0 to 3.4 | 60 - 100 | 0.9 |
| | 100 - 150 | 0.6 |
| | 150 - 300 | 0.4 |
| | 300 - 450 | 0.3 |

**Table 6.5: Lane Widening on Curves in Urban Areas**

It is desirable to locate a barrier kerb at least 0.5 m clear of the edge of the adjacent traffic lane, to compensate for a driver's tendency to shy away from them. Usually, the width of the channel will provide an adequate clearance.

Where over-dimension vehicles use the road, eg. heavy haulage by-passes, wharf access routes, etc, allowance must to be made for the size of these vehicles and their tracking characteristics. The local heavy vehicle operators must be consulted and a suitable design vehicle developed for these routes.

### 6.2.5 Bus Routes

The desirable lane width for a bus route on new construction projects is 3.5. The minimum width is 3.0 m.

On existing roads the following conditions apply:

**(a)** Kerbside lanes used by buses should not be marked less than 3.0 m wide, as measured from the face of the kerb. Where a lane has to be 3.0 m or less in width the kerbside lane should be made wider than the adjacent lanes, to offset the effects of drivers shying away from kerbs, channels, power poles and other roadside structures.

**(b)** Site specific measures to mitigate the effects of narrow lanes should be investigated. These include parking restrictions, median width variations, indented bus bays, etc.

**(c)** The appropriate bus operator must be consulted during the planning stages to ensure that the road design proposed is acceptable to them.

### 6.2.6 Auxiliary Lanes

Auxiliary lanes, other than parking and turning lanes, should have the same width as the adjacent through traffic lanes

### 6.2.7 Parking Lanes

**(a)** Parking lanes are not normally provided on rural roads but provision for parking should be made at rest areas and layby's.

**(b)** It is normal practice to provide parking lanes on urban roads and.

The provision of parking lanes on urban roads, where they often serve the function of a shoulder, is determined mainly by the operational requirements of the road. These are described briefly below:

- **Major Routes - Single Purpose:** Limited access urban routes and urban motorways which cater for moving traffic and only the occasional stop. Design parameters are similar to those of rural roads, shoulders are normally provided and the rural cross section forms are acceptable. Parking is not an issue other than providing for the occasional stopped vehicle, eg. broken down, fatigue stop, etc.
- **Major Routes - Mixed Purpose:** These form the bulk of major urban routes. They normally have frontage development and have to cater for site access movements, parked vehicles, the parking and un-parking of these vehicles as well as moving traffic. Their design principles differ from those of rural roads and their cross sections usually include parking lanes, which often serve the function of shoulders, in addition to the traffic lanes.
- **Local Access Roads:** The main design controls for these types of road are property access, property drainage and the width between kerbs. Providing for parked vehicles is also an important factor.
- **Frontage / Service Roads:** These are not really a separate road class and they may be either local access or mixed purpose roads. The lowest class of service road provides only local access, eg. residential access, industrial development, shopping centres, etc.

  On urban corridors in large cities they can eventually carry significant proportions of through traffic. As the through traffic component of a service road increases there is a tendency for fewer connections to the rest of the street system and in these cases service roads tend to provide a mixed function service with increasing importance given to other than local access traffic. They can eventually become arterial / collector roads in their own right.

**(c) Lane Width**

- An exclusive parallel parking lane should have a minimum width of 2.5 m. Where kerb and channel is used the width of the channel may be included in this width, although this is not a desirable practice. This minimum width should only be used in situations where there is no likelihood of the lane being required for traffic purposes in the future and the reduced capacity of the road produced by this arrangement is adequate for the traffic volumes expected.
- A parallel parking lane which is used as a travel lane during peak times should have the same width as a normal traffic lane, ie. desirably 3.5 m and 3.0 m minimum, as measured to the lip at the channel.
- Shared parallel parking and traffic lanes should be at least 5.5 m wide, ie. 3.5 m traffic lane plus a 2.0 m, as measured to the lip of the channel, parking lane. This is the borderline between acceptable and difficult traffic operations.
- In areas where frequent parking is combined with reasonable arterial traffic volumes all spare width should be put into the outer traffic lane/parking lane combination as this is where most of the *'side friction'* occurs. This situation occurs mainly in suburban shopping/business areas on arterial roads. where speeds tend to be slower and there is merit in reducing the through traffic lane widths to obtain this additional space.
- Where angle parking is provided the Austroads *Guide to Traffic Engineering Practice, Part 11: Parking* should be used to determine the appropriate parking lane width. Markings should be as defined in the *Manual of Traffic Signs an Markings, Part II: Markings*.

### 6.2.8 Turning Lanes / Turning Roadways and On / Off Ramps

The desirable width for a turning lane is 3.2 to 3.5 m. The minimum width is 3.0 m.

On and off ramps lanes must be 3.5 m wide and the ramp carriageway should be at least 5.0 m, and never less than 4.5 m, wide to ensure reasonable traffic flow conditions past a stopped or broken down vehicle. Refer to drawing *TNZ 1/2000/77/7994/1* for the standard geometric designs for motorway on and off ramps.

Where a ramp has two or more lanes each lane must be at least 3.5 m wide on a straight and widening should be applied on curves.

### 6.2.9 Cycle Lanes

Cyclists are legitimate users of public roads and provision must be made for them. They can be accommodated on or off the carriageway within the road reserve or on a separate route.

Figure 6.5 shows the lateral forces which affect cyclists when they are in close proximity to heavy vehicles travelling at speed.

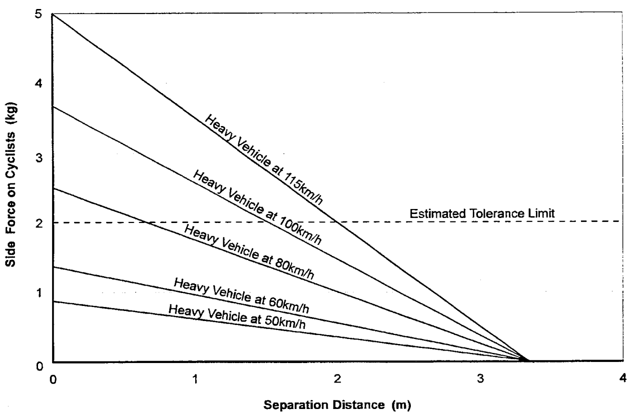



**Figure 6.5: Lateral Forces on Cyclists Caused by Heavy Vehicles**

***NOTE:*** ***Lateral forces may be increased where enclosed roadways create a 'wind tunnel' effect, eg. under bridges. In these cases, it may be appropriate to encourage cyclists to use the footpath, with fencing and/or signing, to increase the separation distance.***

Where cycle lanes are provided on state highways the appropriate widths for shared and exclusive cycle lanes should be determined from the Austroads *Guide to Traffic Engineering Practice, Part 14: Bicycles*. Exclusive cycle lanes are preferred where space is available and Table 6.6 lists details of common Cycle Lane configurations.

Traffic lane widths that result in a *'squeeze point'* for cyclists should be avoided wherever possible. On left hand curves, parked cars tend to *'truncate'* the corner and use up the space allocated to cycles in a shared lane and parking restrictions should be considered in these situations.

Cycle lanes must be designed on the basis that bicycles have tyres only 20 mm wide and the appropriate facilities provided, eg. bicycle safe sump gratings. Also, all adjoining road furniture must be free from protrusions that may snag the clothing of cyclists, or cause unnecessary injury in a fall.

| Speed (km/h) | Facility | Lane Width (m) |
|---|---|---|
| 60 | Exclusive lane | 1.5 |
| 80 | Exclusive lane | 2.0 |
| 100 | Exclusive lane | 2.5 |
| 60 | Shared with parking lane | 4.0 * |
| 80 | Shared with parking lane | 4.5 |

* 4.5 m is the preferred width, to allow cyclists to avoid a parked car door opening.

**Table 6.6: On Road Cycle Lane Widths**

Where a cycle lane is located adjacent to a concrete safety barrier less than 1200 mm high, and it is considered necessary to provide some additional protection to prevent cyclists falling over the barrier, eg. on bridges higher than five metres, a rail located 1400 mm above the surface of cycle lane should be provided on top of the barrier. The rail should be a minimum of 75 mm diameter and must not have the potential to spear an impacting vehicle.

Where a cycle lane located is adjacent to a steel guardrail in similar conditions to those described above, a 1400 mm high wire mesh fence should be provided behind the guardrail.

Refer to Section 6.3.8 for more details of making provision for cyclists on road shoulders.

### 6.2.10 Location of Kerbs and/or Channels

As a general principle kerbs should be avoided in high speed environments. Where they are used the kerb and/or channel must be located outside the traffic lanes on both the nearside and the offside of the road.

Where the design speed is:

**(a)** **>70 km/h:** The kerb and/or channel face must be offset at least 1.0 m from the edge of the adjacent traffic lane.

**(b)** **≤70 km/h:** A reduced kerb and/or channel offset may be used, ie. 0.5 m in areas without street lighting and zero (0.0 m) in areas with street lighting.

## 6.3 Shoulders

### 6.3.1 General

The shoulder is that portion of the carriageway adjacent to the traffic lanes and flush with the pavement surface. It accommodates stopped vehicles, provides lateral support to the road pavement layers and, if sealed, offers improved conditions for cyclists.

Shoulder width is measured from the edge of the traffic lane to the shoulder hinge point. Edge lines should therefore be marked so that their inside edge corresponds to the outside edge of the traffic lane.

All safety barriers, signs, guide posts, drains and kerbs must be located outside the shoulder.

