

Network Technical Guideline

Supplement to Austroads Guide to Road Design (AGRD)

Part 3: Geometric design (2021)

Version 5.0, November 2021



Supplement to Austroads Guide to Road Design Part 3: Geometric design (2021)

This Supplement must be read in conjunction with the Austroads Guide to Road Design Part 3.

Reference to any Department of Transport or VicRoads or other documentation refers to the latest version as publicly available on the Department of Transport's or VicRoads website or other external source.

Document Purpose

This Supplement is to provide corrections, clarifications, and additional information to the *Austroads Guide to Road Design Part 3: Geometric Design* (2021). This Supplement refers to the content published in Edition 3.3 (February 2021) of the Austroads guide.

If this Part to the Austroads Guide to Road Design is updated, or the information is moved to another Austroads publication, then the content in this supplement should be adopted as supplementary content to the current equivalent Austroads content. Where there is conflicting content in this Supplement with updated content, contact the Department of Transport for clarification as to which content takes precedence.



Version	Date	Description of Change
1.0	July 2010	Development of Supplement
1.1	Sept 2010	Minor changes to text, references and layouts. Figure 5.1 & figures in table updated
2.0	July 2011	Section 2.2.7 Livestock Crossings, Section 5.3.1 Car Stopping Sight Distance, Section 7.1 Compound Curves, Section 7.6.1 Minimum Radius Curves, Section 8.4.2 Grading Point, Section 8.5.3 Maximum Grades, Section 8.6.3 Crest Vertical Curves, Section 8.6.5 Sag Curves
3.0	Sept 2012	General edits & corrections, Section 3.3 General Operating Speeds on Urban Roads, Section 3.4 Operating Speeds on Rural Roads, Section 4.7 Medians, Section 4.4 Verge, Section 4.6 Roadside Drainage, Section 5.2 Sight Distance, Section 7.6 Side Friction & Minimum Curve
3.1	Dec 2012	Section 4.6 Roadside Drainage, Section 10.2 Bridge Cross Section, General edits & corrections
4.0	Jan 2017	Significant review to reflect changes to AGRD Part 3
5.0	Nov 2021	See below

Additional notes on current version

- New DoT format
- Section 4.2.4 -Traffic Lane Widths updated. Traffic lane widths now measured to the middle of line or line group to align with Austroads.
- Section 4.5 -Batters Slopes updated to provide additional guidance and consistency across DoT Standards.
- Section 4.6 -Roadside Drainage updated to align with the guidance provided in Section 4.5.



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1 Introduction

1.3 Design Criteria

Refer to VicRoads Supplement to Austroads Guide to Road Design (AGRD) Part 2, Section 2.3 for VicRoads approved policy and process regarding the use of Extended Design Domain (EDD).

2 Fundamental Considerations

2.2 Design Parameters

2.2.2 Road Classification

VicRoads uses a functional classification system for its rural arterial road network. Four classifications are provided which include M, A, B, C. The classification reflects both the function and standard of the road. These classifications are also used in the state route numbering scheme. Refer VicRoads Supplement to Austroads Guide to Traffic Management Part 4 – Network Management.

Μ	Roads are duplicated freeways or expressways connecting the capital cities and major provincial centres, and linking major centres of production with Victoria's export terminals;
A	Roads are two-lane two way roads which serve the same role as M roads but carry less traffic.
В	Roads provide the primary link between major regions not served by A roads, and also highly significant tourism regions.
С	Roads provide the more important links between other centres of populations, and between these centres and the primary transport network.

2.2.7 Design Vehicle

Refer to VicRoads Supplement to AGRD Part 4, Section 5.2 for further information regarding choice and application of Design Vehicles in Victoria.

Design Considerations for Trucks (from RDG 2.2.5.1)

Refer to Table V2.1 for design considerations for trucks.

2.2.10 Access Management

Refer to VicRoads Supplement to AGRD Part 6B, Section V2.2.4 for further information regarding livestock access.



Table V2.1: Provision for Trucks – Checklist (from RDG Table 2.2.7(b))

LOCATION	PROVISION FOR TRUCKS
Intersections	Provide for the swept paths of trucks. Refer to Austroads Design Vehicles and Turning Path Templates.
	Provide sufficient stopping distance (lateral sight distance restrictions are often critical).
	Provide sufficient sight distances to allow trucks to turn safely on each road.
	Provide radii appropriate for the turning speeds of trucks.
Horizontal curves	As far as possible, avoid locating features which are likely to require trucks to brake on curves, such as intersections where the main road is on a low radius curve.
Reverse curves	Provide either straights 0.6V metres long or spirals between reverse curves to allow for the spiral tracking of trucks. Where deceleration is required on the approaches to a lower radius curve, sufficient distance must be provided to enable truck drivers to react and decelerate.
Compound curves	If deceleration is likely to be required, allow sufficient distance for truck drivers to react and decelerate.
Spirals	Provide spirals where required for trucks, see AGRD Part 3, Section 7.5.4.
Grades	Provide sufficient signs to warn truck drivers of steep downhill grades.
	Provide adequate sight distance on approaches to curves on steep downhill grades.
Sag vertical curves	Provide stopping sight distance and adequate clearance beneath overpasses.
Superelevation	Avoid adverse superelevation wherever practicable.
	Check that superelevation has been increased on downgrades.

Notes

1. The speed to be used for determining each sight distance referred to in Table V2.1 is the truck operating speed for the particular direction of travel.



3 Speed Parameters

3.3 Operating Speeds on Urban Roads

Adoption of Operating Speed approach for Victoria as described in the Guide is acceptable.

3.3.1 Melbourne Arterial Road Network

Speed surveys are carried out twice per year on the arterial road network in the Melbourne metropolitan area. In 1994, 48 locations (24 sites x 2 directions) were selected for inclusion in the survey. During the period 2002 to 2005 another 28 additional locations (14 sites x 2 directions) were added to the survey program. The sites are grouped by speed limit, their previous speed limit and whether the carriageways are divided or undivided.

Review of survey results indicates that a significant reduction of operating speed occurred on the network between 2000 and 2004 and that operating speed has effectively stabilised at very close to the posted speed limit (as at 2012).

Adoption of an Operating Speed equivalent to the posted speed limit for design purposes in the Melbourne metropolitan area for arterial roads is considered acceptable.

3.3.2 Metropolitan Freeways/Motorways

A review of speed study results for these roads does not indicate the same change in driver behaviour as was demonstrated on the urban arterial network. An Operating Speed of 10km/h greater than the posted speed limit should be adopted for metropolitan freeways/ motorways.

When necessary, a risk-based approach using the available speed data may be adopted to assist in choosing an appropriate Operating Speed (less than 10 km/h greater than the posted speed limit) for a project where design controls warrant an alternative approach to ensure that a value-for-money design solution can be developed. The Extended Design Domain (EDD) approval process included in VicRoads Supplement to AGRD Part 2 should be used to document decisions made to adopt Operating Speed less than 10 km/h greater than the posted speed limit for existing metropolitan freeways/motorways.

3.4 Operating Speeds on Rural Roads

3.4.1 Major Rural Cities

The VicRoads speed survey currently does not include monitoring of major arterial roads located in major rural cities (i.e. Geelong, Ballarat etc.). It might be considered reasonable that a similar approach to the Melbourne metropolitan area be adopted for major rural cities that have an established arterial network and an appropriate speed enforcement program. Appropriate judgement is needed when considering adoption of Operating Speed equivalent to the posted speed limit in major rural cities. Such decisions should be supported by analysis of results from an appropriate speed survey.

