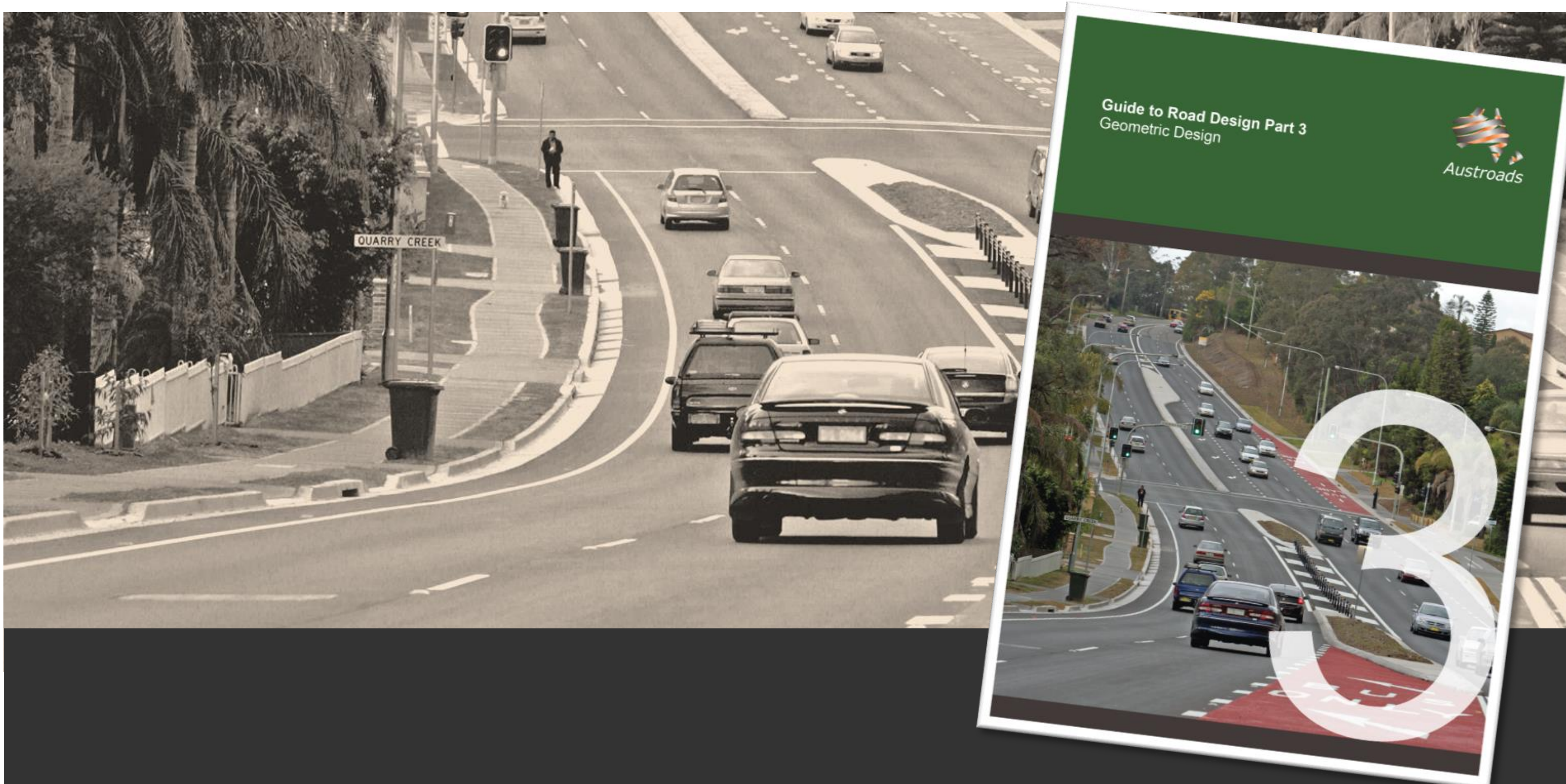

Guide to Road Design Part 3: Geometric Design

Session 2 – 25 October 2016

Austroads

Today's moderator

Angela Racz
Online Training Coordinator
Knowledge Transfer - ARRB Group

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Housekeeping

Webinar = 60 mins

Question time = included

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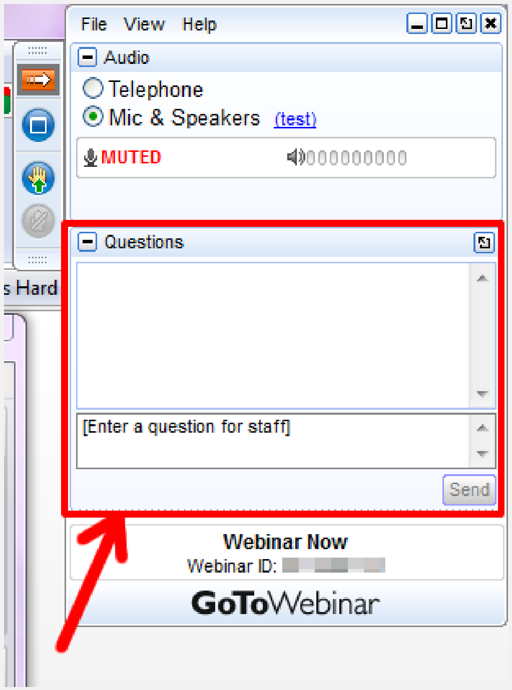

Please type your questions here

Today's presenter

Peter Aumann
Principal Research Engineer
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ARRB Group

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Introduction

Guide to Road Design Part 3 : Geometric Design

Available at

https://www.onlinepublications.austroads.com.au/items/AGRD03-16

Note

Free PDF downloads for Australian and New Zealand road agencies including councils. Email austroads@austroads.com.au for log-in.

Webinar – two sessions

Session 1 – Design objectives, Speeds, Cross-section

Session 2 – Horizontal and Vertical Alignment, Superelevation

Session 1 – Follow-up

Unsealed road information

ARRB Special Report No 33 - A Review of Subdivision Design Criteria (1986) Laurie Comerford

Unsealed Roads Manual - Guidelines to Good Practice (2009) George Giummurra

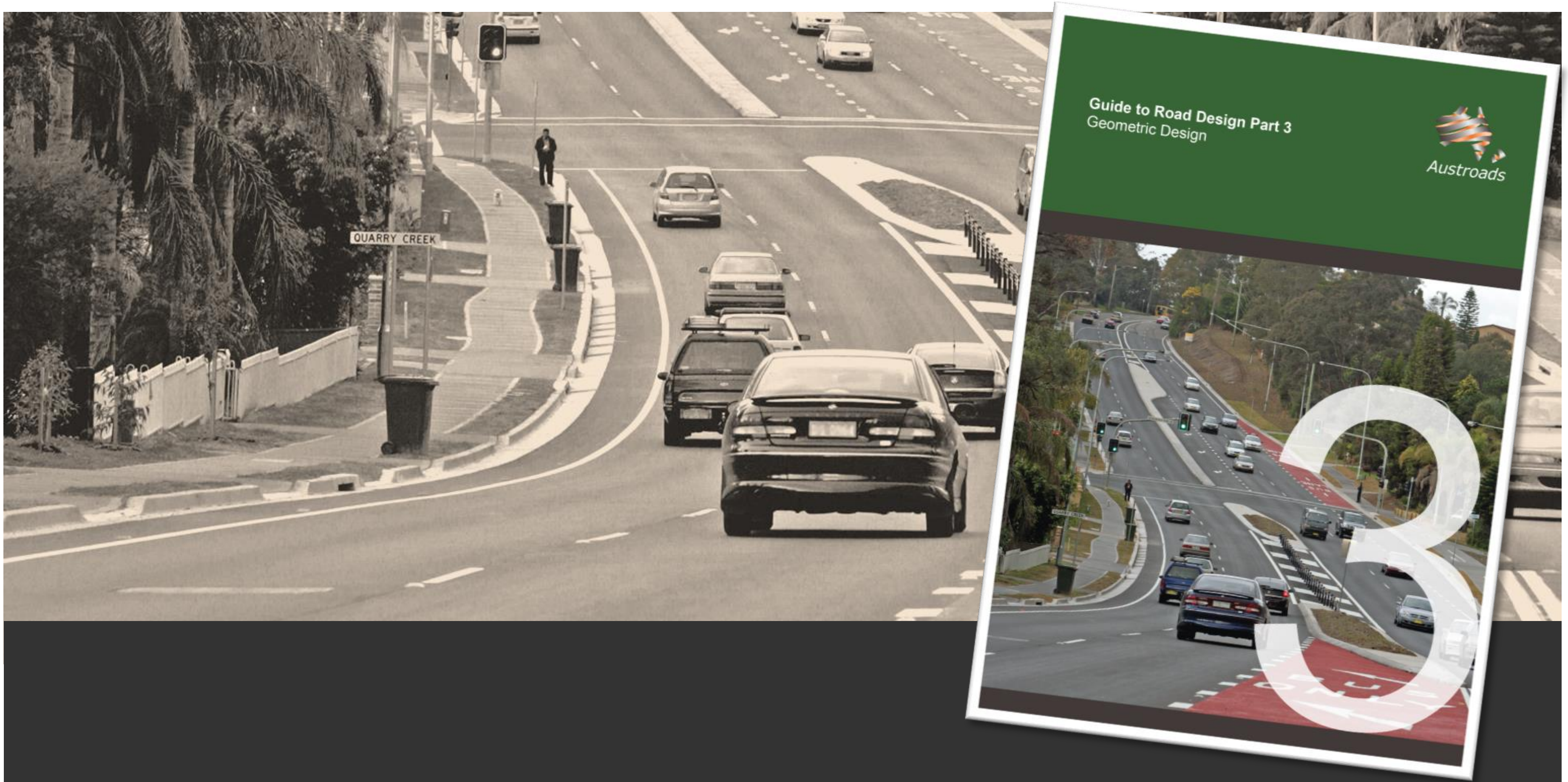
Content - Session 2

Sight distance

Horizontal alignment

Vertical alignment

Auxiliary lanes



Sight Distance

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Sight distance

Coefficient of deceleration (5.2.3)

Consider longitudinal friction factor for unsealed roads shown in Table 5.4 (new).