Factors that need to be considered when determining shoulder widths include:

- **Support for the pavement structure:** 0.5 m is the minimum width needed to provide a realistic level of pavement support in most situations.
- **Space for a driver to use to avoid a collision and regain control:** The shoulder will rarely be sufficiently wide enough for this purpose and the *'clear zone'* is the area in which it will occur. The wider the shoulder, the more use it will be for this purpose and, based on North American studies that have shown that the accident risk is halved if the shoulder width is increased from 0.6 to 3.0 m, a shoulder width of 3.0 m is desirable wherever it can be reasonably provided. .
- **Clearance to posts and other fixed objects:** An adequate shoulder width provides shy line clearance. It also provides marginal increases in capacity but this effect reduces to zero when shoulder widths exceeds 1.8 m, see Tables 6.1, 6.2 and 6.3 for more details.
- **Space for a stationary vehicle to stop clear, or partly clear, of the traffic lanes:** A 2.5 m shoulder is desirable to allow passenger cars to stop clear of the traffic lanes. Wider shoulders, ie. 3.0 m or more, should be used on high standard high volume roads to provide for larger vehicles to stop clear of the traffic lanes.
- **Sight distance across the inside of a horizontal curve.**
- **Costs of providing additional width, particularly where an existing formation is being used:** A Cost Benefit analysis must be carried out if greater than standard widths are proposed.

### 6.3.2 Two-Lane Two-Way Rural Roads

#### (a) Shoulder Width

Table 6.7 shows shoulder the width requirements for rural roads that have minimal pedestrian and/or bicycle traffic. A transition taper of approximately 1:50 should be used between different width shoulders that adjoin one another. These transition lengths may, however, need to be lengthened to ensure a satisfactory appearance.

| Nominal Shoulder Width (m) | Situation |
|---|---|
| 0.5 - 1.0 | Widths less than 1.0 m should only be used on low volume roads (<500 vpd), pavement overlay and/or rehabilitation projects where a full width carriageway seal is to be provided and formation widening is not justified. |
| 1.0 | The minimum width adjacent to a road safety barrier and the desirable minimum for general use. It is also an appropriate width when a full width sealed shoulder is to be constructed as a full depth extension of the standard pavement. |
| 1.5 | The normal width for a sealed, or partly sealed, shoulder. |
| 2.0 - 2.5 | For use on higher volume roads, particularly when there is a need to make periodic provision for vehicles to stop completely clear of the traffic lanes. |
| 3.0 | Normally only used on major urban arterial roads, eg. expressways and motorways. May also be used on high speed high volume rural and recreational routes where there is a need to make frequent provision for vehicles to stop completely clear of the traffic lanes. |

***NOTES:***

1. ***In 100 km of travel a driver would expect to encounter some 4 to 5 stopped vehicles for every 1000 vehicles/hour using the road. Of these something less than 5% will have little choice as to the exact location of their stop.***
2. ***Shoulders between 0.5 m and 1.5 m do not enable a vehicle to stop clear of traffic lanes. 2.0 m shoulders enable vehicles to stop largely clear of the traffic lanes.***
3. ***There is evidence that safety does not improve significantly for shoulder greater than 1.5 - 2.0 m wide. Continuous 2.5 m shoulder can therefore normally only be justified only on high volume roads and where speeds are also high.***
4. ***It is important to provide frequent opportunities for vehicles to stop completely clear of the road on all roads with shoulders less than 1.5 m, and also on higher volume roads with shoulders less than 2.5 m, by flattening side slopes on some of the lower fills and at the transitions of cuts and fills.***
5. ***Sealing is sometimes continued beyond the shoulder hinge point and down the batter slope on the high side to protect the pavement from ingress of water. On floodways, the seal should be continued down the batter on both sides where no other protection is provided.***

**Table 6.7: Rural Road Shoulder Width Guidelines**

#### (b) Sealed Shoulder Width

Shoulders on rural roads should be sealed for a minimum width of:

- 0.75 m when the predicted design year AADT is between 500 and 2000, and
- 1.5 m when the predicted design year AADT is greater than 2000.

Wider sealed shoulders are required when provision is to be made for cyclists, see Section 6.3.8.

A full width sealed shoulder should be provided:

- adjacent to a lined side drain or kerb,
- where a safety barrier is provided adjacent to a 1.0 m wide shoulder,
- on the outer shoulder of a superelevated curve,
- where a rigid pavement is proposed,
- where environmental conditions require it, eg. to minimise maintenance costs in high rainfall areas and on floodways.

### 6.3.3 Multilane Rural Roads, Expressways and Motorways

**(a) Multilane Rural Roads**

Shoulders on dual carriageway rural roads, with two lanes or more in each direction, must be at least:

- 2.0 to 2.5 m wide on the left hand side (nearside), and
- 1.0 m wide on the median side (offside).

Shoulder seal width should be determined in the same manner as for two-lane two-way rural roads.

**(b) Expressway and Motorways**

Shoulders on expressways and motorways need to be at the upper end of the width range, because the high travel speeds on these roads are usually combined with high traffic volumes. Shoulder widths for these types of road shall be:

**(i) Nearside (Left) shoulder**

A minimum of 2.5 m, to allow most smaller vehicles to stop clear of the running traffic lane. The desirable width is, however, 3.0 m and this should be provided wherever possible.

**(ii) Offside (Median) shoulder**

1. A minimum of 1.0 m for two-lane one-way carriageways but greater widths should be provided wherever possible. 1.5 m is the desirable minimum width, at least 1.8 m is needed adjacent to a safety barrier to ensure 100% lane capacity and 2.0 m provides shy line clearance.
2. A minimum of 2.0 m for one-way carriageways with three or more lanes. 3.0 m is, however, the desirable median shoulder width in these cases and it should be provided wherever possible, to allow vehicles to stop clear of the adjacent traffic lane.

**(iii) Clearances to Physical Obstructions**

Where there are physical obstructions adjacent to the traffic lanes, eg. safety barriers, shoulder widths for expressways and motorways are determined by lane capacity and shy line clearance considerations. 100% lane capacity clearance must be provided in all circumstances and shy line clearance provided wherever possible. Refer to Tables 6.1 and 6.3 for details of lane capacity and shy line clearances.

eg. To achieve 100% lane capacity at design speeds of 100 km/h and higher the shoulder adjacent to a median barrier must be at least 1.8 m wide. A 2.0 m shoulder will provide shy line clearance and is the desirable minimum median shoulder width in these situations.

### 6.3.4 Auxiliary Lanes

The width of the nearside shoulder adjacent on an auxiliary lane should be:

- 1.0 m generally,
- 2.0 m adjacent to a safety barrier, and
- 3.0 m in merge areas.

***NOTE:*** ***At merges it is important that the shoulder remains trafficable and a full width sealed shoulder is desirable in these areas.***

### 6.3.5 On and Off Ramps

Ramp shoulders must be fully sealed and have shoulder widths of:

- a minimum of 1.0 m and desirably 2.0 m on the left hand side (nearside), and
- a minimum of 0.5 m, and desirably 1.0 m, on the right hand side (offside).

Ramp shoulder widths may, occasionally, be reduced in special circumstances but the total carriageway width should not be less than 5.0 m, and never less than 4.5 m. Refer to drawing *TNZ 1/2000/77/7994/1* for the standard geometric designs for motorway on and off ramps.

### 6.3.6 Urban Roads

Where a *'traffic lanes + shoulders'* design is appropriate for an urban road the guidelines for shoulder widths on rural roads may be applied. However, urban traffic conditions are usually quite different to rural traffic conditions, eg. urban arterial roads normally have frequently repeated peak hour flows while rural arterial roads normally have fairly consistent traffic flows. Urban road operating speeds are also usually well below free running speeds and design volume/capacity is the most important factor. It is rare, therefore, that a full width, fully paved shoulder can be economically justified as a breakdown lane. Table 6.8 gives guidelines for shoulder widths on urban roads.

| Nominal Shoulder Width (m) | Situation |
|---|---|
| 0 | The clearance between a traffic lane and a semi-mountable kerb, eg. a raised median or island, can be zero (0) but a clearance of 0.5 m to any kerb is desirable in all situations. |
| 0.5 - 1.0 | The normal offside (median) shoulder for a depressed median. |
| 1.0 | The minimum nearside shoulder for general use. |
| 1.5 - 2.5 | The normal nearside shoulder for use on major urban roads - in urban situations isolated stopped vehicles on a 1.8 m shoulder have been shown to have a negligible effect on capacity and safety. |
| 3.0 | For use in special cases where the frequency of stopped vehicles is combined with high traffic volumes and high speeds. This situation is mostly found on arterial outlets to major cities where recreational peaks are much *'flatter'* than urban commuter peaks, and where traffic volumes just below those that can cause considerable reductions in traffic speeds, often persist for long periods. |

**Table 6.8 Urban Road Shoulder Width Guidelines**

### 6.3.8 Cyclists

Where there is an identified need to provide for cyclists Figure 6.6 should be used to determine the sealed shoulder width needed to accommodate them in a safe manner. Refer also to Section 6.2.9: *Cycle Lanes*.

