Australia: New National Guide to Road Design

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Abstract
The Austroads Road Design Review Panel, the peak industry body comprising members from road/transport authorities from the States and Territories of Australia, New Zealand and the design consulting industry, has developed a new, truly national Guide to Road Design. Released in July 2009 and comprising eight parts, this guide provides the essential reference to road design practitioners across Australia and New Zealand. For the first time, each of the member authorities has agreed to use the new national guide in lieu of their State based guidelines.

The development of the new Guide to Road Design saw a substantial review undertaken of the existing state and national guides, and of current best practice by member authorities both locally and internationally.
Significant changes and highlights of the new series include:

- introduction of the Extended Design Domain concept for the geometric and intersection design guides;
- a geometric design guide that introduces revised design parameters and consolidates the original urban and rural design guides into the one document;
- the design of unsignalised at-grade intersections, which has volume-based warrants that are derived from statistical analysis of local crash data;
- the design of roundabouts, which now focuses on the design of the entrance curve rather than the design envelope through the roundabout;
- new guides that deal specifically with freeway interchanges and roadside design elements including safety barriers;
- recognition of cycling as an important mode of transport and incorporation of their design requirements throughout the various parts, instead of having a separate exclusive part dedicated to cycling.

INTRODUCTION

Austroads is the association of Australian and New Zealand road transport and traffic authorities. Austroads members are the six state and two territory transport and traffic authorities from Australia, the Commonwealth Department of Infrastructure, Transport, Regional Development and Local Government, the Australian Local Government Association, and the New Zealand Transport Agency.

Austroads purpose is to contribute to the achievement of improved Australian and New Zealand transport related outcomes through facilitation, collaboration and harmonisation in road management. Key strategic goals of Austroads include undertaking nationally strategic research to address current and emerging issues relating to road assets and to produce a comprehensive range of publications to assist road agencies in the planning, design, construction, maintenance and operation of road transport infrastructure.

During 2004, Austroads Council agreed to redevelop their range of publications into ten new, logically structured and complete publication series to replace the somewhat fragmented range of Austroads guides and manuals. The series themes are:

- Asset Management
- Bridge Technology
- Pavement Technology
- Project Delivery
- Project Evaluation
- Road Design
- Road Safety
- Traffic Management
- Transport Planning
- Tunnels

These guides were launched in July 2009, and for the first time, each state and territory road authority have agreed to adopt the Austroads Guides as their primary reference document, replacing their State based guidelines and manuals. The State and Territory Road Authorities are each embarking on a transition process from their existing guidelines to the new Austroads Guide.

This paper provides details of some of the key changes to road design guidance for practitioners in Australasia, as published in the Austroads Guide to Road Design (AGRD) (1).

BACKGROUND AND OBJECTIVES

One of the key objectives of the Austroads Road Design Review Panel (RDRP), during the development of the AGRD, was to provide clear and unambiguous road design guidance to practitioners. The source of the information for the new guide was drawn from:

- existing Austroads publications
- New Zealand Transport Agency (formerly Transit New Zealand) publications
- individual Australian State and Territory road design guides
- existing road design research (both local and international)

These existing documents were compared to identify the best practice or research to adopt in the new AGRD. In trying to develop a comprehensive design guide that was applicable in both urban and rural areas with varying extremes in climate and topography, the RDRP sought to provide a greater level of flexibility in the design parameters for practitioners. The major revisions discussed below, were implemented to enable practitioners to provide efficient designs, which are tailored to the constraints of the site, and do not compromise on the safety of the road. Figure 1 shows the structure of the AGRD.