Speed (km/h)	Coefficient of longitudinal deceleration for cars (d)
30	0.27
40	0.27
50	0.27
60	0.27
70	0.26
80	0.25
90	0.24

Sight distance

Longitudinal deceleration (5.3.1)

Use of d of 0.26 from Table 5.5 :

Use only with approval of road agency

In hilly or undulating terrain relatively higher costs and environmental impacts

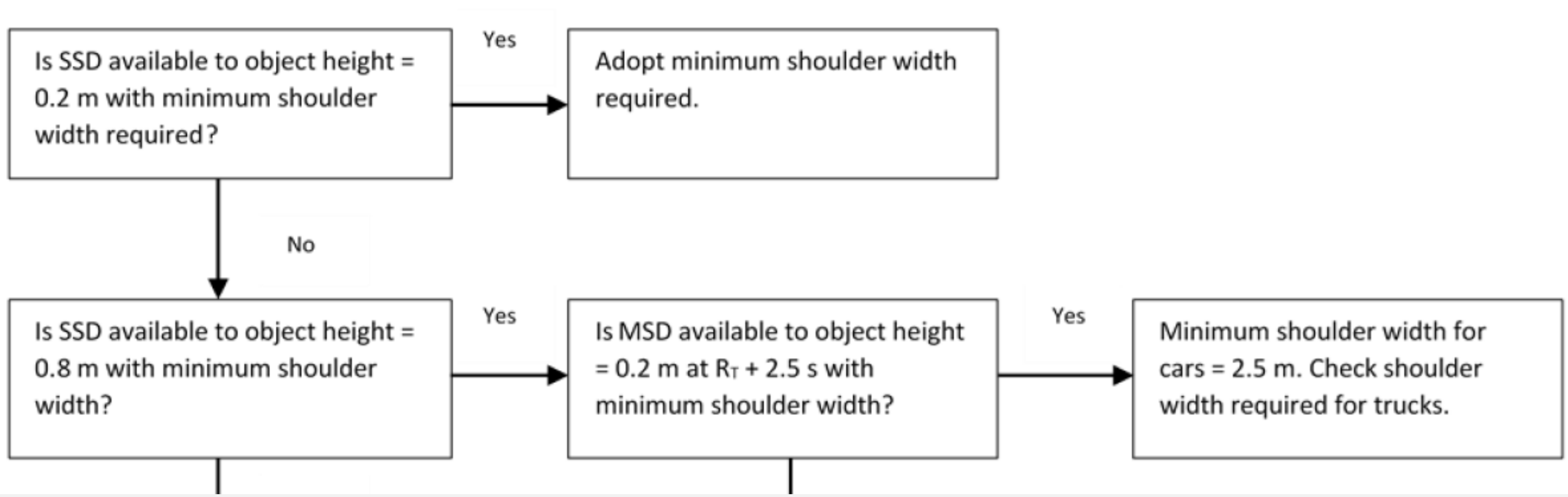
Table 5.5: Stopping sight distances for cars on sealed roads

Design speed (km/h)	Absolute minimum values Only for specific road types and situations[1] based on d = 0.46[2],[3]			Desirable minimum values for all road types based on d = 0.36			Values for major highways and freeways in flat terrain[7] based on d = 0.26	
	R_T = 1.5 s[4]	R_T = 2.0 s[4]	R_T = 2.5 s	R_T = 1.5 s[4]	R_T = 2.0 s[4]	R_T = 2.5 s	R_T = 2.0 s	R_T = 2.5 s

Sight distance

Flowcharts (5 and Appendix G)

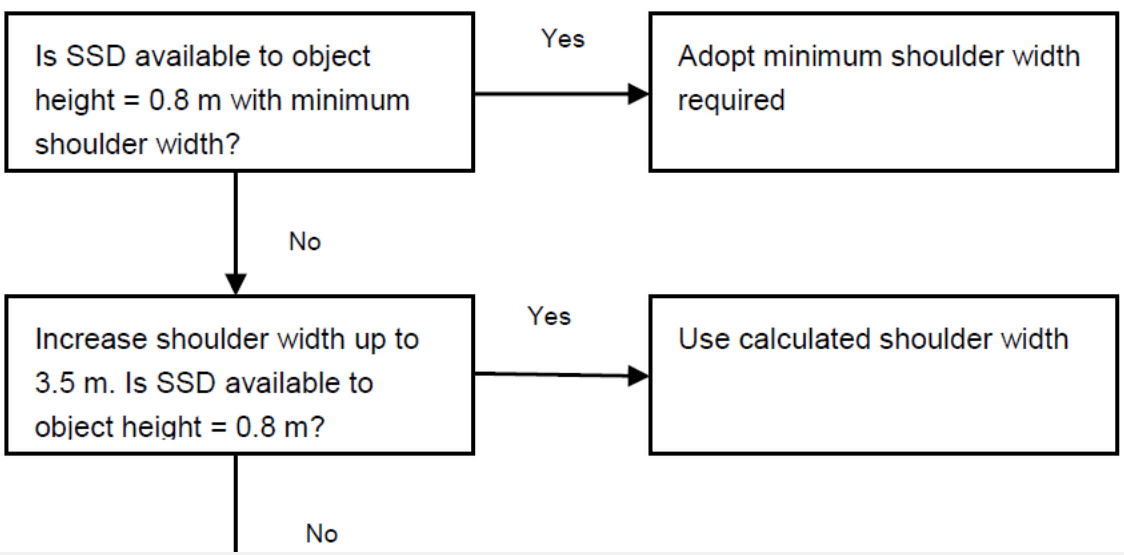
G.1 Car Stopping Sight Distance Requirements on Horizontal Curves with Roadside Barriers



Sight distance

Flowcharts (Appendix G)

G.2 Truck Stopping Sight Distance Requirements on Horizontal Curves with Roadside Barriers



Sight distance

Sight distance other restrictions (5.11)

Where horizontal and vertical curves occur together potential critical sight lines should be checked

Check sight distances to objects

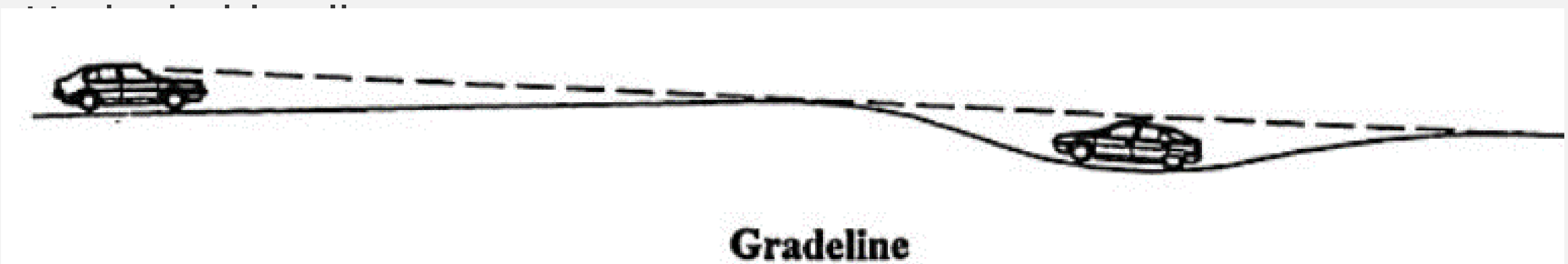
Should be > stopping sight distance

Coordination Horizontal and Vertical Geometry

Safety Considerations (6.2)

Hidden dips (additional commentary)

Potential hazard - a driver may attempt to overtake, unaware that a vehicle is approaching in the opposite direction.