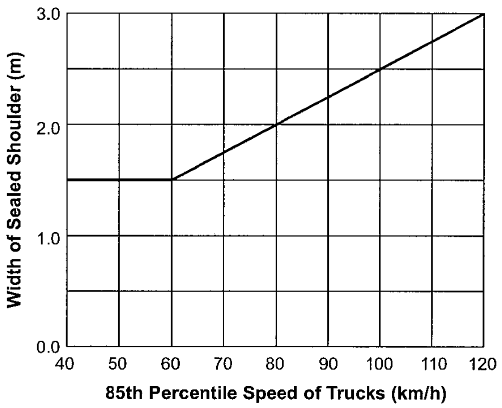
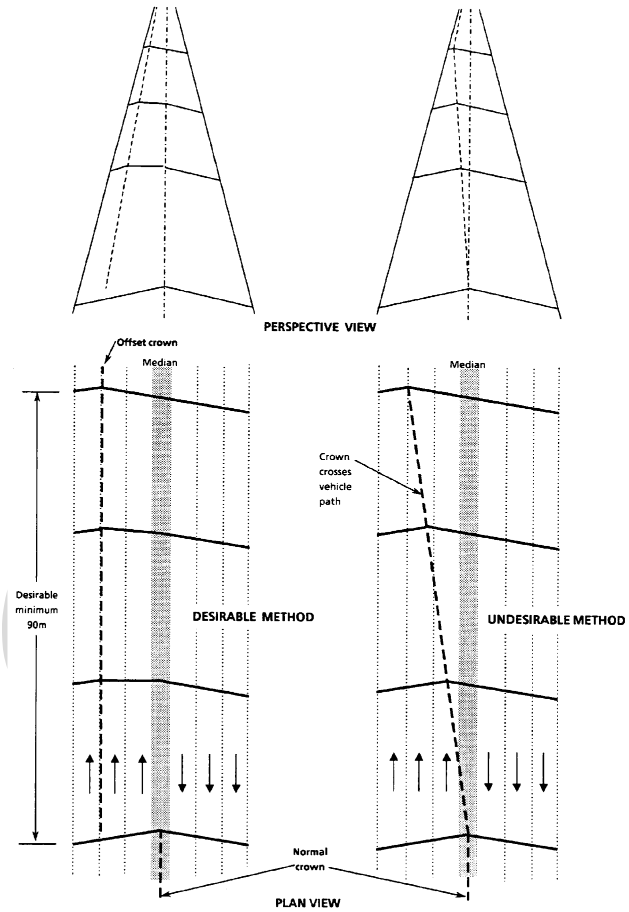



**Figure 6.6: Recommended Sealed Shoulder Widths to Safely Accommodate Cyclists**




*Source: WA*

**Figure 6.8: Development of a Longitudinal Crown on a One-way Road Carriageway**

## 6.4 Crossfall

### 6.4.1 General

Crossfall is the slope of the carriageway surface, as measured normal to the road alignment. Its main purpose is to facilitate pavement drainage.

On straight sections of road the pavement crossfall usually slopes downwards from either the centreline or the median. However, an inward sloping crossfall, or one-way crossfall may occasionally be needed for some special alignment, drainage or side slope situations, eg. a short straight between two horizontal curves in the same direction.

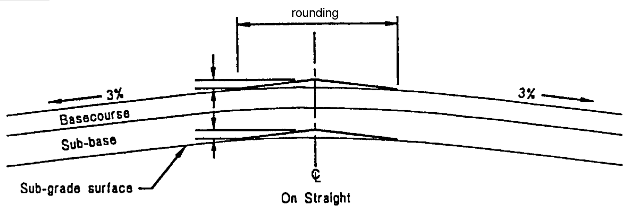
On curved sections of road the carriageway normally slopes upwards from the centreline or median, to help counteract the centrifugal forces on vehicles travelling around the curve. This form of crossfall is known as superelevation.

Changes from one crossfall to another must be transitioned over a length to satisfy the rate of rotation and relative grade requirements given in Section 4.5: *Superelevation*.

Sufficient dimensions, levels, cross sections and/or profiles must be provided on road construction drawings to enable the design to be accurately reproduced in the field.

### 6.4.2 Pavement Crossfall

On two-way carriageways the traffic lane(s) are usually configured in cross section to form an inverted 'V', which usually gets rounded at its highest point, or crown, during the pavement construction process.




*Source: WA*

**Figure 6.7: Two-lane Two-way Road Typical Crossfall Details**

On wide dual carriageway roads it may sometimes be necessary to longitudinally crown a one-way carriageway, so that one, or two, of the traffic lanes drain towards the median. This minimises the depth of water flows on the pavement surface by reducing flow path lengths, which helps reduce the potential for aquaplaning. Figure 6.8 illustrates the desirable and undesirable methods of developing a longitudinal crown on a one-way carriageway.

The crossfall required on straight sections of road, which should be as flat as possible, is determined by the surface water drainage requirements of the pavement and its surface texture. For a given crossfall the smoother the surface the more efficient it is in shedding water. This feature must, however, not override the requirements to maintain at least the design friction requirements between vehicle tyres and the pavement, for safety reasons.

### 6.4.2 Shoulder Crossfall

On straight sections of road sealed shoulders should normally have the same crossfall as the adjacent traffic lane. In areas where heavy rains are expected, shoulder crossfalls may be made 1 to 2% steeper than those used for the traffic lanes, to assist in draining the pavement surface quickly.

On horizontal curves the shoulders should be superelevated to the same crossfall as the adjacent traffic lane.

Typical crossfalls for various types of pavement surface are shown in Table 6.9.

| Road Surface | Traffic Lane (%) | Shoulder (%) |
|---|---|---|
| Cement Concrete | 2.0 - 3.0 | 2.0 - 4.0 |
| Asphaltic Concrete | 2.5 - 30 | 2.5 - 4.0 |
| Chip Seal | 3.0 - 4.0 | 3.0 - 4.0 |
| Unsealed | 3.5 - 4.0 | 4.0 - 5.0 |

**Table 6.9: Typical Pavement Crossfalls**

### 6.4.3 Crossfall in Urban Areas

In urban areas there are many controls which may force departures from the crossfall values shown in Table 6.9.

Where it is necessary to increase crossfalls the maximum sustained crossfall should not exceed 4%. A local increase to a maximum of 6.0% may be acceptable, but only in extreme cases because the stability of high vehicles becomes a problem on crossfalls greater than this as does the clearances to poles, signs, etc.

### 6.4.4 Median Crossfall

The crossfall of the adjacent carriageway should be carried across the median shoulder.

Paved medians, including those bordered by kerbs, should be crowned at the centre and generally follow the crossfall of the adjacent pavement.

Medians up to about 9 m wide should be approximately level or follow the crossfall of the road.

Medians greater than 9 m wide should be sloped downward from the adjoining carriageway shoulders to form a shallow valley in the centre. The median side slope should be ≤1:10 with ≤1:20 being preferred. Side slopes as steep as 1:6 may only be used in exceptional cases when necessary for drainage, stage construction, etc.

At intersections the median cross slope must match the slope of the road through the intersection and should not be greater than 6.0%. Crossfall should be provided on right turn lanes in a manner that ensures the lane is adequately drained and the amount of water at the median nose area is minimised.

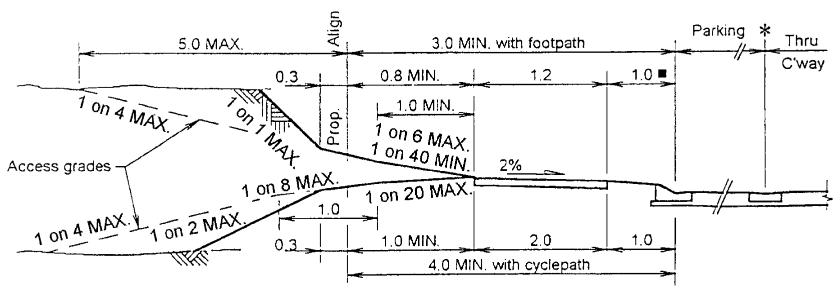
### 6.4.5 Footpath Crossfall

It is usual to slope the footpath towards the road, so that stormwater does not drain on to adjoining properties. Where this cannot be achieved drainage onto adjacent properties must be arranged with the property owners. This is not usually an issue in rural areas.

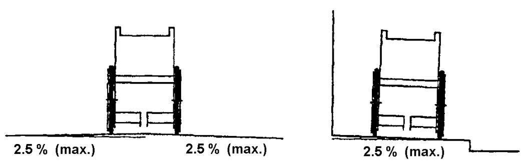
Footpath design requires consideration of several factors:

- Drainage across the footpath
- Pedestrian requirements for a walkway
- Use by wheel chair bound people
- Requirements for sight impaired people.

A 3.0% crossfall is best for drainage reasons but this conflicts with the need to accommodate wheel chairs. For wheel chairs a maximum crossfall of 2.5% should be used but 2.0% is preferred. In these circumstances, care is required to ensure that water does not accumulate on the walkway or become a hazard to people with disabilities. Figure 6.9 illustrates typical footpath cross section design details.




**(a) Footpath Cross Section Details**




**(b) Maximum Crossfall and Camber for Wheelchairs**

*Source: Queensland MR*

**Figure 6.9: Footpath Crossfalls**

## 6.5 The Clear Zone

### 6.5.1 General

In spite of careful attention to the geometric design of roads and the application of safety/guidance devices, such as pavement markings and traffic signs, vehicles do occasionally run off the road. There are a number of reasons why this happens, including:

- Driver fatigue or inattention
- Excessive speed
- Driving under influence of alcohol or drugs
- Collision avoidance
- Roadway conditions such as ice, snow or rain
- Vehicle component failure
- Poor visibility.

Studies have indicated that, on high speed roads, a clear traversable width of about 9 m from the edge of the traffic lane allows the drivers of about 80 percent of vehicles that run off the road to regain control with minimum damage to both vehicles and occupants. This area is termed the *'clear zone'* and it must have a slope $\leq$1:6 and be kept free of obstacles or contain only objects which will collapse or break away on impact without significantly damaging errant vehicles.