3.4.2 Rural Highways and Intermediate/High Speed Rural Roads

A review of speed study results for these roads does not indicate the same change in driver behaviour as was demonstrated on the urban arterial network. An Operating Speed of 10km/h greater than the posted speed limit should be adopted for rural highways and high speed rural roads.

When necessary, a risk-based approach using the available speed data may be adopted to assist in choosing an appropriate Operating Speed (less than 10 km/h greater than the posted speed limit) for a project where design controls warrant an alternative approach to ensure that a value-for-money design solution can be developed. The Extended Design Domain (EDD) approval process included in VicRoads Supplement to AGRD Part 2 should be used to document decisions made to adopt Operating Speed less than 10 km/h greater than the posted speed limit for existing rural highways and intermediate/high speed rural roads.



4 Cross Section

4.1 General

4.1.1 Functional Classification of Road Network

VicRoads uses a functional classification system for its rural arterial road network. Four classifications are provided which include M, A, B, C. Refer Section 2.2.2 of this Supplement and VicRoads Supplement to Austroads Guide to Traffic Management Part 4 – Network Management.

4.2 Traffic Lanes

4.2.4 Traffic Lane Widths

Victorian traffic lane widths are measured to the face of kerb (line of kerb) or to the middle of the line or line group for multi-lane roads, or roads with shoulders. Refer Section 4.6.4 of this Supplement for clearances from line of kerb to traffic lanes for different kerb types.

Where a temporary track is placed on a tightly curved alignment, 4.0m minimum width should be provided for each lane and the remainder of the width should be provided by means of a full depth sealed shoulder.

4.2.5 Urban Road Widths

VicRoads accepts lane width values as per AGRD Part 3, Table 4.3. Table V4.1 provides VicRoads Urban Freeway lane and shoulder widths. Where a Freeway Management System is installed, narrower shoulder widths may be considered as discussed in AGRD Part 3, Appendix A.

Figures V4.4 and V4.5 are provided for general guidance and show cross sections commonly adopted in Victoria for various road types. Cross section requirements for specific projects should be confirmed during preparation of the functional design. In particular, opportunities to adopt Safe System elements into cross sections being considered for design should be investigated as a priority as part of establishing project scope.

Element	Lane/Shoulder Width (m)	Comments
Traffic lane (1)	3.5	General traffic lane width
Lane width on interchange ramps	3.5 – 4.5	Range of lane widths on interchange ramps (refer VicRoads Supplement to AGRD Part 4C for freeway ramp widths)
Left Shoulder (2) (sealed for the full width)	3.0 (3)	Minimum shoulder width adjacent to a safety barrier Minimum shoulder widths on freeways of 3 or more lanes
Median Shoulder (2) (sealed for the full width)	3.0 (3)	Minimum shoulder width adjacent to a safety barrier Minimum shoulder widths on freeways of 3 or more lanes

Notes:

1. Traffic lane widths are measured to the face of the kerb or to the middle of the line or line group.

- 2. Shoulder widths may be locally narrowed where there are overpass bridge piers or similar large constraint. Designers should maintain at least minimum clearances/offsets from traffic lanes to barriers where locally narrowing shoulders.
- 3. A 3.0m wide shoulder enables a truck to stop clear of the traffic lane.

Where the wearing course is placed on the traffic lane, but not the shoulders (e.g. open graded asphalt), this should extend for the full width of shoulders on the high sided of superelevation. The wearing course should extend a minimum of 0.3m beyond the edge line to minimise the risk associated with the edge drop off.



4.2.6 Rural Road Widths

Refer Section 2.2.2 and Section 4.1.1 of this Supplement for further information regarding functional classification and traffic lane widths to be adopted on Victorian Rural Road Network.

M, A and B roads will have a distinctive appearance based on the minimum widths of carriageway elements.

For C roads and unclassified roads, the widths of cross section elements for new construction are mainly determined by traffic volume. The widths of carriageways are summarised in Table V4.2.

Figures V4.4 and V4.6 are provided for general guidance and show cross sections commonly adopted in Victoria for various road types. Cross section requirements for specific projects should be confirmed during preparation of the functional design. In particular, opportunities to adopt Safe System elements into cross sections being considered for design should be investigated as a priority as part of establishing project scope.

V4.2.7 Over Dimensional (OD) Vehicles

For further information regarding Over Dimensional (OD) vehicles, refer to the VicRoads website (www.vicroads.vic.gov.au)

4.3 Shoulders

4.3.2 Shoulder Width

Additional Information

AGRD Part 3 Table 4.4 identifies that the minimum shoulder widths adjacent to barriers on urban freeways should be 3.0 m. This shoulder width allows for trucks to stop clear of the traffic lane and where there are three or more lanes, for vehicles to pull off in the median shoulder without having to try and change multiple lanes in an emergency situation. Shoulders having a minimum width of 3.0 m can also be provided on urban freeways to allow for future reconfiguration of the cross section resulting in an ultimate narrow median shoulder to accommodate an additional lane as part of managed motorway implementation.

Similarly, for non-urban freeways 3.0 m wide shoulders may not be warranted adjacent to a barrier particularly for the median shoulder. Median shoulders 1.0 m wide could be considered suitable on carriageways with less than three lanes as motorists would generally be able to pull over to the outside shoulder in the event of a breakdown. However, consideration should be given to provide appropriate shoulder width to allow for maintenance activities and other relevant engineering considerations. The type of safety barrier chosen and the width of shoulder/medians adjacent to a safety barriers should also take into consideration guidance provided in AGRD Part 6.

4.3.3 Shoulder Sealing

Refer to Table V4.2 for sealed shoulder widths.

Additional Information

All M roads shall have full depth, full width shoulders. All A roads shall have shoulders partially sealed to 1.5m width. B roads may have shoulders sealed to 1.0m on sections which have a demonstrated record of run-off-road accidents. Consideration should be given to providing 1.0m sealed shoulders on the outside of curves on C roads.

Sealed shoulders reduce accident rates and there are road safety benefits where shoulders are sealed for 1.5m width. Fully or partly sealed shoulders offer further advantages for the longevity of the pavement, which should be considered when designing new construction or widenings. A full width seal should be considered where long vehicles are expected to track over the shoulders.



Classification and (AADT)	Lane Widths (m)	Shoulder Widths (m)	Sealed Shoulder (m)	Total Seal (m)	Carriageway (m)
М	Duplicated Carriageway 2 x 3.5 each	LHS 3.0 RHS 1.0	LHS 3.0 RHS 1.0	11.0 each	11.0 ⁽²⁾ each
A (AADT<1500) (AADT>1500)	2 x 3.3 2 x 3.5	2.0 2.5	1.5 1.5	9.6 10.0 ⁽³⁾	10.6 12.0 ⁽²⁾
B (AADT<1500) (AADT>1500)	2 x 3.3 2 x 3.5 ⁽¹⁾	2.0 2.0	0 ⁽⁴⁾ 1.0	6.6 9.0 ⁽³⁾	10.6 ⁽²⁾ 11.0
C ⁽⁶⁾ (AADT<1500) (AADT>1500)	2 x 3.1 2 x 3.5 ⁽¹⁾	2.0 2.0	0 ⁽⁴⁾ 0 ⁽⁴⁾	6.2 7.0 ⁽³⁾	10.2 11.0
Local access (51 – 150) Private access	1 x 4.0	1.5	NA	4.0	7.0
(1 – 50)	1 x 3.0	2.0	NA	unsealed	7.0

Table V4.2: Widths of Rural Carriageway Elements (from RDG Table 3.6.3)

Notes

1. Where there are more than 500 trucks ADT two way on roads with unsealed shoulders

a) Traffic lanes may be widened to 3.7 m, and

b) Total seal on curves may be widened to provide tracking widths in AGRD Section 7.9.