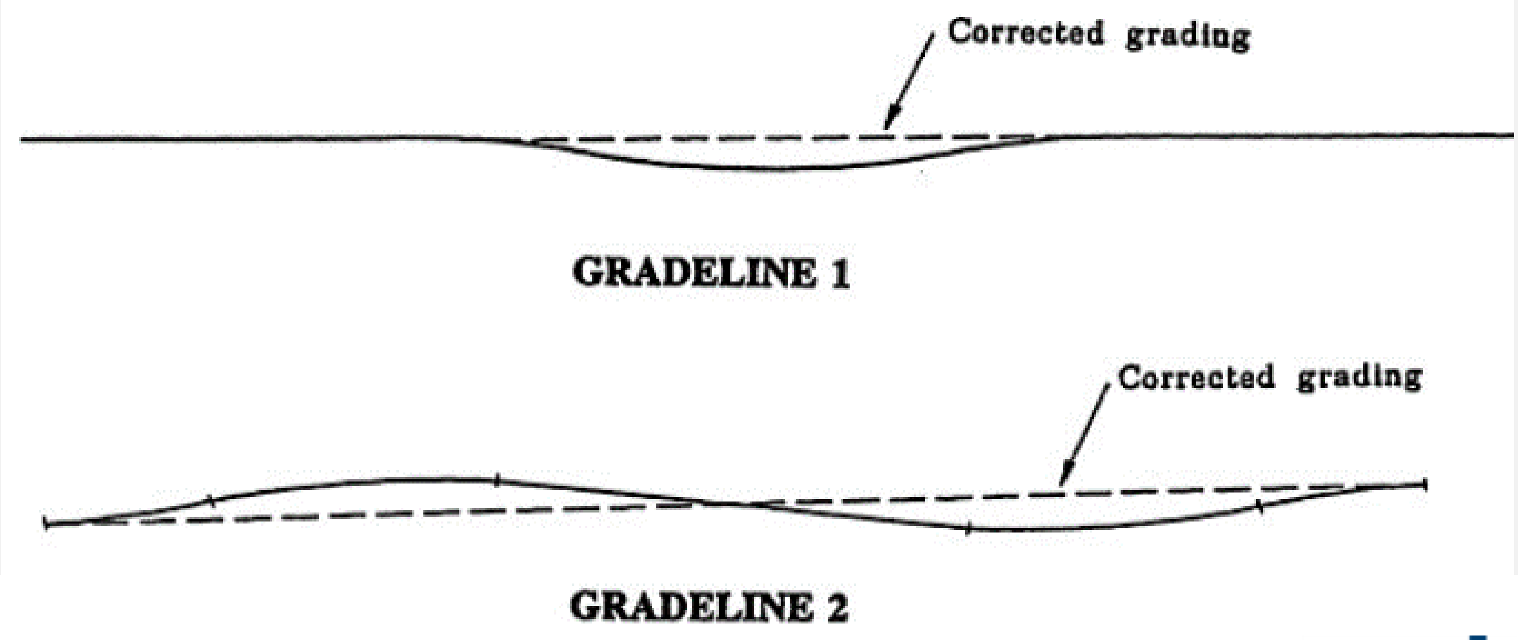


Coordination Horizontal and Vertical Geometry

Safety considerations (6.2)

Hidden dips (additional commentary)

Dips should be avoided on long uniform grades (Figure 6.7), particularly on straight alignments.



Coordination Horizontal and Vertical Geometry

Drainage considerations (6.4)

Where flat areas occur on a pavement treatment by

- introduction of one or more parallel crowns (Section 4.2.3)
- provision of grated trenching to cut off water flow lines

Refer also to Section 7.7.13

Questions?

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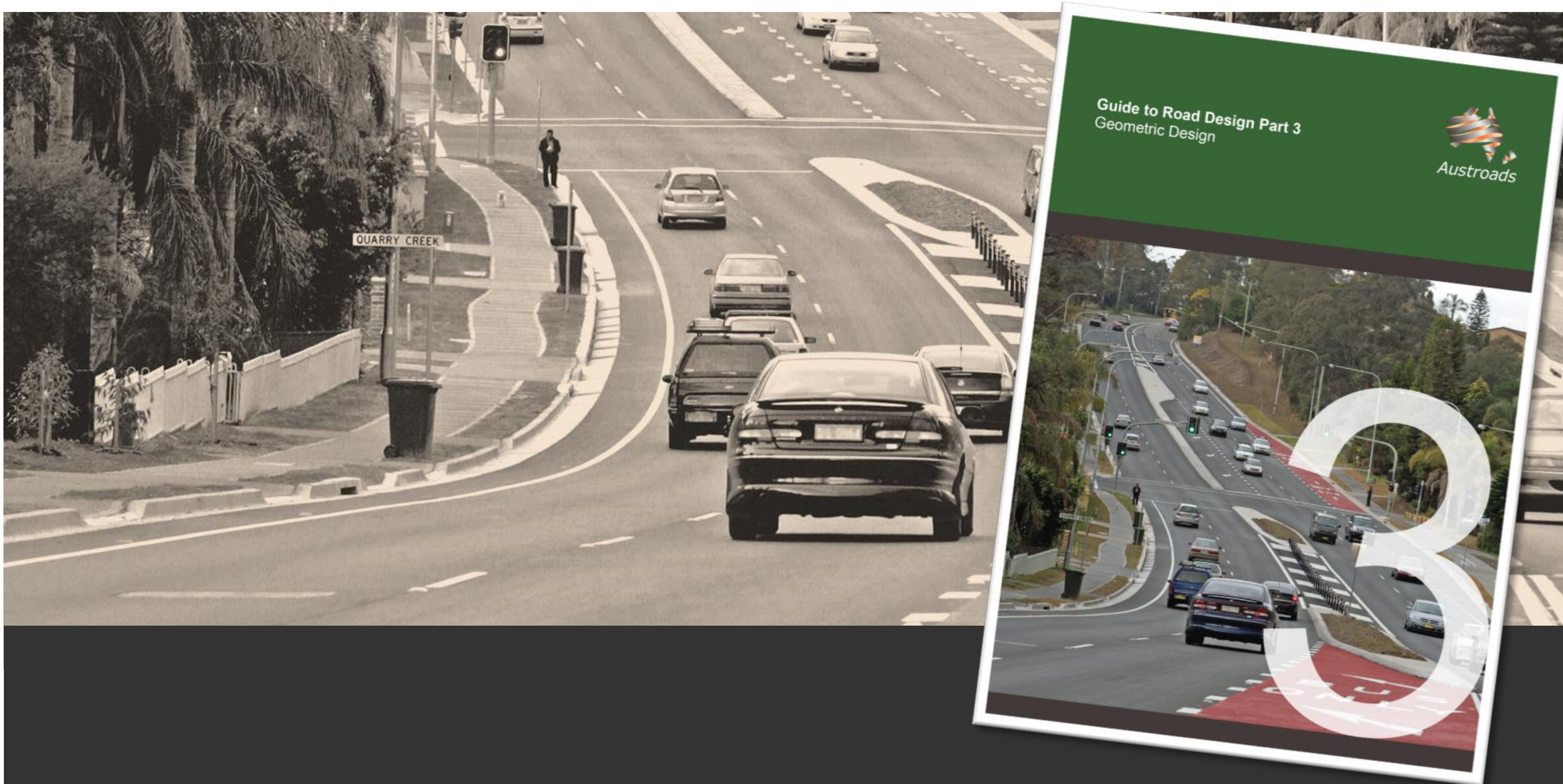

Horizontal Alignment

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Horizontal alignment

Horizontal alignment (7)

Additional general information on curves and changes of speed

- curve causing a speed reduction of 30 km/h from an approach speed of 100 km/h - risk of a run-off-road casualty crash by **5.1** times
- single curve, R <600 m found to have the greatest risk eg a sharp curve with a 100 m R has **5.5** times higher crash risk than a relatively straight section of road.

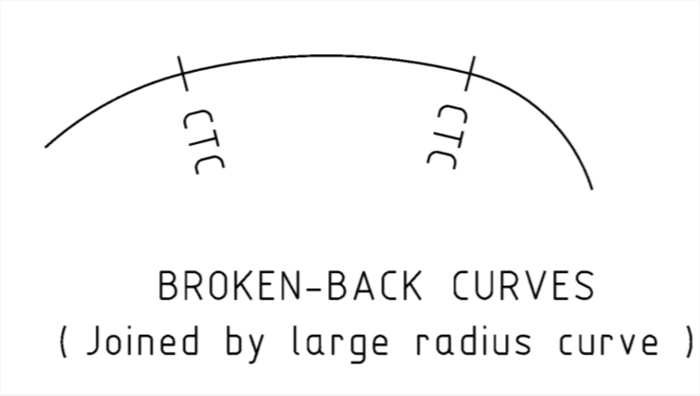
Source: Austroads 2015g, *Road geometry study for improved rural safety*, AP-T295-15

Horizontal alignment

Broken back curves (7.5.2)

Broken back curves avoided wherever possible

- poor lane discipline
- appearance is unsightly
- very difficult to provide the superelevation throughout the curves



Horizontal alignment

Reverse curves (7.5.3)

Desirably

not be used unless sufficient distance

between for full superelevation development

Exceptions

- Constrained locations
- High-speed approaches where used to slow vehicles

Horizontal alignment

Reverse curves (7.5.3)

Where reverse curves are unavoidable

- use of spirals for both curves is essential to provide a smooth and stable transition through the change in direction and superelevation.
- the connected curves should desirably not have a design speed difference exceeding 10 km/h
- normal superelevation development length should be applied to each curve

Horizontal alignment

Reverse curves (cont) (7.5.3)