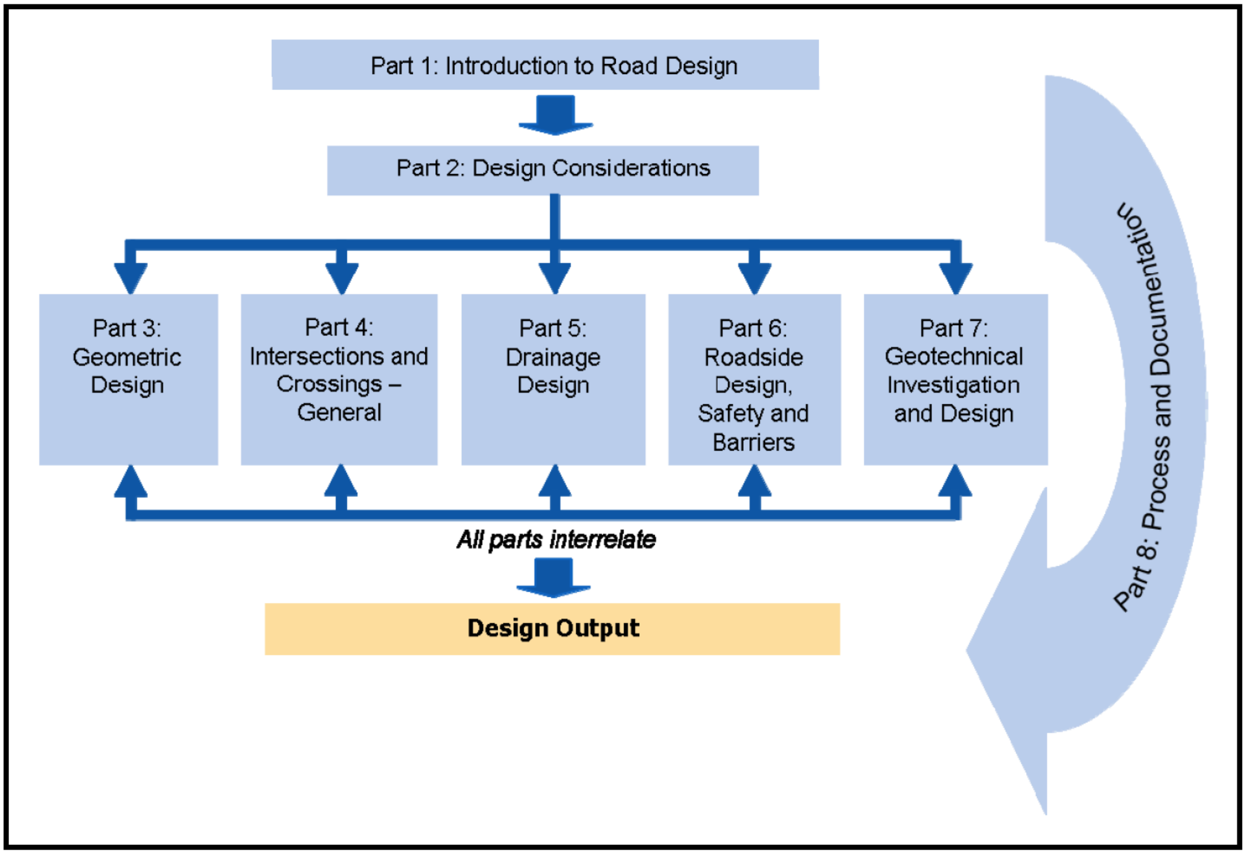


FIGURE 1: Structure of the Austroads Guide to Road Design

SAFE SYSTEMS APPROACH

The third two-year action plan (2005-2006) (2), presented under National Road Safety Strategy 2001-2010 (3), introduced the Safe System concept as an overarching framework for road safety intervention. Austroads has also advocated this approach as a guiding philosophy, and has adopted this in the compilation of the AGRD. This concept, similar to the Swedish Vision Zero approach, recognises that road users are fallible and shouldn't be penalised with death or serious injury when they do make mistakes. The Safe System (Figure 2) approach emphasises the way different elements of the road transport system combine and interact with human behaviour to produce an overall effect on total road trauma. The key components of the system are safer roads and roadsides (infrastructure), safer speeds and safer vehicles.

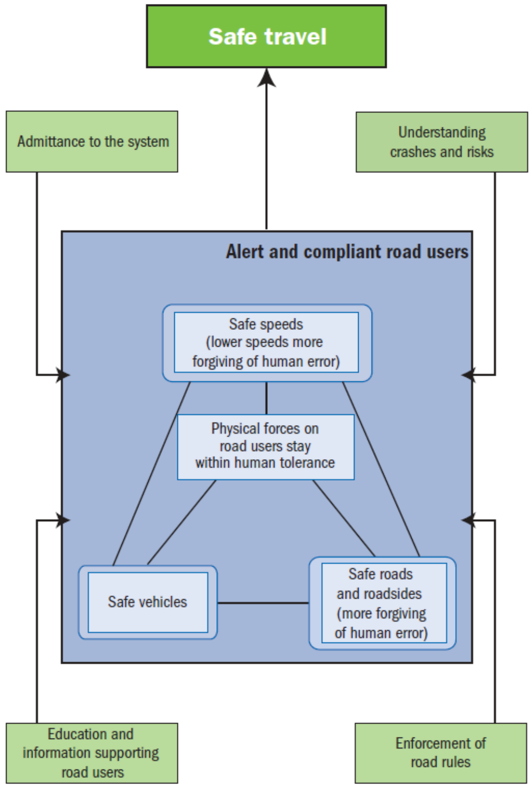


FIGURE 2: Safe System Framework

EXTENDED DESIGN DOMAIN

Extended Design Domain (EDD) has been promoted as a concept by some Austroads member authorities for a number of years, as a way to manage the risk of substandard geometry on existing road infrastructure (4). This concept has now been developed further and adopted into the AGRD. Definitive parameters have been provided for the designer to use in constrained locations for new works and for restoration type projects on existing roads.