An appropriate minimum clear zone width is desirable on all state highways and should be provided wherever practicable. On motorways and expressways the desirable minimum clear zone width is 9 m. This clear zone width may be difficult to justify for engineering, environmental and/or economic reasons on two-lane two-way roads, because of lower speeds and traffic volumes. The minimum desirable clear zone in these situations is obtained from Table 6.10 or Figure 6.12, with adjustments made for horizontal curvature, gradient and cut/fill side slope.

Although the clear zone concept is normally applied to unkerbed rural roads an appropriate speed related clear zone should also be provided in urban areas, especially on new construction works. Figure 6.10 shows cross sections details for three typical clear zone situations.

Clear zone width is measured from the outside edge of the adjacent traffic lane and includes the any adjacent auxiliary traffic lanes, shoulders, medians, verges, footpaths and traversable batters. This width is related to site-specific conditions such as predicted traffic volume, traffic speed, road geometry, side slope, weather, development adjacent to the road, and environmental conditions. It also applies to both sides of the vehicle, including the right hand or off side of the vehicle in dual carriageway median lane situations.

Obstacles located in the clear zone should be removed, relocated, made breakaway, or shielded by guardrail or crash cushions.

### 6.5.2 Clear Zone Requirements

**(a)** To be regarded as part of the clear zone the roadside area:

- should be traversable and relatively flat, ie. side slopes must be $\leq$1:6,
- side slopes must not be steeper than 1:4 on embankments and 1:3 in cuttings,
- side slope must have changes rounded in a manner that ensures all wheels of an errant vehicle remain in contact with the ground, to assist the driver to regain control of their vehicle, and
- must be clear of large, fixed objects such as trees with an ultimate trunk diameter greater than 100 mm, structure support piers, culvert headwalls, large solid, ie. non frangible, sign support structures, non traversable gutters and barriers, etc, because colliding with these would cause unacceptable rapid deceleration rates to the occupants of an impacting vehicle. Only objects which will collapse, or break away on impact, should be located in the clear zone, to ensure minimal damage to an errant vehicle and its occupants.

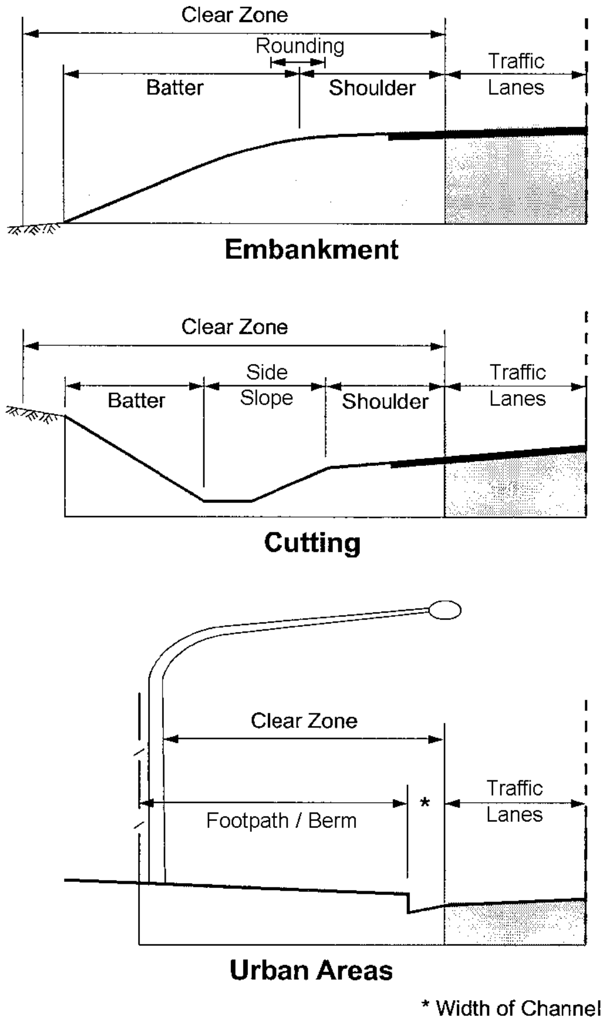



**Figure 6.10: Typical Clear Zone Cross Section Details**

Table 6.10 and Figure 6.12 show the lateral clearance, or clear zone width, required on a straight level section of road in respect to design/operating speed and AADT.

Where it is not possible to provide an adequate clear zone free of non-frangible obstacles the need for a safety barrier should be investigated. The provision of a clear zone is, however, often better practice than the erection of a safety barrier, due to the length of barrier generally required.

***NOTE:*** ***Clear zone widths obtained from Table 6.10 and Figure 6.12 represent a reasonable measure of the degree of safety considered appropriate for state highways. The widths are approximate only and both the table and diagram must not be used to infer a degree of accuracy that does not exist, ie. clear zone widths should be rounded to the nearest 0.5 m.***

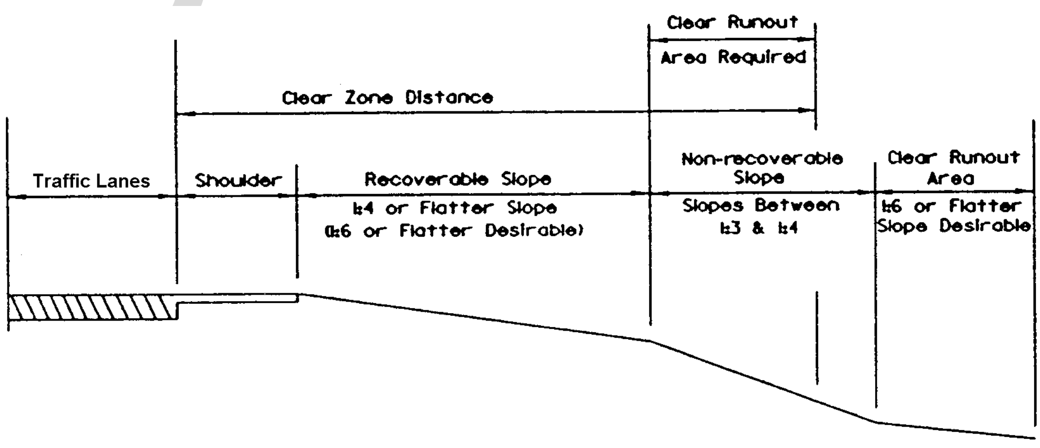
| DESIGN SPEED | DESIGN ADT | FILL SLOPES | | | CUT SLOPES | | |
|---|---|---|---|---|---|---|---|
| | | 1:6 OR FLATTER | 1:5 TO 1:4 | 1:3 | 1:3 | 1:5 TO 1:4 | 1:6 OR FLATTER |
| 60 km/h or Less | UNDER 750 | 2.0-3.0 | 2.0-3.0 | * * | 2.0-3.0 | 2.0-3.0 | 2.0-3.0 |
| | 750-1500 | 3.0-3.5 | 3.5-4.5 | * * | 3.0-3.5 | 3.0-3.5 | 3.0-3.5 |
| | 1500-6000 | 3.5-4.5 | 4.5-5.0 | * * | 3.5-4.5 | 3.5-4.5 | 3.5-4.5 |
| | OVER 6000 | 4.5-5.0 | 5.0-5.5 | * * | 4.5-5.0 | 4.5-5.0 | 4.5-5.0 |
| 70-80 km/h | UNDER 750 | 3.0-3.5 | 3.5-4.5 | * * | 2.5-3.0 | 2.5-3.0 | 3.0-3.5 |
| | 750-1500 | 4.5-5.0 | 5.0-6.0 | * * | 3.0-3.5 | 3.5-4.5 | 4.5-5.0 |
| | 1500-6000 | 5.0-5.5 | 6.0-8.0 | * * | 3.5-4.5 | 4.5-5.0 | 5.0-5.5 |
| | OVER 6000 | 6.0-6.5 | 7.5-8.5 | * * | 4.5-5.0 | 5.5-6.0 | 6.0-6.5 |
| 90 km/h | UNDER 750 | 3.5-4.5 | 4.5-5.5 | * * | 2.5-3.0 | 3.0-3.5 | 3.0-3.5 |
| | 750-1500 | 5.0-5.5 | 6.0-7.5 | * * | 3.0-3.5 | 4.5-5.0 | 5.0-5.5 |
| | 1500-6000 | 6.0-6.5 | 7.5-9.0 | * * | 4.5-5.0 | 5.0-5.5 | 6.0-6.5 |
| | OVER 6000 | 6.5-7.5 | 8.0-10.0* | * * | 5.0-5.5 | 6.0-6.5 | 6.5-7.5 |
| 100 km/h | UNDER 750 | 5.0-5.5 | 6.0-7.5 | * * | 3.0-3.5 | 3.5-4.5 | 4.5-5.0 |
| | 750-1500 | 6.0-7.5 | 8.0-10.0* | * * | 3.5-4.5 | 5.0-5.5 | 6.0-6.5 |
| | 1500-6000 | 8.0-9.0 | 10.0-12.0* | * * | 4.5-5.5 | 5.5-6.5 | 7.5-8.0 |
| | OVER 6000 | 9.0-10.0* | 11.0-13.5* | * * | 6.0-6.5 | 7.5-8.0 | 8.0-8.5 |
| 110 km/h | UNDER 750 | 5.5-6.0 | 6.0-8.0 | * * | 3.0-3.5 | 4.5-5.0 | 4.5-4.9 |
| | 750-1500 | 7.5-8.0 | 8.5-11.0* | * * | 3.5-5.0 | 5.5-6.0 | 6.0-6.5 |
| | 1500-6000 | 8.5-10.0* | 10.5-13.0* | * * | 5.0-6.0 | 6.5-7.5 | 8.0-8.5 |
| | OVER 6000 | 9.0-10.5* | 11.5-14.0* | * * | 6.5-7.5 | 8.0-9.0 | 8.5-9.0 |