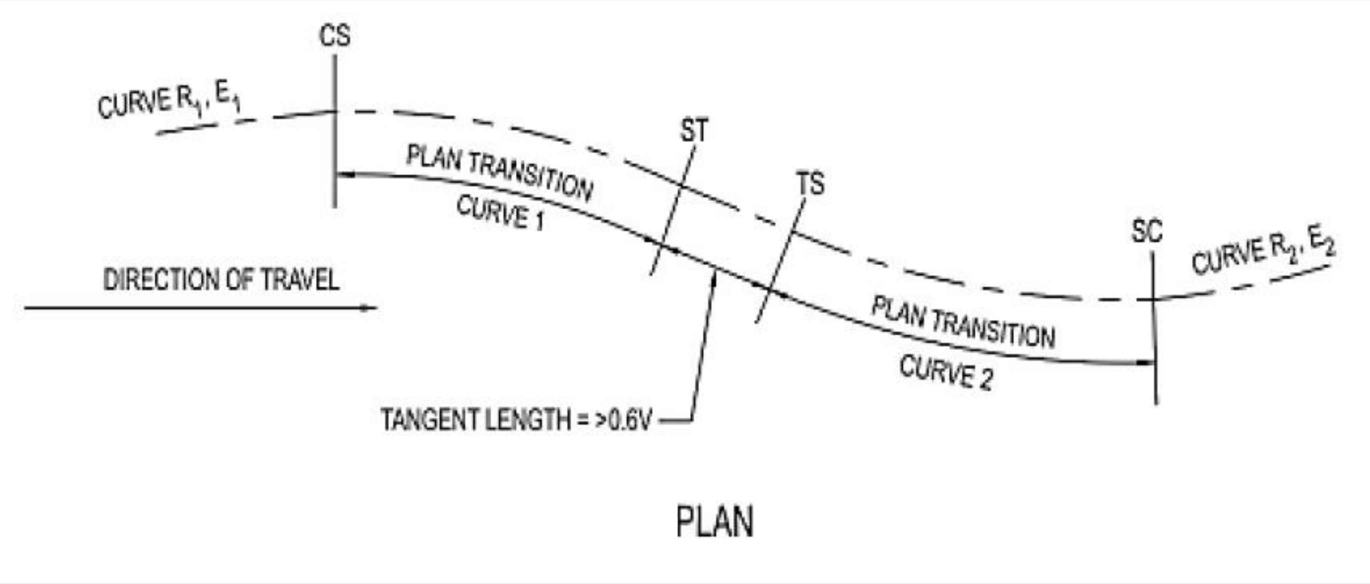
- desirable minimum length between adjacent Transition Spiral (T.S.) points should be equal to the Design Speed (V m)
- desirable minimum length is 0.7V m and the abs. minimum length is 0.6V m
- for trucks the reverse curve should be joined by a tangent at least 0.7V long to allow for wheel tracking (Note change: The tangent previously 0.6 V)

Horizontal alignment

Reverse curves (7.5.3)

Reverse curves with plan transitions and a short separating tangent (new)

Figure 7.3:



Horizontal alignment

Reverse curves (7.5.3)

Reverse curves with plan transition and a short separating tangent

The superelevation development from one curve to the next should be applied over the full length of both curve plan transition lengths and the short tangent

Short tangent lengths should be desirably not less than 0.6 V m, where

V = design speed in km/h.

Horizontal alignment

Reverse curves (7.5.3)

Short separating tangent and no plan transitions

Superelevation development from one curve to the next should be applied to the separating short tangent, and the superelevation runoff should extend into the circular curve as recommended in Table 7.2 (new table).

Table 7.2: Portion of superelevation runoff located prior to the circular curve

Operating speed (km/h)	Portion of superelevation runoff located prior to the circular curve		
	No. of lanes rotated		
	1	2	3
20–70	0.80	0.90	0.90
80–110	0.70	0.80	0.85

Horizontal alignment

Reverse curves (7.5.3)

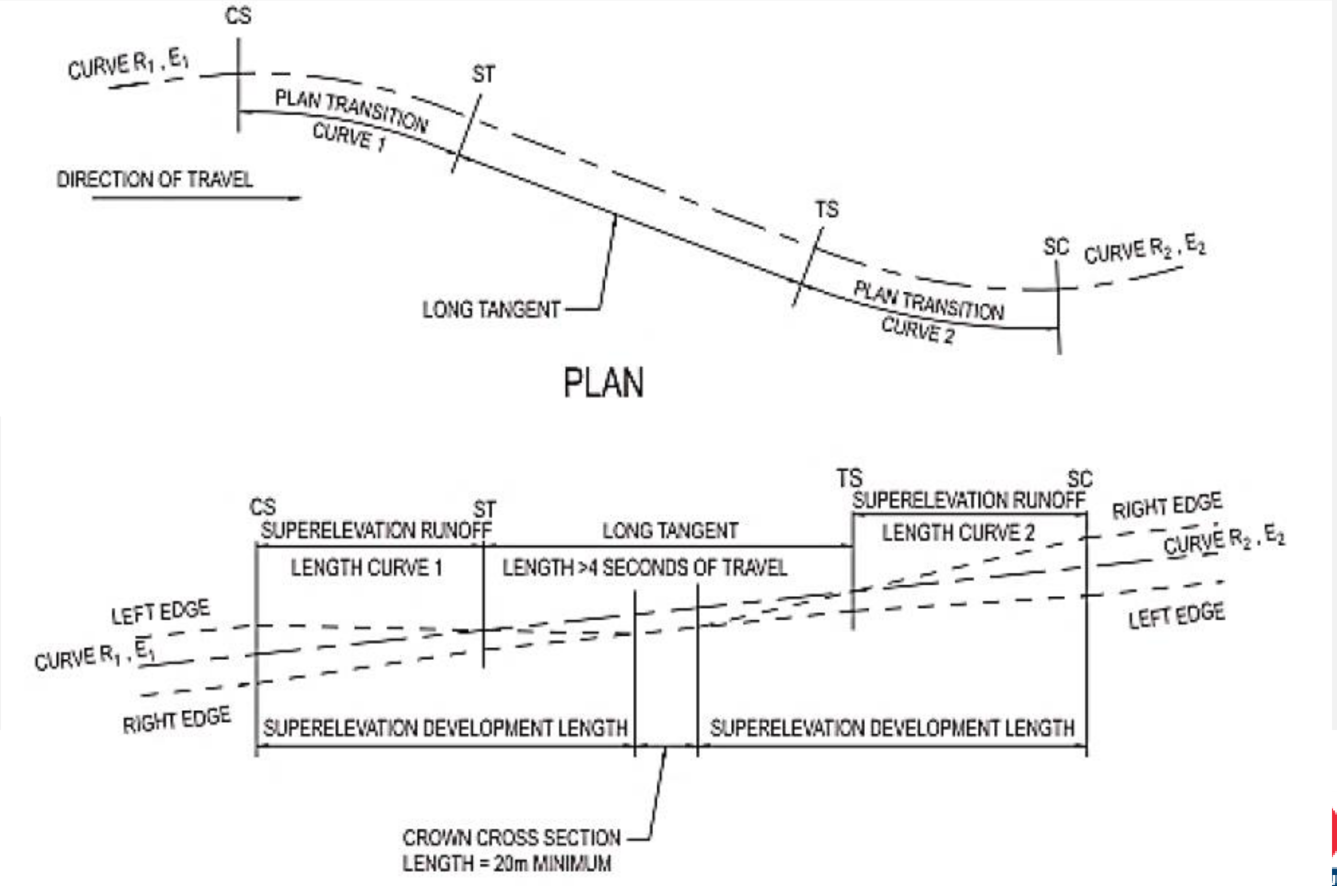
Short separating tangent and no plan transitions (cont)

The min length of short tangent should be the length of both curves superelevation runoff lengths, less the amount extended into the circular curves.

Horizontal alignment

Reverse curves (7.5.3)

Long separating tangent Fig 7.4:

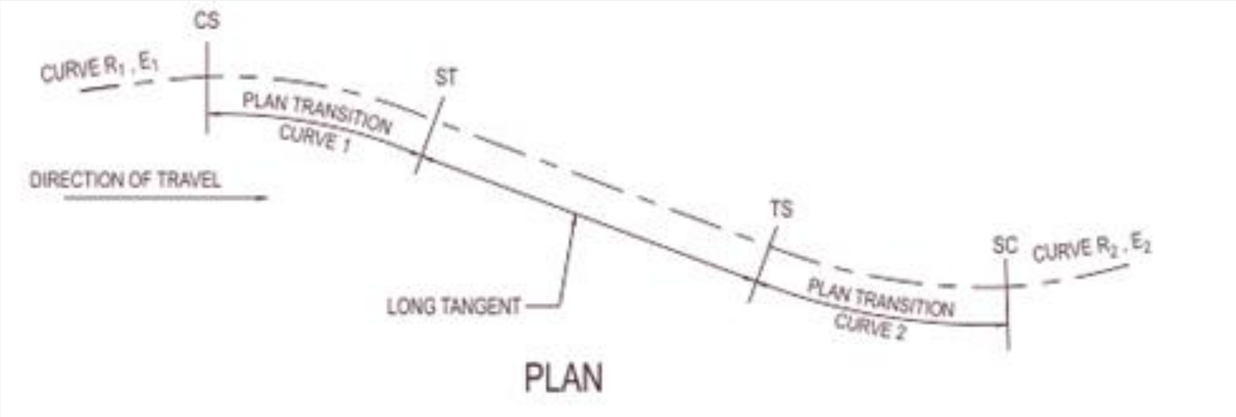


Horizontal alignment

Reverse curves with a long separating tangent (7.5.3)

The straight section should be returned to a crown cross -section, as illustrated in Figure 7.4.