2. Minimum standard prescribed in Victoria's Rural Arterial Road Network Strategy - Draft (VicRoads, 2010).

3. Where road radius is less than 200 m, sealed width should be increased to provide tracking width in AGRD Section 7.9.

4. 1.0m sealed shoulder on designated tourist routes, designated tourist cyclists routes, Principal Freight Network and where warranted by accident record.

- 5. For definitions of M, A, B, C Roads, see Section 2.2 of this Supplement.
- 6. On routes less than 200 v.p.d, generally maintain existing pavement and widths on 'C' roads unless upgrading is warranted by exceptional traffic volumes or by crash records. New works in excess of 100m length will be constructed to the specified standards.





Figure V4.4: Typical Freeway Cross Sections





Figure V4.5: Typical Urban Road Cross Sections





4.5 Batters

Additional information

Selecting an appropriate batter slope depends on multiple site-specific factors (see below), and designers must consider these factors in all applications.

Steeper batter slopes are likely to increase the risk within one or more of these factors, therefore a range of Normal Design Domain (NDD) and Extended Design Domain (EDD) batter slope values are provided in Table V4.11. While steeper batter slopes are possible, they should be limited to constrained locations (e.g. limited Right of Way boundary). Documenting the risk identification and mitigation process is especially important, as is describing the benefit or risks being mitigated as a result of adopting a steeper slope. Considerations which may inform a decision could include the retention of existing vegetation or biodiversity areas.

Consultation with the relevant disciplines should occur during the early stages of design development, to ensure key factors (e.g. landscaping and maintenance criteria) are discussed and addressed appropriately in the design, and locations that require EDD or DE batter slopes can be identified and agreed.

Key factors of batter slope selection

Motorist safety

The roadside risk of a batter slope will be influenced by factors such as speed, slope, height, traffic mix, offset, length and road geometry, as well as the presence of other roadside hazards. In addition, the use of continuous safety barrier may be warranted on high-speed roads regardless of the batter slope. As such, the desirable batter slope from a motorist safety perspective is correlated with the installation of safety barriers.

10:1 is considered recoverable for both cars and trucks and is the desirable batter slope, when unprotected by safety barrier, within roadsides and medians.

6:1 is considered recoverable for cars and therefore is included within the desirable unprotected batter slope range when the percentage of commercial vehicles (CV) is less than 10%.

Batter slopes steeper than 6:1 are likely to be considered hazardous and must be assessed in accordance with AGRD Part 6.

4:1 is considered traversable for cars and is included within the maximum unprotected batter slope range when the percentage of commercial vehicles is less than 10% or the posted speed is <60km/h. This assumes that the batter has been assessed in accordance with AGRD Part 6 and does not warrant safety barrier protection.

When the batter is protected by a barrier, steeper slopes may be considered, however, the hinge point of batter slopes steeper than 6:1 must be located beyond the dynamic deflection width (or barrier support width) unless deemed acceptable in accordance with AGRD Part 6 and the DoT Supplement to AGRD Part 6. The safety barrier itself should be located on a flat surface in accordance with AGRD Part 6.

Safe and efficient maintenance

All batters are considered a workplace in accordance with the OHS Act, Section 28.

The safe and efficient maintenance of a batter will depend on the location, landscaping, maintenance practices and any structural solutions adopted (in lieu of a batter). When comparing options, the designer must consider the whole-of-life issues and consult with the Asset Owner to ensure the slope can be safely and efficiently maintained using agreed practices.

Earthworks and landscape oriented solutions are preferred, when compared to slope treatments and retaining walls, such as beaching, shotcrete, rock mattresses, rock bolts and rockfall catch fences, and structural solutions. Slope treatments and structural solutions used in lieu of a steeper batter slope should only be considered as a last resort, where there is a specific need and/or the whole-of-life cost is deemed to be advantageous. Slope treatments and structural solutions used in lieu of a landscaped batter slope must be approved by the Asset Owner.

For maintenance of grassed batters, 6:1 or flatter is the preferred slope and 4:1 is the maximum slope to facilitate the use of typical mowing equipment. For steeper batter slopes, the designer must consult the Asset Owner (and maintainer) regarding acceptable slopes and grass mowing methods. 2:1 grassed batter



slopes are considered suitable with approval from the Asset Owner where a) the vegetation is established and the Asset Owner chooses to leave the batter un-maintained (often rural contexts), or b) where the grassed batter slope can be safely and efficiently maintained with available equipment (e.g. a 'boom mower').

For maintenance of planted batters, 4:1 or flatter is the preferred batter slope and 3:1 is the maximum to facilitate typical maintenance practices. The designer must consult the Asset Owner (and maintainer) regarding the maintenance of steeper planted slopes.

Batter slopes of 2:1 and steeper can be problematic to maintain and may require specialised equipment for inspection and maintenance practices. In these cases, the designer should consult the Asset Owner and/or consider a series of context sensitive treatments and alternatives to minimise the maintenance effort and risks.

Stability

All Extended Design Domain and Design Exception batter slopes must be deemed stable in accordance with relevant geotechnical requirements in AGRD Part 3 Section 4.5.

Economics

Depending on site-specific constraints, the selected batter slope can have a substantial impact on both the capital cost and operational cost. While Table V4.11 has been provided to capture most scenarios, the designer should always be cognisant of the economic impact of their decisions including the future costs of maintaining the adopted batter slope.

Traditionally, 2:1 grassed batter slopes have been considered economically beneficial where short, localised constraints exist, such as utilities and/or limited Right of Way boundaries. For these scenarios, it is essential that the design addresses how the batter slope will be maintained in the future.

Landscaping and vegetation

Providing an effective and sustainable landscape solution can significantly improve the safe and efficient maintenance of the batter and minimise future maintenance costs. However, landscape establishment and performance on batters will depend on the slope, as well as climate, aspect, soils and batter height. For this reason, the batter slope must be considered in conjunction with the site context, the proposed landscape solution and future maintenance requirements.

Where existing well-established vegetation is being retained or the Asset Owner prefers a grassed landscape, this factor is less important and the designer should focus on providing safe and efficient maintenance practices as discussed above.

For planted landscapes, the batter slope must also allow for suitable establishment and performance of vegetation, thus 3:1 is the maximum planted batter slope when protected by barrier. When considering steeper slopes (steeper than 3:1), the designer must demonstrate that the proposed landscape solution is sustainable and appropriate for the conditions, detailing the climate, aspect, soils, and batter height.

In conjunction when considering barrier slope options, the designer should also consider the impact of the selected batter slope (and width) on existing vegetation. In some locations, it may be beneficial to adopt a steeper batter slope with a narrower width (i.e. earthworks footprint), in order to retain existing vegetation/trees on or at the base of the batter. This should be considered on a site-specific basis and documented appropriately.

Design batter slopes

Substitute information

Table V4.11 provides the design domain for all batter slopes based on the key factors and statements above. Flatter batter slopes should be used where possible to improve roadside safety for motorists, provide for safe and efficient maintenance, ensure stability and improve landscape establishment and performance. This table substitutes Table V4.11 in AGRD Part 3.