*Source: AASHTO*

**Table 6.10: Clear Zone Width Required on a Straight Level Section of Road**

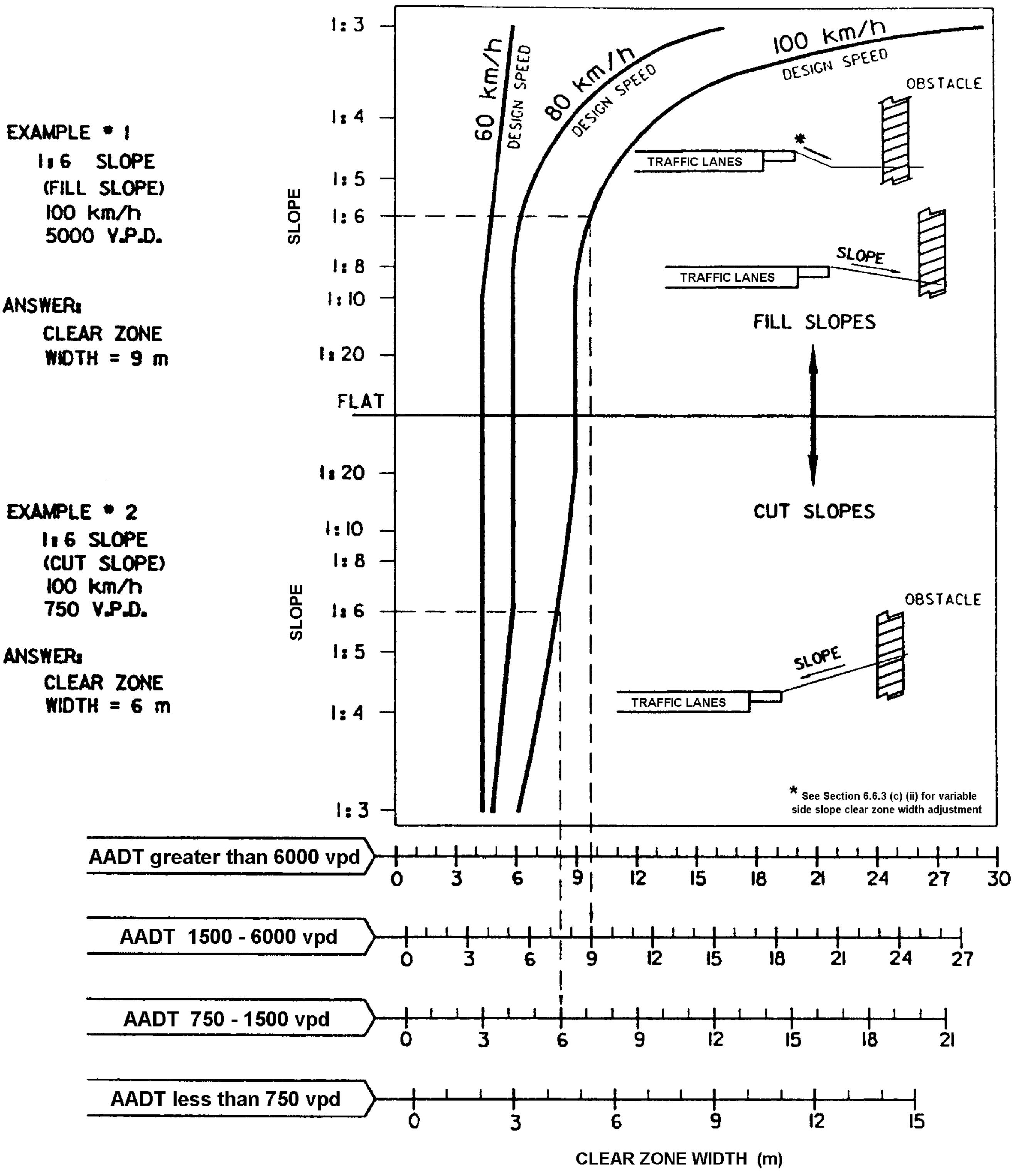
* Where a site specific investigation indicates a high probability of continuing accidents, or such occurrences are indicated by accident history, clear zone distances greater than 9 metres may the designer may be provided, as indicated. Clear zones may be limited to 9 metres for practicality and to provide a consistent roadway template if previous experience with similar projects or designs indicates satisfactory performance.

** Since recovery is less likely on unshielded traversable 1 :3 slopes, fixed objects should not be present in the vicinity of the toes of these slopes. Recovery of high-speed vehicles that encroach beyond the edge of the shoulder may be expected to occur beyond the toe of slope. Determination of the width of the recovery area at the toe of slope should take into consideration the road reserve area, environmental concerns, economic factors, safety needs, and accident histories. Also, the distance between the edge of the traffic lane and the beginning of the 1:3 slope should influence the recovery area provided at the toe of slope. While the application may be limited by several factors, the fill slope parameters which may enter into determining a maximum desirable recovery area are illustrated in Figure 6.11.




*Source: AASHTO*

**Figure 6.11: Fill Slope Parameters**




Source: AASHTO

**Figure 6.12: Clear Zone Width Required on a Straight Level Section of Road**

### 6.5.3 Clear Zone Width Adjustments

**(a) General**

The clear zone requirement at any point on a road is determined by its horizontal and vertical alignment and cross section side slope features.

Adjustments must be made for horizontal curvature, gradient and side slope. The largest of the adjusted distance is the clear zone width required.

Fill embankment slopes are classified as recoverable, non-recoverable or critical. These classifications are:

- **Recoverable Slopes (Traversable)**

  Fill embankment slopes of less than 1:4 are generally considered recoverable. A recoverable slope ≥1:6 enables drivers to retain, or regain, control of their vehicles. Vehicles on recoverable slopes can generally be stopped or slowed down and returned to the carriageway.

- **Non-recoverable Slopes (Traversable)**

  Fill embankment slopes in the range 1:4 and 1:3 are considered non-recoverable slopes. Vehicles can generally be slowed down and stopped, but they are normally unable to be easily returned to the carriageway. An errant vehicle will usually reach the bottom of this type of slope and a clear run-out area at the base of the slope is, therefore, desirable.

- **Critical Slopes (Non-Traversable)**

  Fill embankment slopes steeper than 1:3 are considered critical slopes because vehicles traversing them are likely to overturn. If a critical slope starts within the clear zone the provision of a safety barrier should be considered.

**(b) Adjustment for Road Alignment (Horizontal Curvature and Gradient)**

Horizontal curvature and gradient can significantly affect roadside encroachment rates. American research has shown that the Effective Traffic Volume (*ETV*) can be used to relate encroachment frequency with road alignment.

*ETV* is defined as the traffic volume on a straight flat section of road that is equivalent to the traffic volume on a section of road with horizontal curvature and/or grades and is calculated by the following formula:

$$EVT = K \times AADT$$

Where:

| | | |
|---|---|---|
| *AADT* | = | AADT in Design Year |
| *K* | = | Volume Adjustment Factor. |

*K* is obtained from Figure 6.14, or Figure 6.15 ,using the Encroachment Frequency Adjustment Factor, *M*, from Figure 6.13.

The clear zone width for a straight level road for *AADT* = *ETV* is then obtained from Table 6.10 or Figure 6.12.

**(c) Side Slope Adjustment**

**(i) General**

A roadside slope affects the ability of a driver to manoeuvre an errant vehicle back onto the carriageway. When the roadside slopes upward the encroachment distance is reduced because of the beneficial effect of the slope on braking and steering. Conversely, a downward slope will increase the encroachment distance and can increase the severity of the encroachment, eg. cause a rollover.

**(ii) Effective Clear Zone Width**

A variable fill embankment slope, with a relatively flat recovery area immediately adjacent to the road followed by a steeper side slope, can sometimes be used to lessen the amount of land, and also fill material, required for a new road, eg. if an adequate clear zone width is provided by the flatter slope the steeper slope may be critical or non-traversable.

Clear zone widths for variable fill embankment slopes ranging from level to 1:4 may be averaged to give a composite clear zone width.

Slopes which change from negative to positive cannot be averaged and should be treated as roadside ditches and analysed for traversability, refer to Section 7.2: *Ditches and Back Slopes* for details.

Section 3.3.4 of the AASHTO *Roadside Design Guide* contains several worked examples showing how the clear zone width can be determined for variable slopes.