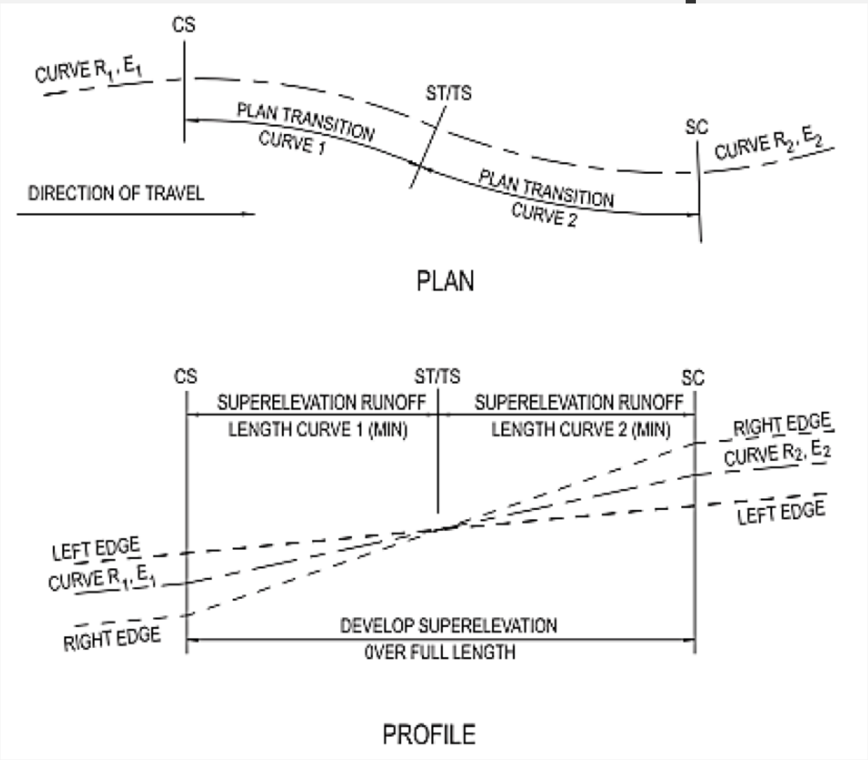
Only used on an undivided two way road, not a divided carriageway.



Horizontal alignment

Reverse curves without a separating tangent (7.5.3)

Fig 7.5



How are we travelling?

Horizontal alignment

Superelevation Design Procedure (7.7.1)

Additional process outline

Step 1: Select each curve radius to suit criteria and controls during horizontal alignment design (Section 7.2)

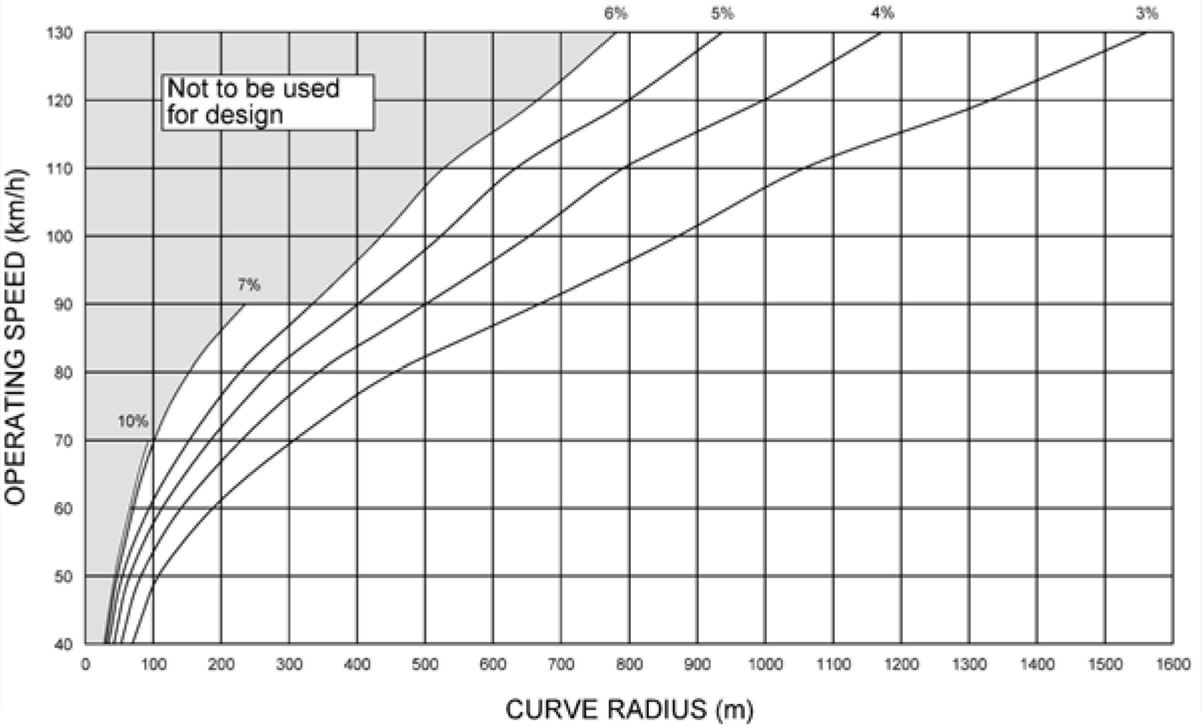
Step 2: Select the superelevation appropriate to the operating speed and the curve radius from Figure 7.7, Figure 7.8 and Figure 7.9

Step 3: Select or apportion the superelevation development length (Section 7.7.6 to Section 7.7.9)

Horizontal alignment

Superelevation Design Procedure (7.7.1)

Fig 7.7 (example)



Horizontal alignment

Superelevation (7.7.1) (cont)

Additional process outline

Step 4: Select the appropriate location for the superelevation development using the advice in Section 7.7.10 and Section 7.7.11.

Step 5: Check the locations of flat spots, and take remedial action if required.

Step 6: Check the maximum depth of water flow through the superelevation development and take any corrective action required (see also Step 5 above).

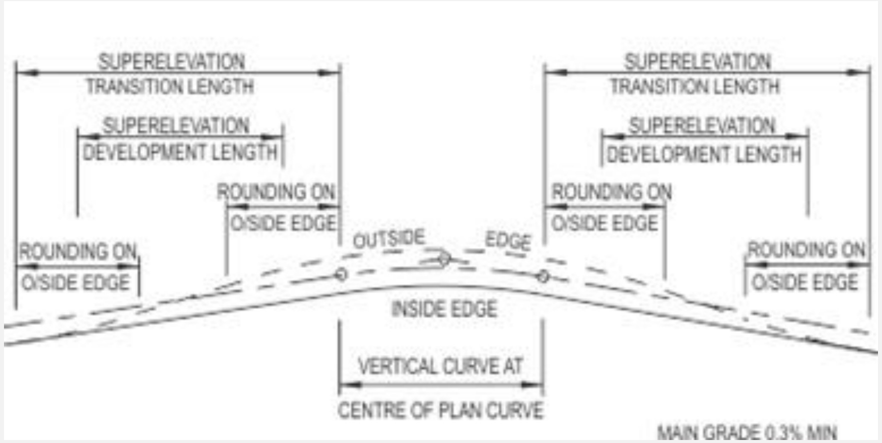
Horizontal alignment

Length of Superelevation Development (7.7.6)

Rounding vertical curve used to ease the grade changes from crossfall to superelevation at the edges of the pavement and formation (some agencies)

Transition length is the superelevation development length incl rounding vertical curves

Rounding curve lengths are shown in Table 7.9 (new).



Horizontal alignment

Superelevation development on shoulders (7.7.12) (new)

Sealed shoulders

Fully sealed or partially sealed, with the shoulders same crossfall as the abutting pavement

Superelevation development is similar to the pavement, width rotated increased by the full width of the shoulder.