		Median	Cut batters and fill batters		
		Datters	> 10% commercial vehicles	< 10% commercial vehicles ³	
	Desirable slope (when <u>not</u> protected by barrier)	10:1 or flatter	10:1 or flatter	6:1 or flatter ³	
Normal Design Domain	Desirable slope (when protected by barrier)	6:1 or flatter	6:1 or flatter	6:1 or flatter	
	Maximum slope (when not protected by barrier)	6:1	6:1 (posted speed >60 km/hr) 4:1 (posted speed ≤60 km/hr)	4:1 ^{3,4}	
	Maximum slope (when protected by barrier) ¹	6:1	 4:1 (earth batter, mown)⁸ 3:1 (earth batter, planted) 2:1 (rock batter)⁷ 		
Extended Design Domain	The following values are considered the maximum EDD slope when protected by barrier and suitably landscaped ⁵ and drained ⁶	-	 2:1 (earth batter, mown or planted)⁸ 1:1 (rock batter)⁷ 		
Design Exception		All steeper batter slopes ¹⁰			

Table V4.11: Design batter slopes

1. The batter hinge point to be located outside the dynamic deflection width (or barrier support width) unless deemed acceptable in accordance with AGRD Part 6 and the DoT Supplement to AGRD Part 6.

2. Median batter slopes provided in this table are intended to align with Table 4.16 of AGRD Part 3.

 The designer must consider future traffic growth (10 years unless agreed) to ensure the road is unlikely to exceed 10% commercial vehicles (CV) after batter construction. Where the percentage of CV is uncertain, the >10% column should be adopted.

4. Batters must be assessed and deemed a tolerable roadside risk in accordance with AGRD Part 6 and the DoT Supplement.

5. The landscape design and species selection must be appropriate for the conditions, detailing the climate, aspect, soils and batter height. Available guidance to be used where possible.

- 6. Drainage (kerb or catch drain) to be provided above batter slope where the surface falls towards the batter slope.
- 7. 'Rock' is defined in AS 1726 Geotechnical site investigations as 'any aggregate of minerals and/or organic materials that cannot be disaggregated by hand in air or water without prior soaking'. A 'rock batter' is a batter consisting entirely of insitu rock. Earth strata at rock batter crests, earth zones on rock batters, and all other batters are an 'earth batter'.
- 8. 2:1 earth batter slopes are considered Normal Design Domain when protected by barrier <u>and</u> when either a) the batter is <1.5m high and contained to a localised length of <50m to reduce impact on existing services/boundaries (and that this criteria is not repeated frequently along the route), or b) where the Asset Owner approves of the proposed whole-of-life costs and maintenance methods (e.g. boom mower or un-maintained).

9. Slope treatments and structural solutions used in lieu of a steeper batter slope must have an advantageous whole-of-life cost and be approved by the Asset Owner.

10. The designer must demonstrate that the batter slope is safe, efficiently maintainable, stable, economical and will achieve DoT's (and local government if relevant) landscaping objectives. Refer key factors of batter slope selection.

Existing batters and brownfield sites

Brownfield sites are often constrained by the Right of Way boundary, existing services and existing vegetation. While it is not always economical or desirable to modify existing batter slopes, the principles and guidance above remain relevant.

Where projects are impacting on an existing batter, they must assess the batter in accordance with the key factors discussed above (i.e. is the existing batter safe, maintainable, stable, economical and does it continue to achieve DoT's landscaping objectives). Existing batters, with slopes beyond the Normal Design Domain or Extended Design Domain, may have ongoing risks within one or more of the key factors of selection and should be addressed.

Where projects or designers are influencing an existing batter, the batter slope should be either modified to comply or left as is after documenting the risks and obtaining approval from the Asset Owner and/or Engineering department. Where these risks have already been documented, no approval is required.



4.6 Roadside Drainage

4.6.1 Table drains

The principles and requirements in Section 4.5 are also relevant to the design of table drains.

As per Table V4.11 - Design batter slopes:

- 6:1 is the desirable side slope and 4:1 is the maximum side slope for table drains assuming specific conditions.
- 2:1 slopes are only considered Normal Design Domain when
 - o protected by barrier and when the Asset Owner approves of the proposed maintenance, or
 - the table drain is not deeper than 0.5m. (Note: this allowance is specific to table drain slopes and is not covered in Table V4.11.)

AGRD Part 3, figures 4.18 and 4.19 may be used for information only. These figures do not reflect the multiple factors that can influence batter slope selection as detailed in Section 4.5.

4.6.2 Catch drains

Catch Drains are generally located on the high side of cut batters. As such, providing for safe and efficient maintenance of the drain and batter is a primary factor that requires consideration when developing design solutions.

Refer VicRoads Standard Drawings for Roadworks SD1521 and SD1531.

Catch Drain Type A may be used where the natural materials are not dispersible and erodible. The minimum practical width for construction of a flat bottomed drain is 2m, but 2.5m is preferable.

Catch Drain Type B may be used for small flows in non-erodible materials. The mounded catch drain shall be used above cut batters where the natural material is erodible, or wherever it is necessary to achieve minimum disturbance of existing vegetation.

4.6.4 Kerb and channel

For Pram Crossing details refer AGRD Part 4, Section 8.2.4, Australian Standard AS 1428.1 and T.E.M Vol 3 Part 2.19 - Accessibility (DDA) Guidelines for Road Infrastructure.

V4.6.4.1 Kerb & Channel Types (from RDG 3.6.11.4)

There are four basic types of kerb, kerb and channel or channel combinations:

- Fully Mountable Kerb
- Semi-Mountable Kerb
- Barrier Kerbs
- Channels

Examples of each type are illustrated in Figure V4.8. For dimensions of kerbs and kerb terminals refer to VicRoads Standard Drawings for Roadworks, SD2001, SD2101 and SD2103.





Figure V4.8: Kerb and Channel Types (from RDG Figure 3.6.11.4)

V4.6.4.2 Mountable Kerb and Channel

Mountable kerb is suitable for:

- the outside of curves on interchange ramps;
- on the approach noses of traffic islands which are likely to be trafficked;
- types M4, M5, M6 on SD2001 are for separation of normal traffic lanes from special areas intended for use by long or over dimensional vehicles in medians or on roundabouts. These shall not be placed where pedestrians or cyclists will cross the kerb, as they could pose a tripping hazard.

V4.6.4.3 Barrier Kerbs

Barrier kerb shall not be used on high speed and intermediate speed roads, as it is more likely to trip and overturn an errant vehicle. It is not recommended for use under safety barriers on high speed routes because the rail deflects on impact and the barrier kerb and rail combination may form a ramp to launch an errant vehicle.

Barrier kerb is suitable for:

- drainage behind guardrail;
- car parks, shopping areas;
- matching into council kerbing;
- under or close to bridge railing;
- indented bus bays.

V4.6.4.4 Channels

Channel types CD2 to CD4 have more drainage capacity than kerb and channel, and may be used as a catch drain adjacent to the high side of carriageway provided that the specified clearance is provided to the nearest traffic lane.

The curved channels CD2 and CD3 could create steering problems, and CD4 channel could create tripping problems. For this reason these channels should not be located adjacent to or close to the edge of traffic lanes. As vehicles can roll when tripped at relatively low speeds, other options should be considered before channels are located on the outside of curves.



V4.6.4.5 Kerb and Channel on Structures

Where there is a footpath in front of a bridge barrier or road safety barrier, SM type kerb and channel shall be used. Where B type kerb and channel is used, the face of the kerb shall be located directly below the face of barrier rail. Refer to Figure V4.9 for layout details.



Figure V4.9: Kerb and Channel for Structures (from RDG Figure 3.7.7)

V4.6.4.6 Clearance to Kerbs

Clarification

When longitudinal barriers such as kerb and channel, safety barriers, or retaining walls are located adjacent to traffic lanes, drivers tend to position their vehicles away from the barrier. This may reduce the effective capacity of the road. This behaviour may be countered by providing a clearance between the barrier and the traffic lane or shoulder.



The amount of clearance required depends on:

- the position of the barrier, whether adjacent to a traffic lane or a shoulder;
- the operating speed of the traffic;
- the height and type of barrier.