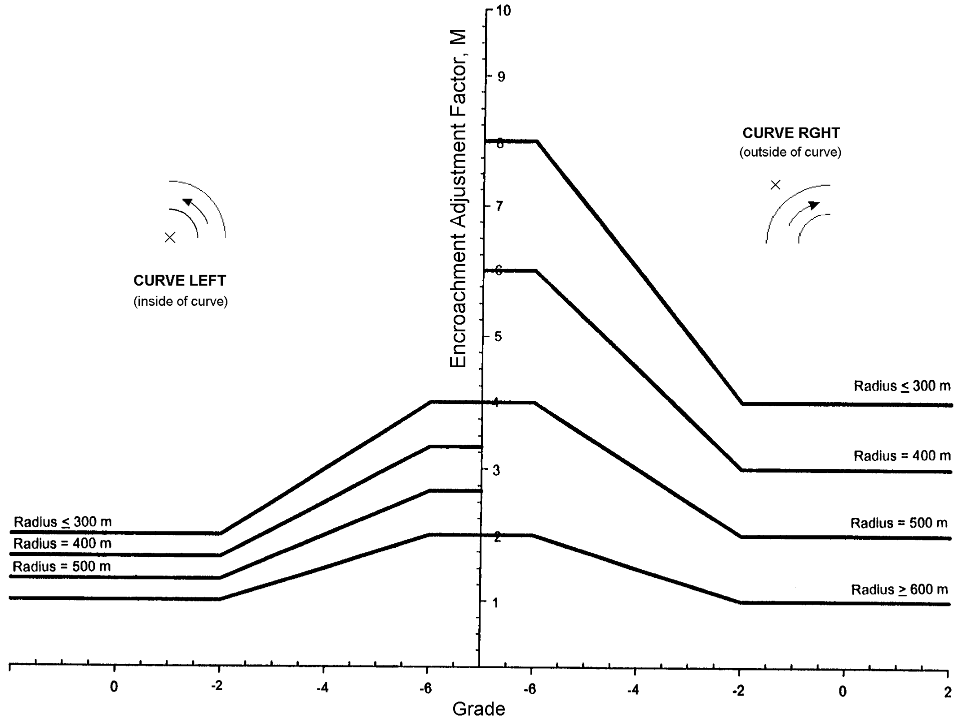
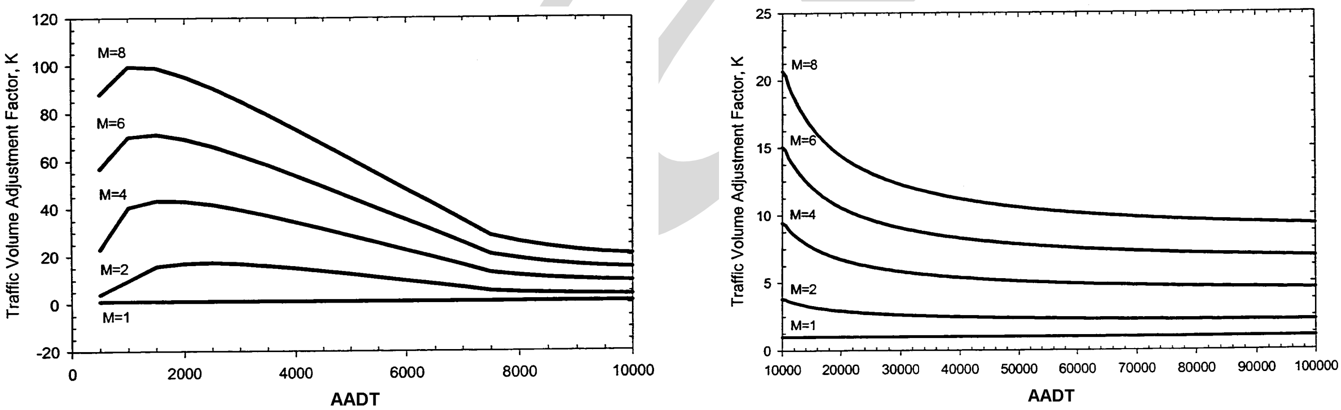
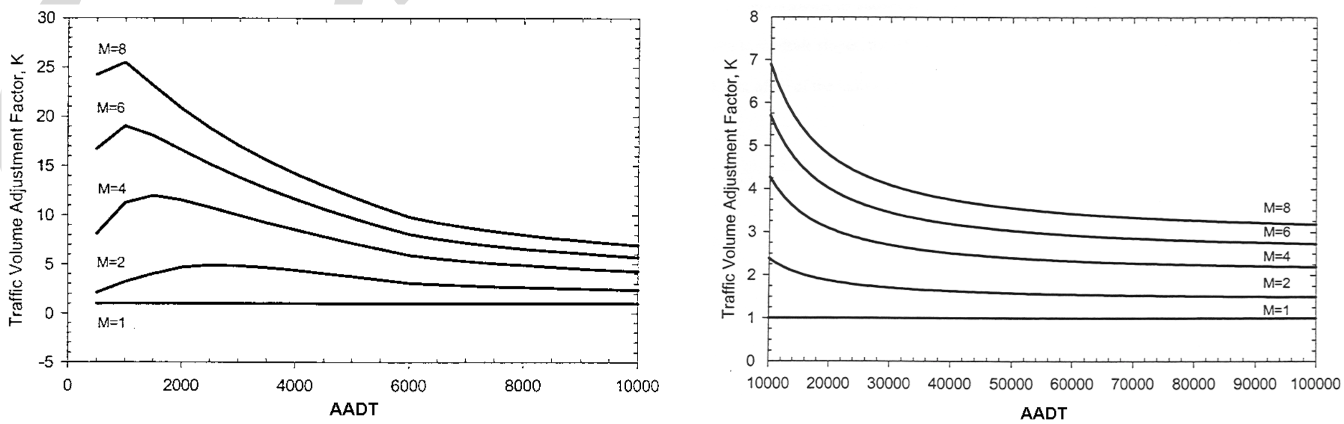



**Figure 6.13: Encroachment Adjustment Factor *M***




(a) (b)

**Figure 6.14: Traffic Volume Adjustment Factor, *K*, for Two-lane Two-way Roads**




(a) (b)

**Figure 6.15: Traffic Volume Adjustment Factor, *K*, for Dual Carriageway Roads**

### 6.5.4 Roadside Safety Barrier Warrant

Roadside safety barrier warrants are typically based on a subjective analysis of roadside elements or conditions. The two main factors normally used in determining the need for a safety barrier on an embankment are the height of the fill and its side slope. However, the probability of a roadside encroachment, which is related to the current AADT on the road, also needs to be considered. A warrant for use as a guide for the provision of roadside safety barriers on state highway fill embankments is given in Figure 6.16.

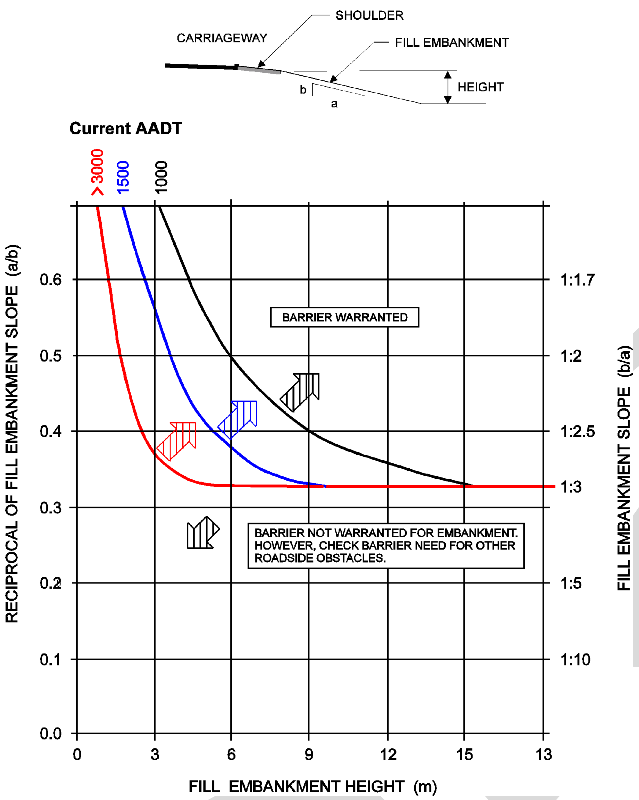



**Figure 6.16: State Highway Fill Embankment Safety Barrier Warrant**

## 6.6 Medians

### 6.6.1 General

Medians separate the carriageways for traffic travelling in opposite directions on dual carriageway roads and, for maximum efficiency, they should be highly visible night and day and should also contrast with the traffic lanes. Medians are used to:

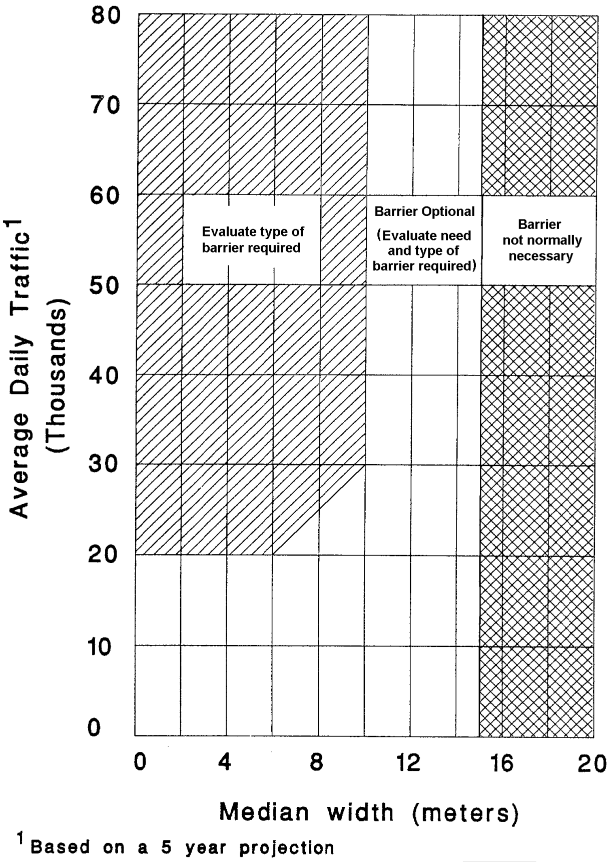
- significantly reduce the risk of collisions by separating opposing traffic streams,
- provide a recovery area for out-of-control vehicles,
- provide a stopping area in case of emergencies,
- minimise the effects of headlight glare
- accommodate safety barriers and glare screening.
- provide width for future lanes,
- improve capacity by restricting access to property and minor side streets,
- prevent indiscriminate u-turn movements,
- provide space for speed changes and storage of right-turning / 'U'-turning vehicles and restrict these movements to signalised intersections and/or right turn bays,
- provide a safety refuge for pedestrians,
- collect stormwater run-off from the road and carry it to drainage system, and
- provide an open green space in urban areas.