Horizontal alignment

Superelevation development on shoulders (7.7.12) (new)

Unsealed shoulders

Usually have a higher crossfall than the pavement for drainage purposes

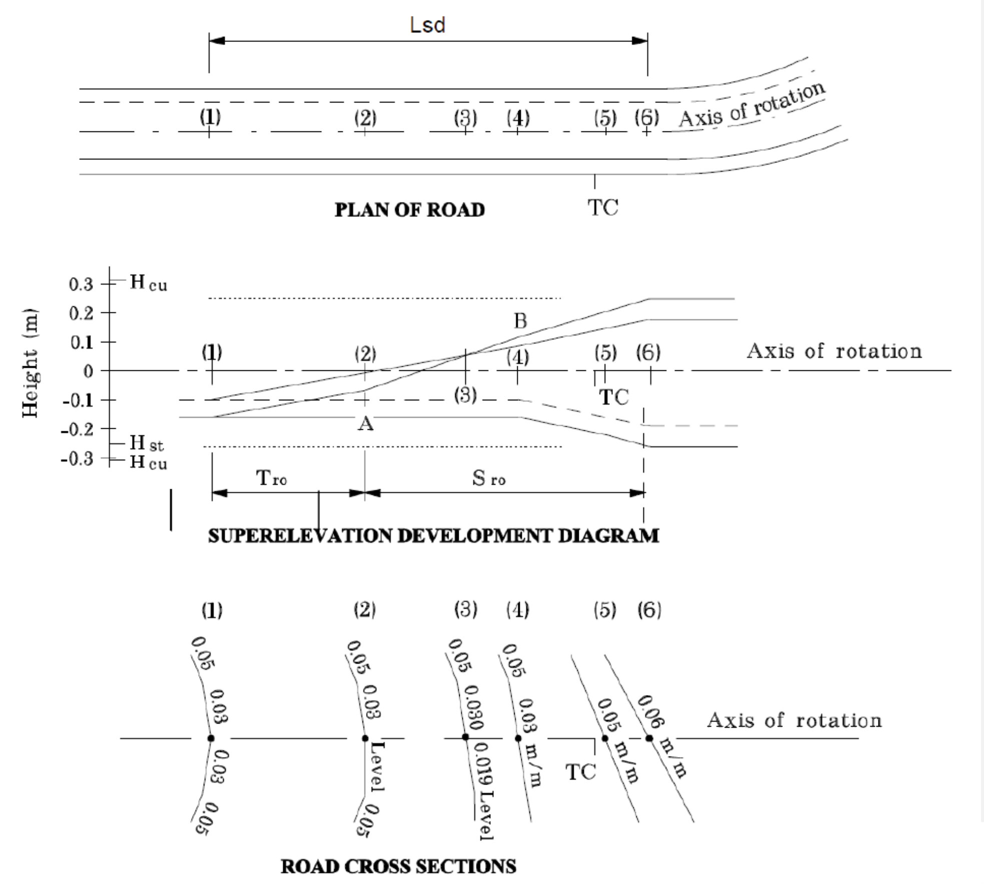
Maintain a drainage slope at the point in superelevation development where the pavement is level.

High side of superelevation, shoulder crossfall equals pavement slope (and the shoulder should be sealed) for safety reasons.

Horizontal alignment

Superelevation development on shoulders (7.7.12) (new)

Fig 7.12



Horizontal alignment

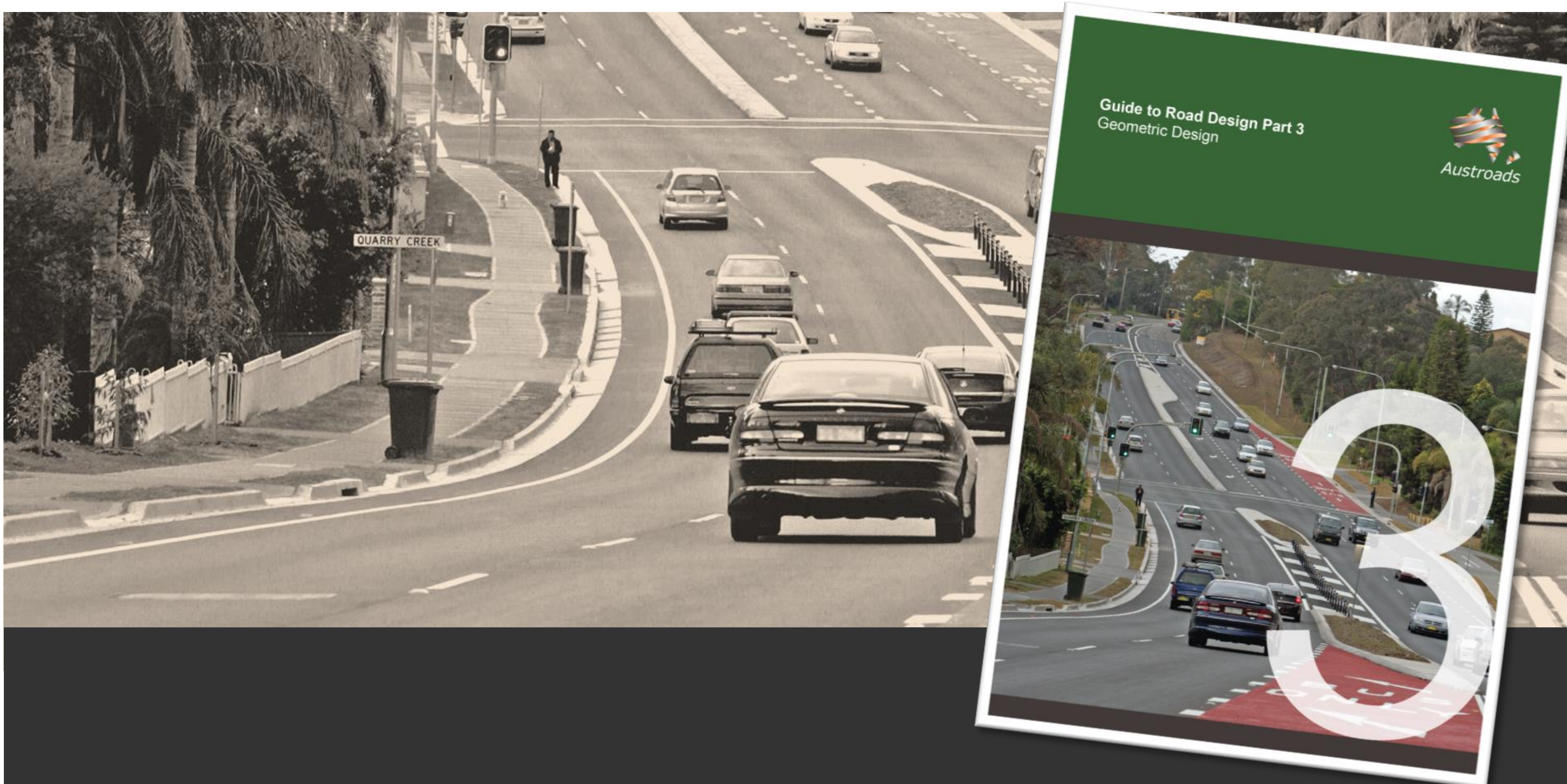
Development of superelevation to avoid drainage problems (7.7.13) (new)

Flat areas may occur when level cross-section coincides with level longitudinal grade

Avoided by continuing crossfall or longitudinal grade through superelevation areas, rotating the pavement about one edge

Pavement edge grade changes may incorporate a rounding vertical curve centred on the ends of the superelevation development length

Series of examples Figures 7.14-7.21



Vertical Alignment

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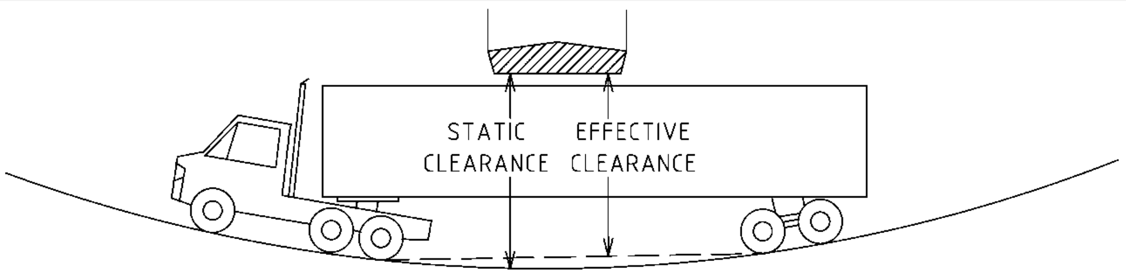
Vertical alignment

Vertical controls (8.2)

Additional information on providing for a 19 m design semi-trailer or other appropriate design vehicle

For arterial roads, where there is no alternative route a 25 m long restricted access design vehicle must be used



Vertical alignment

Vertical alignment (8.2.2) (new)

Need for identification of all critical control points over roads/freeways

Control levels calculated and clearance (Table 8.1, current) applied to establish the level controls for the grading of the crossing road