Clearances to different kerb types are set out in Table V4.3. These clearances do not apply where a kerb abuts a shoulder wider than 0.8m. However, the clearances set out in Table V4.3 shall apply to CD type channels abutting shoulders.

Kerbs located in the vicinity of a road safety barrier can affect the vehicle trajectory and hence the effectiveness of the barrier (refer AGRD Part 6). Therefore, the placement of kerb and channel must be considered in conjunction with the Safety Barrier Design Process and offset requirements detailed in AGRD Part 6 and VicRoads supplementary information.

Table V4.3: Minimum Clearance from Line of Kerb to Traffic Lane (from RDG 3.6.12.3)

SPEED Operating Speed (km/h)	KERB TYPE	MINIMUM CLEARANCE Edge of lane to line of kerb (m)
0-60	HPBK ⁽⁴⁾	0.3
0-79	B ⁽⁴⁾ or SM	0
	SM	0
80-99	CD4	1.0
	CD2/CD3	Not permitted
	SM	0.8
100+	CD4	3.0
	CD2/CD3	Not permitted
Freeways	SM	0.8
Notes:		

1. Clearances to kerbs do not apply where shoulders are wider than 0.8m.

2. The minimum width of lane abutting CD channels is 3.5m.

- 3. Standard kerbs and channels are shown on SD2001, SD2100 and SD2103. Channel width assumed is 0.3m.
- 4. Barrier kerb not recommended for speeds greater than 60km/h
- 5. HPBK High Profile Barrier Kerb

4.7 Medians

4.7.1 Median Width

Clarification

Refer VicRoads Supplement to AGRD Part 6, for further information regarding median barrier requirements and hazard, treatment option and risk assessment guidance.

Table 4.15 provides minimum urban median widths for a number of scenarios. In Victoria, the minimum urban median width shall be 2.0m where signal pedestals or lighting are provided in the median (i.e. Normal Design Domain). Median widths of 1.8m and 1.5m shown as shown in the table for varying width lantern displays shall be only considered as a Design Exception. The EDD Approval process shall be adopted for proposals having median widths less than 2.0m where signal pedestals are proposed.

Central barrier in narrow medians

Additional Information

Road Design Note 03-08 – Central barrier in narrow medians, provides guidance for the design, implementation and justification of safety barriers in narrow medians to address the risk of head-on crashes on rural and urban roads.

The design of median widths to accommodate median barrier installation is influenced by a number of factors including if the installation is part of a greenfield development or retrofit to a brownfield site. AGRD Part 1 provides guidance on providing context sensitive design. This applies to designing of barrier treatments in medians where Normal Design Domain (NDD) values should be suitable but may not be practical in constrained situations where values outside NDD may be adopted taking into account suitable consideration of risk and consultation with the relevant road authority.

Practitioners should consider the following factors when designing the incorporation of barriers into medians:

- Sight distance (AGRD Part 3 Clauses 5.1 to 5.5)
- Barrier dynamic deflection (AGRD Part 6 (2020) Clause 5.3.15)
- Barrier system width (including footing or terminal width)
- Position in relation to kerb (AGRD Part 6 (2020) Clause 5.3.5 & Table 5.3)
- Shy line (AGRD Part 6 (2020) Clause 5.3.5 & Table 5.4)
- Drainage
- Maintenance (refer GRD Part 6 (2020) Clause 5.3.9)

4.9 Bicycle Lanes

4.9.13 Advisory Treatments

Advisory treatments indicate or advise road users of the potential presence of cyclists and of the location where cyclists may be expected to ride on a road. They consist of pavement markings and/or warning and guide signs, and as such have no regulatory status. Refer VicRoads Traffic Engineering Manual for further information on advisory treatments to be adopted in Victoria.

4.10 High Occupancy Vehicle (HOV) Lanes

4.10.2 Bus Lanes

Refer VicRoads Supplement to Austroads Guide to Traffic Management Part 8 – Local Area Traffic Management for further information regarding VicRoads requirements for Bus Lanes.

4.10.3 Tram/Light Rail Vehicle (LRV) Lanes – Tram Track Design Standards

The Department of Transport and the tram operator (Yarra Trams) should be contacted to confirm all horizontal and vertical clearances for light rail vehicles.



4.11 On-street Parking

4.11.3 Angle Parking

Reverse in angle parking is prohibited in Victoria.

4.11.4 Centre of Road Parking

Reversing out of centre-of-road parking is prohibited in Victoria unless signage permits.

4.12 Services Roads, Outer Separators and Footpaths

4.12.1 Service Roads

Additional Information

One-way service roads should be at least 7.5m wide between kerbs to allow for backing of caravans and trailers into private property. Absolute minimum width is 6m.

4.12.3 Urban Border

The width required for public utility services generally will increase according to the function of the road, that is, more services are usually present on collectors and arterials than on local streets. For guidance regarding desirable utility service widths refer to Code of Practice for Management of Infrastructure in Road Reserves (2016). Consultation with appropriate service authorities should also be undertaken regarding allowance and desired clearances for utility services. The widths specified should be achieved where new subdivisions are developed.

4.13 Bus Stops

4.13.1 General

Refer VicRoads Bus Bus Stop Guidelines, Feb 2006 for guidance regarding the provision of indented bus bays.

4.13.2 Urban (Indented bus stop bays)

Refer VicRoads Bus Bus Stop Guidelines, Feb 2006 for guidance regarding the provision of indented bus bays.

Refer VicRoads Standard Drawing SD2071 for design details of an indented bus bay layout.

4.13.3 Rural

School bus stops: Refer AGRD Part 4 for further information regarding school bus stops.



5 Sight Distance

5.1 General

Additional Information

The sight distance required depends on the characteristics of the driver, the vehicle and the environment: Driver:

- alertness of driver,
- recognition of the hazard,
- actions available to the driver for example, to stop, to change direction.

Vehicle:

- type of vehicle car or truck,
- friction between the tyre and the road,
- eye height (partly a function of driver),
- speed of vehicle.

Road Environment:

- road geometry the effects of grade and curvature on stopping distances,
- road surface sealed or unsealed, smooth or rough,
- road illumination at night,
- placement of road furniture, hard landscaping and planting.

5.2 Sight Distance Parameters

5.2.2 Driver Reaction Time

Additional Information

Driver Reaction Time (from Rural Road Design Guide 8.2.3)

A driver reaction time of 2.5 seconds is desirable for the geometric design of all roads. However, in midblock situations where there is an expectation for increased driver alertness, such as locations with additional signs or line marking in an urban area or, where it may not be practicable to design for a 2.5 second reaction time such as low speed alignments in difficult terrain, a minimum reaction time of 2.0 seconds may be considered.

For truck drivers, the 2.5 second time actually consists of a 2.0 second initial reaction time (which is a reflection of the fact that truck drivers are professional drivers and in traffic, are usually able to see over vehicles in front) plus a 0.5 second inherent delay in the operation of the air brake system that is used on articulated heavy vehicles.

Ageing of Drivers (from Rural Road Design Guide 8.2.4)

As people age, they experience decreasing physical and mental capabilities and become more susceptible to injury and shock. Human functions subject to deterioration due to ageing include:

- visual ability;
- attention capacity;
- reaction time; and
- contrast sensitivity.

A number of road design elements may be associated with older driver crashes in Australasia. In particular, improvements to intersection sight distances, provision for separate turn phases at traffic signals, more conspicuous traffic signal lanterns and more clearly defined vehicle paths have the potential to reduce crash and injury risk for older drivers.