Medians are highly desirable on arterial roads with four or more traffic lanes and may have a depressed or raised form, or be made flush with the surface of the carriageways

Median width is measured between the edges of opposing traffic lanes, including the adjacent offside (right hand) shoulders, if any. Median widths range from a minimum of 1.2 m in urban areas to 25 m or more in rural areas

Economic factors generally limit median width. Construction and maintenance costs increase in proportion to median width but the additional cost may not be appreciable compared with the cost of the road as a whole, and may be justified in view of the benefits derived. Medians should, however, be made as wide as possible while also being in balance with other components of the road cross section. As far traffic operation is concerned a freedom of operation, in the sense of physical and psychological separation from opposing traffic, is achieved when median widths are about 12 m or greater. At such widths the carriageways are truly divided, the noise and air pressure of opposing traffic is not noticeable and the glare from headlights at night is greatly reduced. With widths of 18 m, or more, a median can be pleasingly landscaped in a park-like manner. Planting can be used to achieve this effect but it must not compromise the clear zone requirements.

Where possible, median widths should be such that safety barriers are not warranted. However, consideration must be given to the need for a safety barrier when determining median widths and Figure 6.17 contains the warrant for the provision of median barriers on dual carriageway state highways. This warrant has been developed from research studies and analysis of the limited data available on cross-median accidents and, in the absence of site specific or more recent data, an explicit level of accuracy should not be implied.




Source: AASHTO

**Figure 6.17: State Highway Median Barrier Warrant**

The performance, location and placement requirements for roadside safety barriers erected on state highways are detailed in Section 7.3 of this manual, *Longitudinal Road Safety Barriers*. Details of the location and placement of road safety barriers within medians, and the method for determining the performance levels required for these barriers are given in Subsection 7.3.12: *Median Barriers*.

Wider medians should be provided on roads with at-grade intersections. The median should be wide enough to adequately shelter the design vehicle(s) crossing at intersections as well as allowing for safe manoeuvres at commercial and/or private accesses. These intersections may need to be controlled, for safety reasons, but the clearance times required for vehicles to cross a wide median may lead to inefficient traffic signal operation.

Where road reserve width is restricted, wide medians may not be justified, if they have to be provided at the expense of narrowed verge areas. An adequate verge width is required to provide a buffer between private development along a road and the carriageway, particularly where zoning is limited or non-existent. The verge area must provide space for footpaths, traffic signs, utility services, parking, drainage channels, structures, reasonable clear zones with proper side slopes, and any retained natural growth. Narrowing these areas may tend to the development of obstacles and hindrances similar to those a median is designed to avoid.

A depressed median configuration should normally be used on rural roads for more efficient drainage reasons and the side slopes should be traversable. Median side slopes:

- should preferably be ≤1:20,
- should not exceed 1:10, particularly when a median barrier is installed, and
- must not exceed 1:6.

***NOTE:*** ***The appropriate clear zone width, and/or median barrier location, must also be achieved in all situations.***

Steeper slopes, ie. up to 1:4, may, however, be considered in urban areas and on rural roads with independently aligned and graded carriageways.

In general, depressed medians should be kept clear of obstructions within the clear zone requirements of the road and the use of head walls, unprotected culvert openings, solid sign foundations, non-frangible sign posts and light poles should be avoided. Where longitudinal culverts are required, eg. under cross overs, the ends facing traffic should be sloped at 1:20 (preferably), no steeper than 1:6, and provided with traversable safety grates. All other drainage inlets should be designed with their tops flush with the ground.

Raised medians should only be used on arterial roads in urban areas, particularly where it is desirable to regulate right-turn movements. They can also be used where the median is to be planted, particularly on relatively narrow medians. Careful consideration must be given to the location and type of planting in these situations because it can create problems for maintenance activities and larger plants, such as trees, can cause visual obstructions for the drivers of turning vehicles.

The use of painted, or flush, medians on urban roads has become a common practice and widths of 3.0 to 4.8 m will usually provide an optimum design in these situations. Flush medians offer several advantages when compared to multi-lane roads without medians, including:

- reduced travel time,
- improved capacity, ie. remove right turning vehicles from the traffic lanes,
- reduced accident frequency, particularly of the rear-end type, and
- public preference, both from drivers and owners of abutting properties.

Flush medians may also be used on urban expressways where speeds are 70 km/h or less but median safety barriers might be required in some cases. The median area should be slightly crowned or depressed. The crowned type eliminates the need for collecting drainage water in the median. The slightly depressed type is, however, generally preferable and a cross slope of about 4 percent, or a minor steepening of the roadway crossfall, should be used.

In general medians should be designed to ensure that they are as maintenance free as possible. This will minimise the amount of time that maintenance personnel will be required to spend on the median thereby reducing their exposure to traffic hazards. Planting should consists of *'frangible'* species with ultimate trunk diameters no greater than 100 mm, unless they are outside the clear zone and/or located behind an appropriate safety barrier. Landscaping design and species selection will depend on the specific circumstances and requires specialist input. Features in medians that limit horizontal sight distance on curves should normally be located such that adequate sight distance is achieved. The offset needed to achieve this is illustrated on the diagram in Figure 6.18 which shows a median landscape treatment for right hand curves.

Where street lighting is not provided headlight glare across the median can be a nuisance, particularly where the road has relatively sharp curvature. Under these conditions some form of antiglare treatment should be considered in the median design, usually as part of a safety barrier installation.

### 6.6.2 Urban Roads

In urban areas it is desirable to provide a median on roads with four or more lanes. For good traffic operation a one-way carriageway width of more than 9.0 m between kerbs is required to allow for adequate two travel lanes plus a shared parking lane/travel lane. On carriageways less than 9.0 m wide parking and/or breakdowns will restrict traffic flows and reduce capacity. Medians can, however, be provided on roads with carriageways that have 7.0 m to 9.0 m between kerbs where:

- mountable kerbs are used and an area outside the kerb is provided to enable vehicles to stop clear of the travel lanes, or
- the design hourly traffic volumes can be accommodated in one travel lane when separate turn lanes are provided for significant turning traffic volumes.

At signalised intersections medians need to be wide enough to accommodate signal posts, lanterns and servicing facilities. The desirable minimum median width to accommodate these features is 2.4 m, and this also allows for maintenance ladder spread. Where there are three lanes or less at the stop line, a minimum median width of 1.2 m may be used, provided that all intersection movements can be adequately controlled by overhead lanterns on mast arms.

### 6.6.3 Rural Roads

A median should always be provided when a rural road is widened to four lanes or more, or is constructed initially as a dual carriageway road.

Research has shown that the minimum median width required to adequately separate traffic on high speed dual carriageway roads, without the use of safety barriers, is about 15 m. Where 15 m cannot be achieved the minimum median width shall be determined by the largest of the clear zones required for either carriageway. The clear zone in these situations shall be measured from the outside edge of the median traffic lane to the outside edge of the shoulder of the opposite carriageway. Where this minimum width cannot be achieved a median safety barrier will probably be required, refer to Figure 6.17 for the warrant for the provision of median barriers on dual carriageway state highways.

The absolute minimum median width for a rural road, and which may only be used as a last resort in situations where the width of the road reserve is very restricted, is a rigid road safety barrier with two minimum width median shoulders. Refer to Section 6.3.3 for median shoulder width requirements.

Rural roads will sometimes have independently aligned and graded carriageways. Special attention needs to be given to the carriageway relationship in these cases, to minimise the effects of headlight glare. The median width at any point must also never be less than the minimum clear zone calculated by the method described in the preceding paragraph. If the minimum width cannot be achieved the need for a median safety barrier must be investigated.

Where it is necessary to provide at-grade cross-median access for turning semi-trailers and the like, a wider median will usually be required to ensure that turning vehicles are sheltered from through traffic. The minimum median width in these cases is governed by the length of the design vehicle expected to use the facility. Local widening only may be considered where it is uneconomic to maintain a wide median over the entire length of road.

Where the additional traffic lanes are anticipated in the future it is desirable to allow for them by providing extra width in the initial median. The ultimate median should, however, not be less than the desirable minimum width of 15 m. The advantages of providing of addition traffic lanes by widening into the median are:

- minimum traffic disruption during construction of the widening,
- minimum interference with roadside furniture, drainage installations and environmental protection devices,
- prevention of further environmental damage during construction of the widening, and
- avoiding disturbing cut batters (particularly important in potentially unstable or erodible country).

There will, however, be circumstances where widening on the outside of existing pavements will be the appropriate solution, including where:

- existing ramps have to be remodelled to suit current standards,
- the existing median is too narrow to accommodate the additional lanes needed and retain a sufficient width,
- there is little disruption to the existing drainage and other infrastructure,
- the existing outer lane pavement has less life remaining than the inner lane and a new outer lane, which will carry most of the heavier loaded slower vehicles, will allow additional life to be achieved for the pavement as a whole, and
- adjoining sections at the start and end of a relatively short project have to be matched.

The decision on how to provide for future widening requires careful consideration of all of the factors involved with the design of the road in question and adopting the solution that provides the best answer for those particular circumstances. Figure 6.19 illustrates typical rural median details.

### 6.6.4 Expressways and Motorways

The requirements for rural road medians described in Section 6.6.3 above also apply to expressways and motorways.