Design procedure for checking critical points is outlined

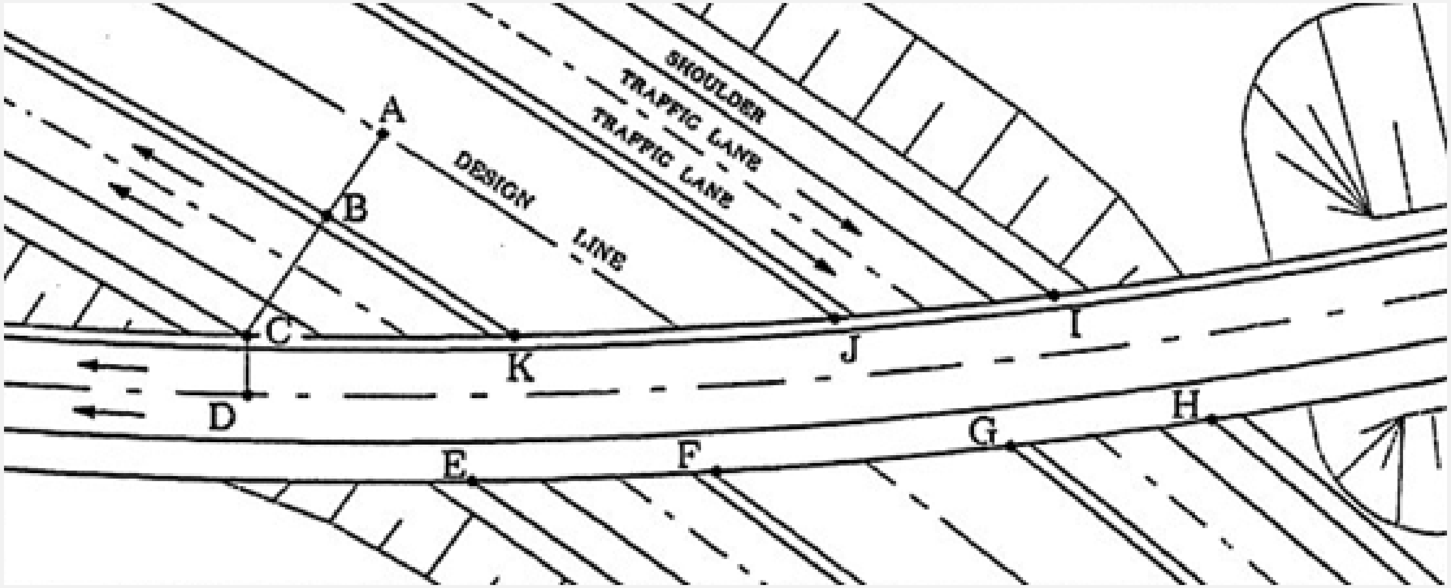
Table 8.1: Typical minimum vertical clearances over roadways and pedestrian/cycle paths

Location	Minimum clearance (m)
Urban and rural freeways	5.4(1)
Main and arterial roads	5.4(1)
Other roads	4.6(1) (2)

Vertical alignment

Vertical alignment (8.2.2) (new)

Critical points (Fig 8.2)



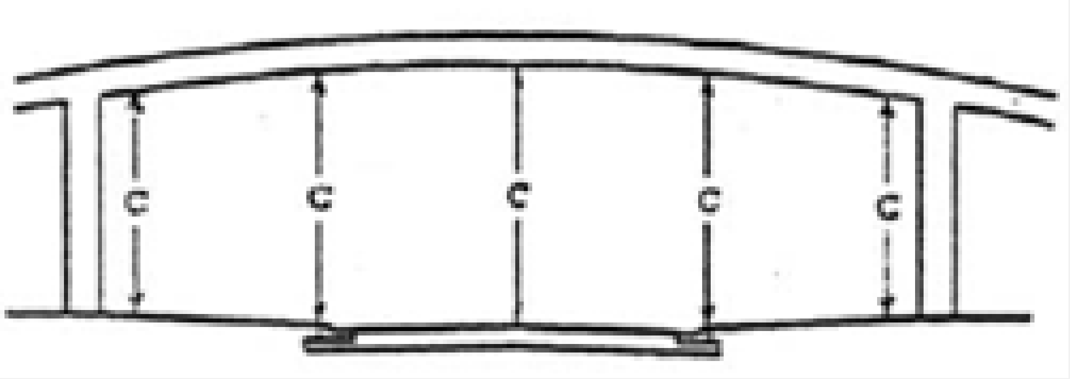
Vertical alignment

Vertical clearances (8.2.4)

Pedestrian bridges

Lighter , more vulnerable to damage by trucks, additional 0.2 m vertical clearance provided

(Clearances shown in Table 8.1, current)



Vertical alignment

Grades (8.5)

Additional information on crash risks

An uphill grade of 6% increased the risk by 2.6 times compared to the general risk level on a flat road.

Downhill grade of the same steepness increased the risk by 5.6 times.

On vertical grades, casualty crashes increase as the road grade increases, particularly downhill grades with a significant increase in crashes and crash severity when the grade is greater than 6%

Vertical alignment

Length of steep grades (8.5.4)

Surfaces (additional information)

Where a sprayed seal surfacing is proposed on long uphill grades on roads operating at 100 km/h should be limited to 4% maximum (absolute maximum of 5%)

To reduce the risk of flushing caused by heavy vehicles tractioning up the grade

Vertical alignment

Crest vertical curves on undivided roads (8.6.3)

Providing overtaking opportunities

Where available sight distance < overtaking sight distance, increasing the length of the VC, overtaking zones extended on each side of the VC

Sight distance between stopping sight distance and overtaking sight distance and not feasible to lengthen the VC - decrease the length of the VC overtaking zones established on each side of the VC.

Stopping sight distance must still be provided

Vertical alignment

Minimum Length of Vertical Curves (8.6.7)

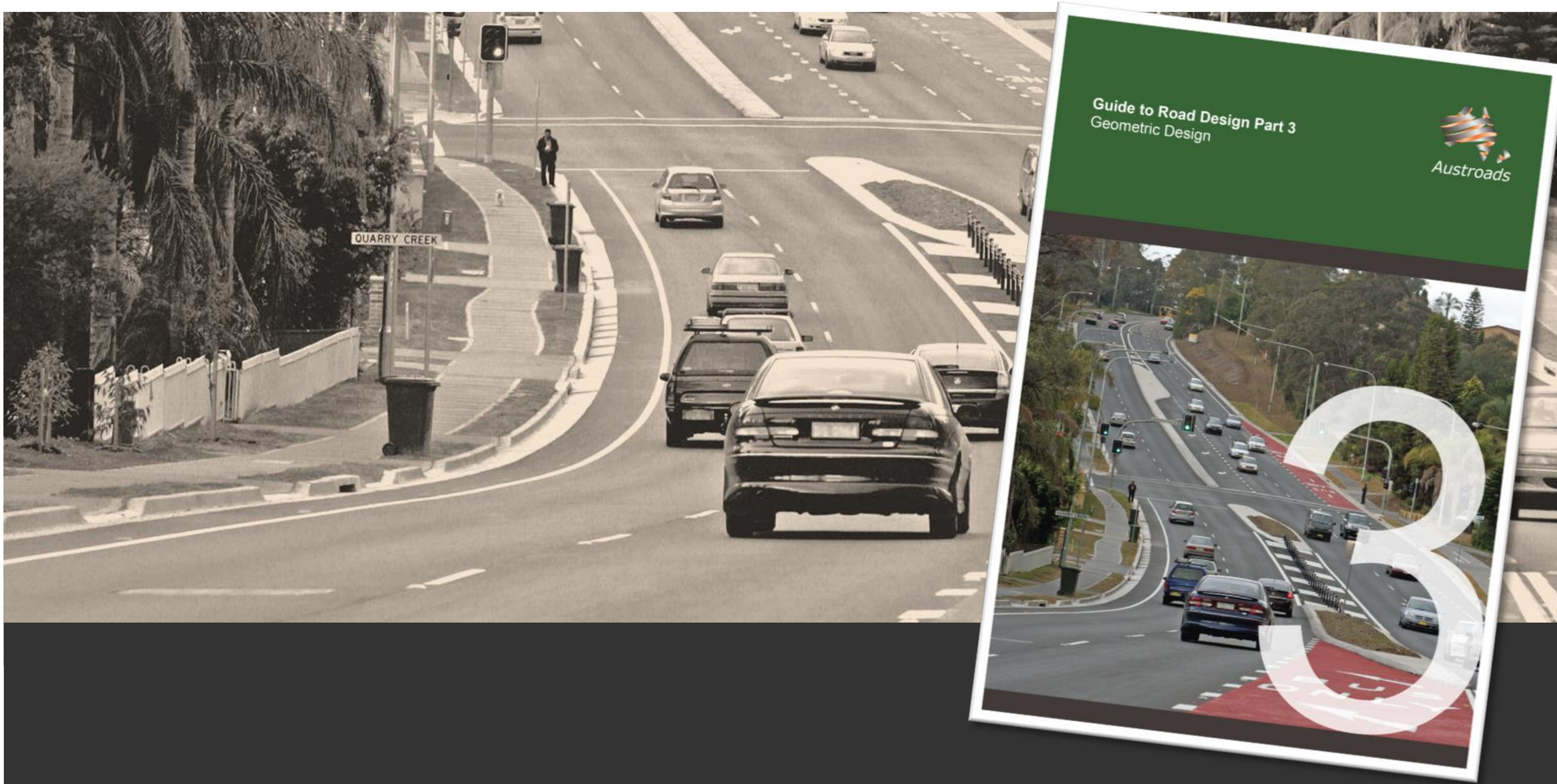
Minimum curve lengths (Table 8.10) increased by 50% when approach is straight and vertical curve is within driver's view for at least 500 m.

On resheet projects it is acceptable to adopt the shorter vertical curves in Table 8.11.

Table 8.11: Minimum length vertical curves for reconstruction

Operating Speed (km/h)	Algebraic change in grade (g_1%–g_2%)									
	0.2	0.4	0.6	0.8	1.0	1.5	2.0	2.5	3.0	3.5
40	0	0	0	0	0	20	20	20	20	20
50	0	0	0	0	20	20	20	25	30	40

How are we travelling?