6 Coordination of Horizontal and Vertical Alignment

No supplementary information

7 Horizontal Alignment

7.6 Types of Horizontal curves

7.5.1 Compound Curves

Clarification

When compound curves are being considered, the smaller radius should not be less than 50 per cent of the larger radius on roads with an operating speed less than 70 km/h and not less than 80 per cent of the larger radius on roads with an operating speed greater than 70 km/h. This relationship between curve radii also applies to broken back compound curves. A check should be made to ensure that there is sufficient superelevation within the first 10m of the start of the smaller radius to cater for the road operating speed.

7.6 Side Friction and Minimum Curve Size

Additional Information

7.6.3 Minimum Curve Radius for Motorways

Adoption of the minimum radii of horizontal curves shown in Table 7.6 provides a reasonable outcome in most contexts from a Road Safety perspective.

When motorways are expected to operate at close to capacity (or when demand exceeds capacity), it is possible that geometry, such as a curve, can adversely influence operational performance outcomes regardless of whether it conforms with values provided in Table 7.6. There is clear evidence that curves having a radius less than 600m can have a negative impact on productivity (vehicle kilometres travelled on a road segment per time) which is defined as the product of traffic speed and traffic flow.

Austroads Guide to Smart Motorways (2016) reflects national and international learnings from road operators and provides guidance in Section C1.4 Horizontal Alignment as follows:

"...curves in the order of 600 m radius (which meet a design speed of 110 km/h) have been known to contribute to slowing traffic and flow breakdown in a 100 km/h speed environment, particularly when associated with an upgrade and/or minimal sight distance.

Where operational speeds may be affected by alignments that restrict a comfortable free-flow speed of 100 km/h, the capacity is likely to be reduced. Typically, a capacity reduction in the order of 5% (say 100 pc/h/lane), or up to 10% if combined with other factors, could be considered."

Operational Performance is a key measure of many projects, particularly urban freeways, so the minimum radius adopted in design should reflect the expected operational outcomes. Typically, adoption of inappropriate curve radii can result in a need to manage a bottleneck that is likely to impact on operational performance during peak flow periods.

Where the adopted design speed is 100km/h or greater and it is expected that a motorway will be operating at more than 85% of the theoretical design capacity more than 3 days per week during peak periods during the design life of the asset, a minimum curve radius of 750m shall be adopted for design. Operational and design capacities adopted for motorway analysis shall be those shown in Austroads Guide to Smart Motorways (2016), Table C1 1.



7.7 Superelevation

7.7.5 Length of superelevation Development

Additional Information

Figures V7.1 and V7.2 provide additional guidance regarding the superelevation development for tangents and spirals to circular curves.

Figure V7.1: Tangent to Circle – Superelevation Development for a Two Lane Two Way Road – Tangent Circle (from RDG Figure 2.7.3(a) in RDG Figure 2.7.3(b))



Tangent to Circle – Superelevation for One Way Crossfall Cases (from RDG Figure 2.7.3(b) in RDG Figure 2.7.3 (b))







Figure V7.2: Spiral to Circular Curve (from RDG Figure 2.7.4(b))

7.7.10 Positioning of Superelevation Runoff without Transitions

Clarification

Tangent to Circular Curve to Tangent (from RDG 2.7.5.1)

The development of superelevation runoff for tangent to circular curves is located with the larger proportion of the runoff length on the approach tangent, rather than on the circular curve. The proportion of runoff located prior to the circular curve is detailed in Table V7.1 and shown on AGRD Part 3, Figure 7.11.

	Portion of Superelevation Runoff Located prior to the Circular Curve				
Operating Speed (km/h)	No. of Lanes Rotated				
()	1	2	3		
20 - 70	0.80	0.90	0.90		
80 - 130	0.70	0.80	0.85		

In general, theoretical considerations favour the practice of placing a large amount of the superelevation runoff on the approach tangent. The driver may have to steer in a direction opposite to the direction to the curve ahead to stay in line. However, the maximum side friction developed on the tangent is equal to the rate of applied superelevation and is at all times less than the rate of side friction considered comfortable. A vehicle travelling at the design speed on the minimum radius curve (with maximum rate of superelevation) develops the maximum side friction considered safe and comfortable. To apply rates of superelevation less than maximum at any point on the circular curve means that vehicles travelling at the design speed develop



side friction factors in excess of the desirable minimum. While the side friction developed on the approach tangent is undesirable, the development of friction factors greatly in excess of the design basis on the circular curve, results in a worse condition.

However, some form of transition path of travel can be expected on the approach tangent and onto the early part of the circular curve. What can be considered lack of superelevation at the beginning of the circular curve is compensated to some extent by the vehicle travelling a curvilinear path that is flatter than the roadway circular arc.

7.7.11 Positioning of Superelevation Runoff with Transitions

Additional Information

Reverse Transition Curves

The only occasion that superelevation runoff might encroach into the circular curve is when the road alignment is in a constricted location. In this case, the shorter than normal transition curves with large superelevations, may be used to produce an acceptable alignment. The proportion of runoff located within the circular curve is detailed in Table V7.1.



8 Vertical Alignment

8.5 Vertical Controls

8.2.3 Flood Levels or Water Table

Additional information (from RDG 2.5.4.2)

In flat terrain, the grade line should generally be located so as to provide a clearance of 0.5m to 1.0m between the water table and the pavement boxing at its lowest point. Further geotechnical and pavement design advice should be obtained to determine the required clearance for specific projects.

For details of design Average Recurrence Intervals and acceptable water levels, refer to AGRD Part 5 – Drainage Design.

On all projects, minimum clearances above flood levels and water tables shall be defined by the client either in the design brief or in the design specifications.

8.2.5 Underground Services

Additional Information (from RDG 2.5.4.3(h))

The minimum cover below table drains of rural arterial roads to underground services is 1.2m, or greater if specified in writing by the owner of the service.

For additional information refer Code of Practice for Management of Infrastructure in Road Reserves (2016).

8.5 Grades

8.5.3 Maximum Grades

Additional Information (from RDG 2.5.6.2)

The desirable maximum grade on the main road through an intersection is 2.5 per cent (2% for intersections at ramp terminals within interchanges). This should ensure that turning trucks are not subjected to excessive overturning forces while cornering. Where it is not possible to achieve the desirable 2.5 per cent maximum longitudinal grade, then the designer shall calculate the maximum adverse crossfall developed for turning vehicles. The maximum adverse crossfall in any direction should not exceed 5 per cent.

A procedure for calculating maximum effective adverse crossfall is included in VicRoads Supplement to AGRD Part 4A, Section 2.2.4. Details of the effects of adverse superelevation and curve radii on turning trucks are included in AGRD Part 4A, Appendix C.

8.6 Vertical Curves

8.6.1 General

Additional Information (from RDG 2.5.A.3)

Limitations on the use of K values

K is used because it enables vertical curves to be specified with a single parameter. It does, however, have the following limitations:

1. the K values are calculated on the assumption that the alignment is straight. This is the worst case. Any curvature in the alignment shifts the line of sight to the inside of the curve where the pavement is lower. The lowering of the pavement effectively increases the K value of the vertical curve increasing the sight distance available. On low radius curves, the line of sight can be clear of the pavement in the critical area. The effect of this will, in most cases, increase the sight distance available relative to a straight alignment. Exceptions could occur when the line of sight is interrupted by a batter or solid barrier.



- 2. as the change in K depends on the radius of the curve, the sight distance, and factors which are site specific, the optimum solution is most easily obtained from graphical plots along the line of sight.
- 3. the K value is based on the assumption that the line of sight remains on the vertical curve (i.e. in the longitudinal direction). Again, this is the worst case position. When the line of sight extends beyond the vertical curve to a straight or sag curve, the sight distance increases. This effect is shown by the curved lines on Figure V8.4. Note that Figure V8.4 is based on superseded stopping sight distance criteria and is provided for additional information only.