If road widening is likely in the future it should be applied on the median side of the carriageway. The width of the median in the initial construction stage should therefore be such that, after the widening is completed, an acceptable median width is retained. Desirably, this width should be at least 15 m to provide the safest situation.

In constrained urban situations, however, narrower medians with safety barriers similar to those used on urban arterials may be more appropriate. The width available for the median will dictate the type of barrier that can be used, based on lane capacity preservation, shy line and barrier deflection requirements. Some typical arterial median cross sections that have been used in restricted urban situations are illustrated in Figure 6.18.

The absolute minimum median width for a dual carriageway expressway or motorway with a design speed of ≥100 km/h is a rigid barrier plus a clearance from the face of the barrier to the edge of the adjacent traffic lane of 2.0 m for a two-lane one-way carriageway, and 3.0 m for a three or more lane one-way carriageway.

This provides the required shy line clearance and ensures 100% traffic capacity for the median traffic lane. Refer to Tables 6.1, 6.2 and 6.3 for more details on shy line and traffic lane capacity clearances.

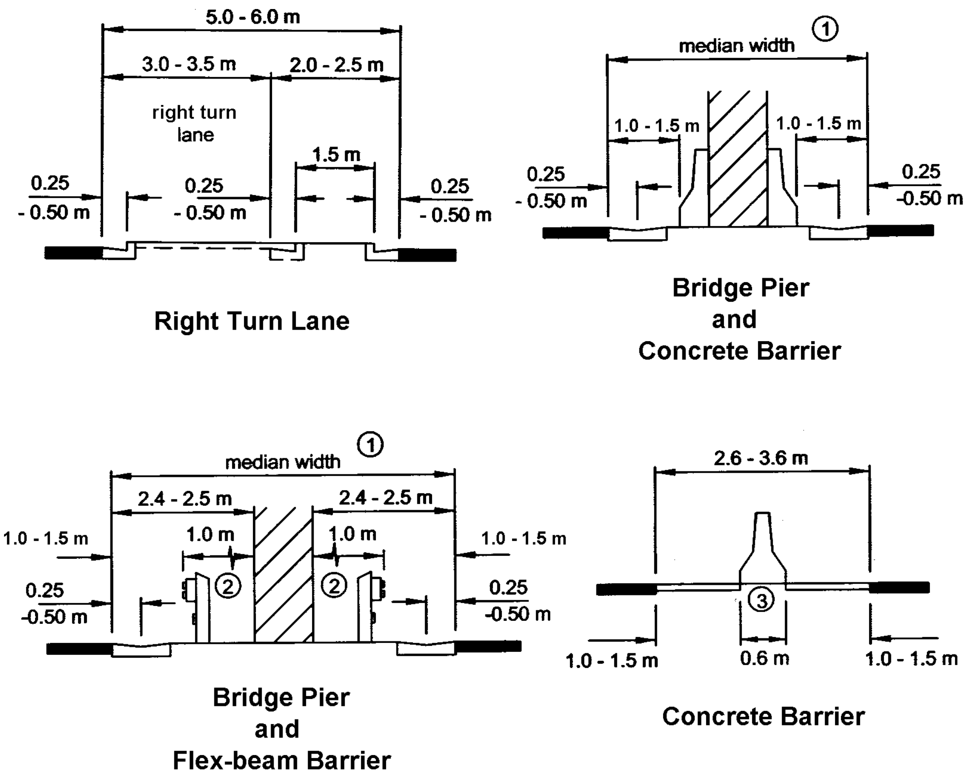
The extensive use of concrete median barriers is not a preferred option, on environmental grounds, and this aspect needs careful consideration when determining median widths.

### 6.6.5 Raised Medians

Raised medians should only be used in urban areas and where design speeds are is 70 km/h or less.

A lateral clearance of at least 0.5 m must be provided from the edge of the traffic lane to the face of the kerb of a raised median in unlit areas. In lit areas no lateral clearance is normally required from the edge of a traffic lane to a raised median. Where the median kerb incorporates a drainage channel, the channel must be located outside the traffic lane.

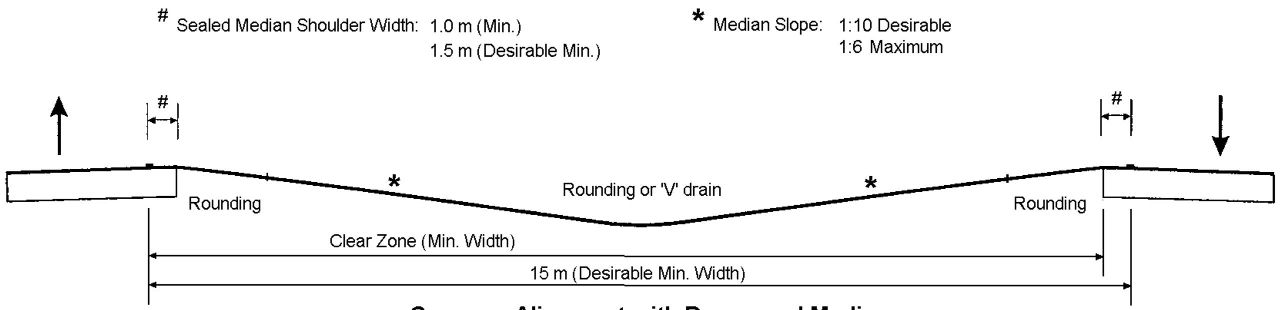
If the design speed is greater than 70 km/h a minimum lateral clearance of 1.0 m from the edge of the traffic lane to the face of the kerb or safety barrier must be provided in unlit areas. In lit areas this clearance may be reduced to 0.5 m for short lengths of road, ie. no more than about 500 m, where the road reserve width is restricted.



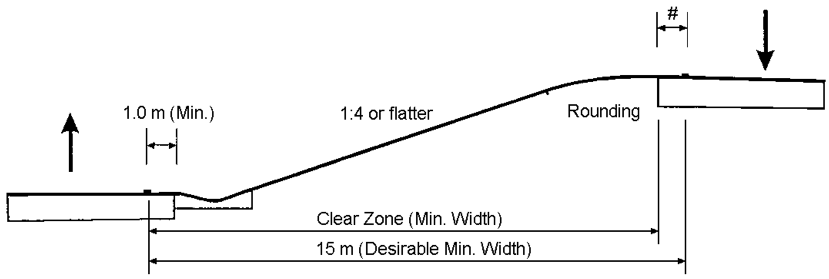

Notes:
1. Median width is dependent on pier width.
2. Deflection allowance is based on flex beam with rub rail and 1.9 m post spacing.
3. With median lighting, additional width is required to accommodate poles.

⊣ Barrier deflection symbol

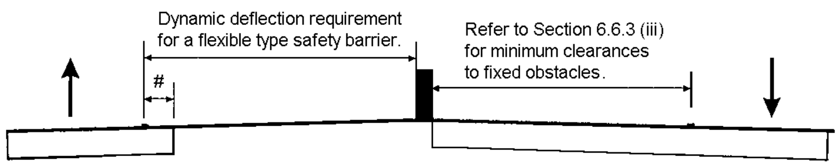
**Figure 6.18: Typical Urban Arterial Median Cross Section Details**



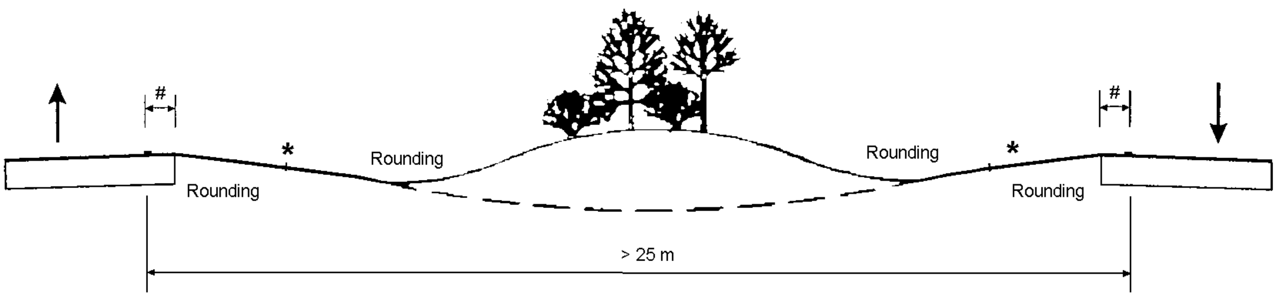

**Common Alignment with Depressed Median**



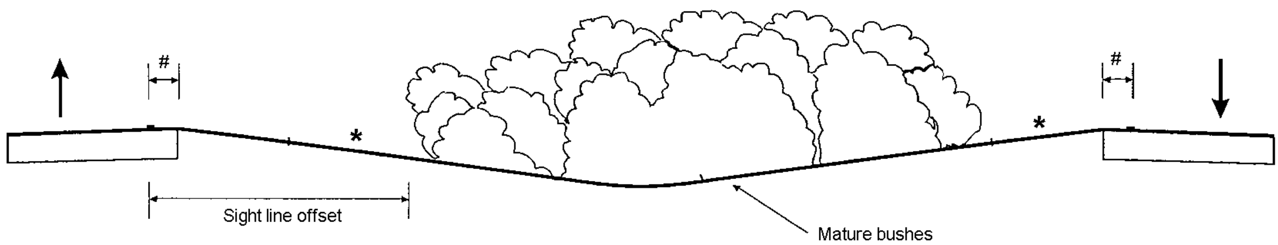

**Independent Alignments with Single Slope Median**




**Minimum Median**




**Median Width Greater than 25 m**




**Landscape Treatment for Right Hand Curves**

**Figure 6.19: Typical Rural Median Cross Section Details**