Auxiliary Lanes

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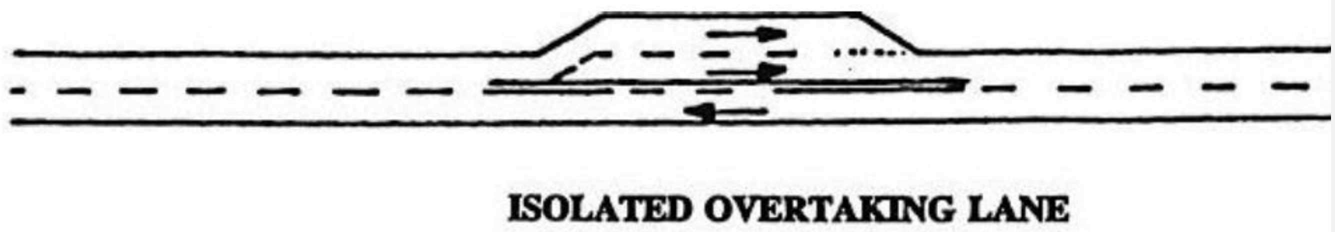
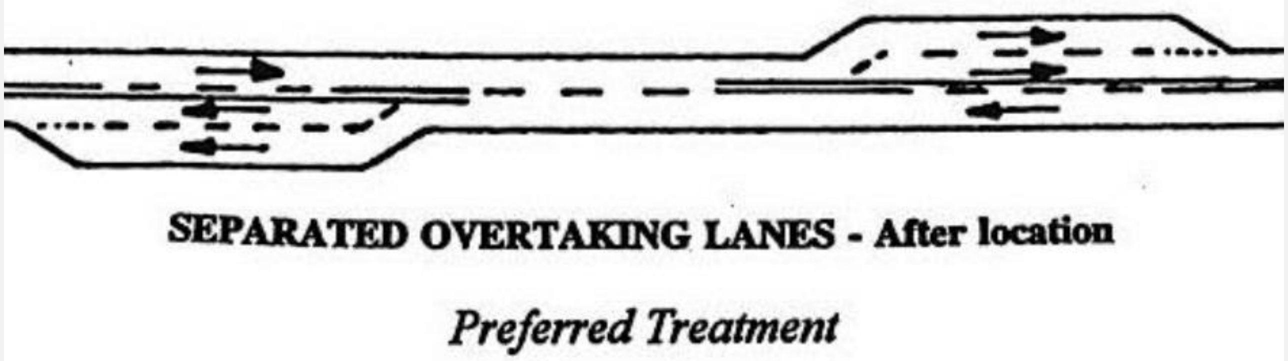
Auxiliary lanes

Overtaking lanes (9.4)

Figure 9.1: Example 1 of layouts of overtaking lanes



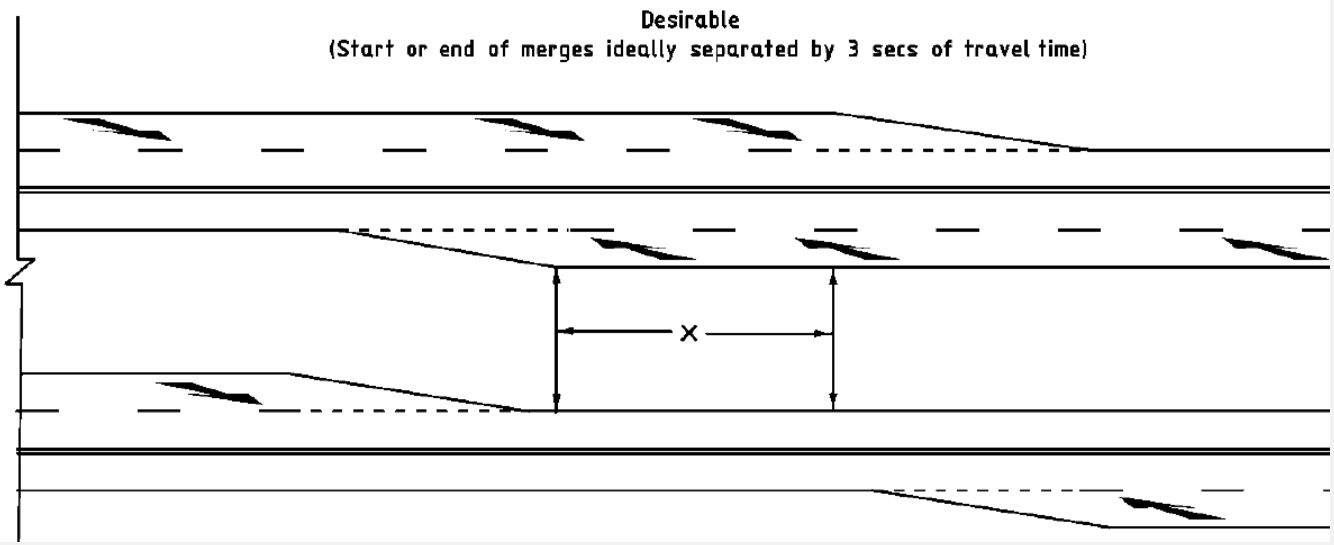


Auxiliary lanes

Overtaking lanes (9.4)

Merge locations

Figure 9.3: Example overtaking lane configurations



Auxiliary lanes

Overtaking lanes (9.4)

Design procedure

Eight step design procedure

Guides designer for

- Location
- Warrants (Fig 9.6)
- Defining the overtaking zone
- Evaluating the effects

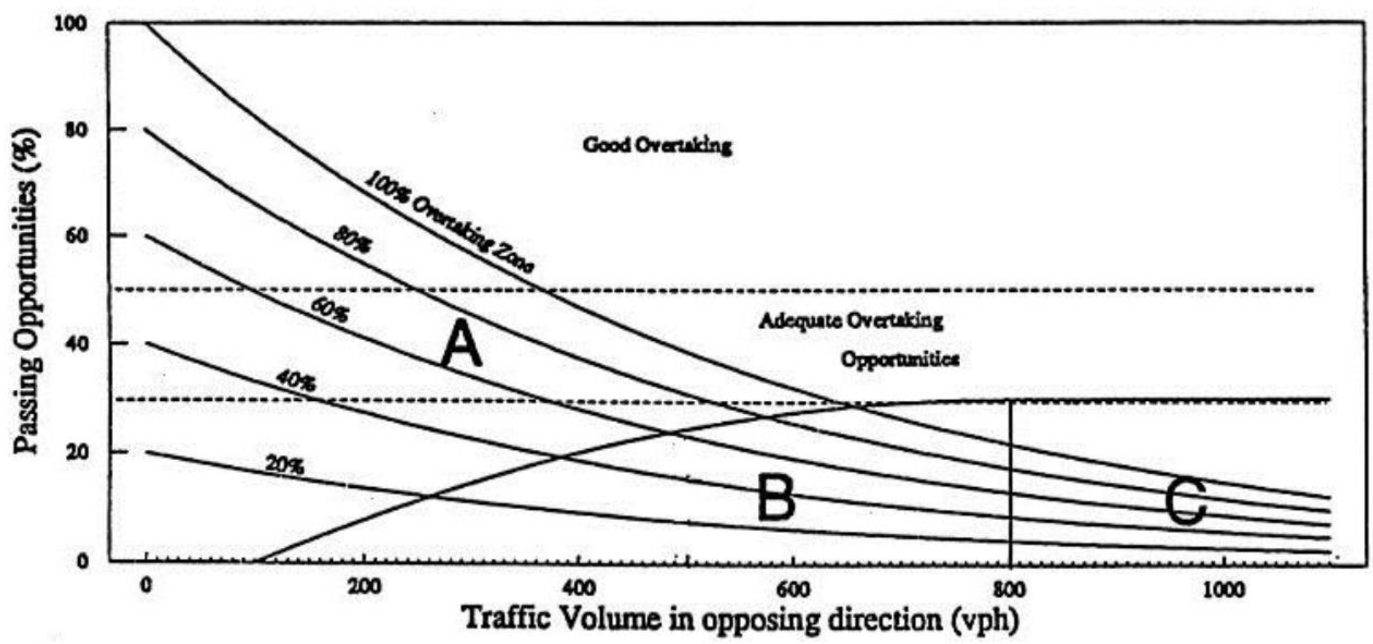
Auxiliary lanes

Overtaking lanes (9.4)

Design procedure

Warrants

Figure 9.6: Overtaking lane warrants



Auxiliary lanes

Auxiliary lanes tapers (9.9.2)

Diverging taper

The widening of the pavement at the start of the auxiliary lane is achieved with a taper. Selecting the start point of an auxiliary lane

- Starting point of an overtaking lane cannot be determined as precisely as that of a climbing lane
- An overtaking lane enhanced by developing pavement widening on a horizontal curve as it provides a smoother entry and leads the traffic into the left side lane

Auxiliary lanes

Auxiliary lanes tapers (9.9.2)

Diverging taper (cont)

- Commencing an overtaking lane on a straight makes the start of the lane more visible for approaching traffic
- Disadvantage of restricting overtaking in the opposing direction.
- Commencing the lane immediately before a curve can create appearance problems. Adjusting the passing lane length or move the passing lane to incorporate the diverge taper into the curve.

Auxiliary lanes

Auxiliary lanes tapers (9.9.2)

Merging taper

Considerations when selecting the termination point of an auxiliary lane:

- Termination needs to be clearly visible to approaching traffic
- Merge sight distance - distance required to allow drivers to decide whether or not to continue an overtaking manoeuvre
- End the merge taper on a straight section of road to provide the best definition of the merge.
- Complete the merge before the end of any median island

Questions?

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Thank you for participating

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