Figure V8.4: Crest Vertical Curve Lengths (Based on stopping sight distance for cars) (from RDG Appendix A Figure 2.5.A.3(c))



Three sections of the curves on Figure V8.4 require explanation:

a) the curved section where L < S i.e. where the length of the curve is less than the sight distance required.

On this curved section of the graph it is theoretically possible to use a vertical curve length which is slightly less than the length obtained from AGRD Equation 17 (L = KA) because sight distance available to the driver extends onto the straight on the approach to the curve. As use of K values in this range provide conservative answers, and the differences are small, it is rarely necessary to take this effect into account. If necessary, however, the minimum curve length for this section can be calculated from AGRD Equation 19 (reproduced below).

- b) The vertical lines forming the left hand limits of the curves indicate the minimum practical length of curve. These minimum lengths are specified on AGRD Part 3, Table 8.10.
- c) the lower limits to the vertical lines indicate points where the grade change is not sufficient to warrant the construction of a vertical curve. These minimum grade changes are shown in AGRD Part 3, Table 8.12.

Other features of the graphs on Figure V8.4 are explained below:

- 1. the straight lines if extended downwards would all start at point (0, 0). This indicates that the lines can be represented by the formula L = KA.
- 2. when the curve length is less than the sight distance, the effect of the parabola on sight distance is reduced. This creates the curving section on Figure V8.4. The formula for vertical curve lengths represented by this section is (AGRD Equation 19):

$$L = 2S - \frac{200}{A}(\sqrt{h_1} + \sqrt{h_2})^2$$



3. because very short vertical curves are both unsightly and impractical to construct, minimum curve lengths are specified for each design speed (AGRD Part 3 Table 8.10). An exception applies on intersection approaches at which all vehicles are required either to stop or to give way. In these circumstances short vertical curves, with lengths in the order of 4m to 10m may be used.



9 Auxiliary Lanes

9.5 Climbing Lanes

9.5.1 General

Additional Information (from RDG 2.8.5.7)

Climbing lanes commonly occur in the overlapping lane "before" configuration, see Figure 9.4. The geometric details are shown on Figure V9.5.

Climbing lanes should be extended for 200m to 300m beyond the crest of the hill to enable trucks to accelerate to a speed close to highway operating speed. This requirement is in addition to the minimum sight distance criterion.



Figure V9.5: Typical Climbing Lane (from RDG Figure 2.8.4)

9.6 Slow Vehicle Turnouts

9.6.2 Slow Vehicle Turnouts

Additional Information (from RDG 2.8.5.3)

In mountainous terrain, occasional provision of a very short lane which allows overtaking of slow trucks may effectively reduce delays.

On low speed roads with left-hand side widening, the diverge taper may be 50m minimum, the minimum lane length 80m and the merge taper 90m minimum.



9.9 **Geometric Requirements**

9.9.2 Tapers

Additional Information

Geometry	Details		
Diverge Taper			
Left Hand Widening	100m (min)		
Right Hand Widening	250m (min)		
Lane Widths	3.5m		
Merge Taper	165m (desirable)		
Sight Distance Standard			
Along lane	Stopping Sight Distance		
Along merge and diverge	Approach Sight Distance		
Minimum length excluding taper	Refer Table 9.2, AGRD Part 3, Section 9.4		

Table V9.1: Geometry Details of Overtaking Lanes (from RDG Table 2.8.4.7(a))

9.9.3 **Starting and Termination Points**

Merge Taper.

.

Clarification

Provide 3m shoulders at the termination of overtaking lanes, refer Table V9.2 below.

be reduced.

Shoulders	
Diverge Taper	Full width shoulders for the Road Class
Parallel Section	Full with shoulders, except where right-turn lane is added to an overtaking section, the left shoulder may

Increase width to 3m, extending at least 40m beyond the end of taper, then transition to full width shoulder

Table V9.2: Shoulder Widths (from RDG 2.7.4.7(c))



10 Bridge Considerations

10.1 General

Further information on Kerb and Channel on Structures is given in Section 4.6.4 – Kerb and Channel of this Supplement.



References

Acronyms

AGRD: Austroads Guide to Road Design AGTM: Austroads Guide to Traffic Management DoT: Department of Transport GTEP – Guide to Traffic Engineering Practice (superseded) RDN: Road Design Note SD: Standard Drawings for Roadworks VRD/RDG – VicRoads Road Design Guidelines (superseded) WRSB: Wire Rope Safety Barrier

Documents:

AS 1428.1 (2009). Design for Access and Mobility Part 1: General requirements for access. AS 1742 (2003). Manual for uniform traffic control devices. AS/NZS 2890.1 (2004). Parking Facilities, Part 1: Off-street car parking. Austroads (2003). Rural Road Design Guide AP G1/03 (superseded). Austroads (2006). Austroads Design Vehicles and Turning Path Templates AP-G34/06. Austroads (2006). Austroads Guide to Road Design - Part 2: Design Considerations. Austroads (2009). Austroads Guide to Road Design - Part 3: Geometric Design. Austroads (2009). Austroads Guide to Road Design - Part 4: Intersections and Crossings General. Austroads (2009). Austroads Guide to Road Design - Part 4A: Unsignalised and Signalised Intersections. Austroads (2009). Austroads Guide to Road Design - Part 4B: Roundabouts. Austroads (2009). Austroads Guide to Road Design - Part 4C: Interchanges. Austroads (2009). Austroads Guide to Road Design - Part 5: Drainage Design. Austroads (2009). Austroads Guide to Road Design - Part 6: Roadside Design, Safety and Barriers. Austroads (2009). Austroads Guide to Road Design - Part 6B: Roadside Environment. DOT (2004). Victorian Rail Industry Operators Group Standards - VRTOGs 0001. Giummarra. G (2009). Unsealed Roads Manual, Guidelines to Good Practice 3rd Edition. Street Works Coordination Committee (1995). Coordination of Street Works - Code of Practice. VicRoads (2003). Road Design Guidelines - Part 7: Drainage Design (latest version). VicRoads (2004). Cycle Notes No. 13: Wide Kerbside Line Markings. VicRoads (2006). Access Management Policy. VicRoads (2007). Oversize and Over Dimensional Special Purpose Vehicles. VicRoads (2007). Oversize Load Carrying Vehicle. VicRoads (2008). Making roads motorcycle friendly - A guide for road design, construction and maintenance. VicRoads (latest). RDN 06-06: Guidelines for the Placement of Tactile Ground Surface Indicators. VicRoads (latest). VicRoads Supplement to AGRD Part 2 Austroads (latest). VicRoads Supplement to AGRD Part 3: Geometric Design. VicRoads (latest). VicRoads Supplements to AGRD Part 4, Part 4A, Part 4B and Part 4C. VicRoads (latest). VicRoads Supplement to AGRD Part 5: Drainage Design. VicRoads (latest). VicRoads Supplement to AGRD Part 6 VicRoads (latest). VicRoads Supplement to AGRD Part 6B VicRoads (Draft 2010). Victoria's Rural Arterial Road Network Strategy. VicRoads (various). VicRoads Standard Drawings for Roadworks. VicRoads (web site). Guidelines for the Movement of Overdimensional and Overmass Vehicles. VicRoads Traffic Engineering Manual Volume 1 - Traffic Management. VicRoads Traffic Engineering Manual Volume 2 – Signs and Markings. Vic. Govt. (2004). Code of Practice for the Management of Road and Utility Infrastructure in Road Reserves.



Appendices

Appendix A Extended Design Domain (EDD) for Geometric Road Design

Refer to VicRoads Supplement to AGRD Part 2 for further information regarding the use of EDD for VicRoads projects.

Appendix E Narrow Median Treatments with Wire Rope Safety Barrier (WRSB)

Additional information – Narrow Median Treatments

Refer to DoT Road Design Note 03-08 – Central barrier in narrow medians, for guidance on the design, implementation and justification of safety barriers in narrow medians.

Appendix E includes information to assist with designing narrow median treatments with a central safety barrier.

The criteria included in Appendix E for the development of narrow median treatment proposals are considered to be in the Extended Design Domain (EDD). The EDD approval process shall be adopted for acceptance of narrow median with central safety barrier treatments for median widths between 1.5m and 8.2m. The process for approval to the use of EDD is included in VicRoads Supplement to AGRD Part 2 – Section 2.3. For projects that do not need to be reviewed by PRC, VicRoads Regional Director Approval is required.

When a central road safety barrier in a narrow median is proposed, the clearance from the edge of the traffic lane to the barrier shall be in accordance with Table E1, noting that an absolute minimum offset of 1m is generally required. Table E1 also contains further information regarding roadside hazards, treatment options and risk assessment guidance.

Key requirements and restrictions regarding the use of a narrow median with a central road safety barrier are shown in AGRD Part 3, Table E1. Other design details regarding this treatment are contained in AGRD Part 3, Figure E2.

Appendix I Reverse Curves

Additional Information (from RDG Part 2.7)

The following figures (Figure VI1.1, Figure VI1.2(a) and Figure VI1.2(b)) are provided as additional cases for the design of reverse curves.





Figure VI1.1: Superelevation Development for Reverse Curves with Short Tangent (from RDG 2.7.5(a))

Figure VI1.2(a): Superelevation Development on Reverse Curves with Spirals (from RDG Figure 2.7.6(a))





Figure VI1.2(b): Use of Minimum Superelevation Length to Improve Drainage (from RDG Figure 2.7.6(b))



Figure VE1.3: Compound Curves (from RDG Figure 2.7.7





Appendix J Transition Curves (from RDG Part 2 Appendix F4)

Additional information

J.4 Characteristics of the Euler Spiral (Clothoid)

VJ.4.1 Standard Notation for Spirals Figure



=	point of change from tangent to spiral.
=	point of change from spiral to circle.
=	length of spiral from T.S to S.C (metres).
=	length in metres from the T.S along the curve to any point on the spiral.
=	design speed in metres per second.
=	design speed in kilometres per hour.
=	intersection angle in degrees.
=	radius in metres of the circular arc (or radius of the spiral at the S.C).
=	radius at distance L along the spiral.
=	abscissa and ordinate respectively of any point on the spiral with reference to the T.S and the initial tangent.
=	co-ordinates of the S.C.
=	spiral angle at any point and at S.C. respectively.
=	polar angle = spiral deflection angle at the T.S. from the initial tangent to any point on the spiral and to the S.C. respectively.
=	long chord distance = chord distance from T.S. to any point on the spiral.
=	back angle = Angle between the long chord and the tangent to the spiral at any point on the spiral.
=	the point on the circle at which the radius is normal to the initial tangent.
=	shift = Offset from the tangent to the S.T.C.
=	abscissa of the offset at P.C measured from the T.S.
=	displacement of tangent point along the tangent due to the introduction of a spiral.
=	spiral constant.
=	tangent distance = distance from I.P to T.S.
=	design secant distance.
=	design friction factor.
=	superelevation in percent.
=	rate of change of acceleration (m/s ³) on transition curve at design speed.

VJ 1.1: Spiral Notation (from RDG Figure 2.4.D.1)



VJ.4.2 Euler Spiral

Spirals can be defined using a number of mathematical equations. The spiral used by VicRoads is the EULER SPIRAL. In its simplest form the equation for the Euler spiral is;

RLL = constant = Ks

Where,

L = length along the spiral from the start to a specified point.

RL = radius at distance L along the spiral

From the equation it can be seen that RL decreases as L increases. The numerical value of Ks fixes the shape of the curve as shown on Figure VJ1.2.

Figure VJ 1.2: Effect of LR Constant on Spiral Shape (from RDG Figure 2.4.D.2)



In road design both the length of the spiral (Lsp) and the radius of the circular curve at the end of the spiral (R) are fixed for each spiral.

 $L_{SP} \times R = K_S$ $L_{SP} \times R = L \times R_L$ $\phi = \frac{L^2}{2R L_{SP}} \dots \dots radians$

One other spiral equation commonly used is where ϕ is the angle between the approach tangent and a tangent at distance L from the start, as shown on Figure VJ1.3.

Figure VJ 1.3: Deflection Angle along Euler Spiral (from RDG Figure 2.4.D.3)





There are two important properties of the Euler Spiral illustrated on Figure VJ1.4:

- 1. The PC point is the location where the TC would be if the spiral were not provided. This point is approximately half way along the spiral.
- 2. The offset between the tangent and the PC is approximately equal to p/2 where p is the total shift.



Figure VJ.4: Location of the PC Point (from RDG Figure 2.4.D.4)

Notes:

- 1. This drawing has been exaggerated to illustrate the geometry.
- 2. For location of the spiral with respect to superelevation development, see AGRD Part 3, Section 7.5 and 7.7.



VJ1.3 List of Spiral Equations (from RDG 2.4.D.3)

T (Tangent Distance)	$= (R + shift) \tan \frac{1}{2} +$	K		
S (Secant Distance)	$= (R + shift) \sec \frac{I}{2} - R$			
(Circ Arc)	$= R (I - 2\phi_s) \text{ where }$ $expressed in radian$ $or \frac{(I - 2\phi_s)}{D} \times 10^{-10}$	I and ϕ_s are both ns 00		
x (Abscissa)	$= \int_{o}^{L} \cos \phi dL$	$= L (1 - \frac{\Phi^2}{5.2!} + \frac{\Phi^4}{9.4!} - \frac{\Phi^6}{13.6!} +)$ $\simeq L - \frac{L^5}{40(RL_{sp})^2}$		
y (Ordinate)	$= \int_{o}^{L} \sin \phi dL$	$= L \left(\frac{\Phi}{3!} - \frac{\Phi^3}{7.3!} + \frac{\Phi^5}{11.5!} - \dots\right)$ $= \frac{L^3}{6(RL_{sp})} - \frac{L^7}{336(RL_{sp})^3}$		
p (Shift)	= y R Versin φ _s	$= \frac{L_{sp}}{2} \left(\frac{\Phi_s}{3.2!} - \frac{\Phi_s}{7.4!} + \frac{\Phi_s}{11.6!} - \dots \right)$ $\simeq \frac{L_{sp}^2}{24R} - \frac{L_{sp}^4}{2688 R^3}$		
Κ	$= x - R \sin \phi_s$	$= \frac{L_{sp}}{2} \left(1 - \frac{\Phi_s^2}{5.3!} + \frac{\Phi_s^2}{9.5!} - \frac{\Phi_s^2}{13.7!} + \ldots\right)$ $= \frac{L_{sp}}{2} - \frac{L_{sp}^3}{240 R^2}$		
$K_{S} (Sniral constant) = L_{r} \times R$ L^{2}				
ϕ (Spiral Angle) = ϕ_s	$= \frac{L_{sp}}{2R} radians$ $= \frac{L_{sp}}{2R} radians$			
A (Rate of change of	acceleration) = $\frac{v^3}{L_{sp}R}$	$= \frac{V^3}{46.656 L_{sp} R}$		

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