Central to the theory of EDD is the premise of a design domain (Figure 3). The design domain describes the range of values for a particular design parameter (such as driver reaction time, deceleration rate, object height in the sight distance model for example). Within the design domain, there exist absolute lower and upper limits. The preferred part of the design domain is described as the Normal Design Domain (NDD), and road design guidance in Australasia has typically utilised design values in this range. For the case of stopping sight distance, desirable and minimum values were provided using alternative reaction times, but both were considered to be acceptable and safe for a given set of circumstances. EDD extends the range of values with the introduction of less conservative parameters, based on research and/or operating experience, which have been found to provide a suitable solution in constrained locations.

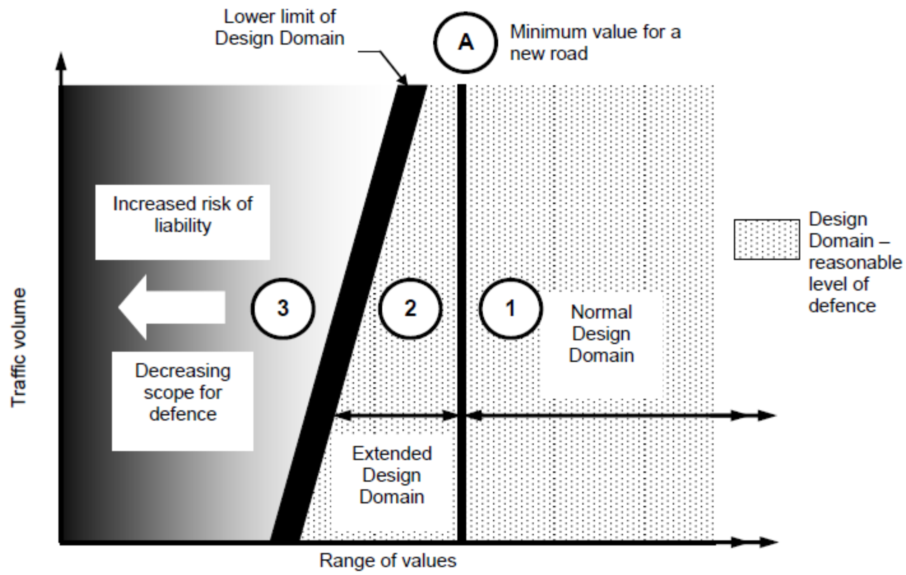


FIGURE 3: Conceptual diagram of Extended Design Domain

The AGRD provides for the use of EDD in addition to the NDD for design parameters relating to:

- cross section
- sight distance
- horizontal geometry
- unsignalised intersection treatments

Whilst the AGRD emphasises the desirability of maintaining NDD values when designing new roads or the significant reconstruction or upgrade of existing roads, the introduction of EDD is a major step towards providing guidance to designers who are faced with a constrained site. Where the design involves existing roads, where there is no significant crash history and where significant constraints exist, the Guide allows for the use of the EDD, subject to the agreement of the managing road authority. The use of these values must be justified and defended on engineering grounds and operating experience. The Guide emphasises that, where a minimum is adopted for one geometric element, it is desirable to adopt a standard that is above the minimum for all other elements.

GEOMETRIC DESIGN

For the geometric design of roads, Austroads previously published two guides; The Geometric Design of Major Urban Roads (5), and The Geometric Design of Rural Roads (6). Both of these guides were substantially revised and updated in 2002 and 2003 respectively (7). While some significant differences exist between aspects of these road categories, there is also substantial overlap between them. For this reason, it was agreed to consolidate this information into one part for the new AGRD.

Operating Speed Model

The Guide continues with the use of the car operating speed model (taken to be the 85th percentile car speed). The operating speed of a car is used to determine other key geometric design parameters which include sight distance, stopping distance, horizontal curve radii, and superelevation.

To reflect the growing freight task in Australia, designers are now required to check all designs to ensure that they cater for trucks, with the truck speed estimated by comparison with car operating speeds or by direct measurement where this is possible. Australian trucks are generally large by world standards - a permitted vehicle on most arterial roads is a 19 m semi trailer (single articulated) with a mass of 42.5 t. B-Doubles 26 m long with a mass up to 62.5 t are permitted as restricted access on many of the nation's arterial roads, with road trains 54 m long with a mass of 125 t are allowed by permit on some remote roads. The design effort to cater for these vehicles, whilst still providing a safe road for cars, can be considerable.

Sight Distance

Vertical Height Parameters

The Guide provides a fully revised set of design parameters for the sight distance model. Many of the existing vertical height parameters were based on the Australian passenger car fleet during the 1970's. An examination of the current vehicle fleet recommended changes to most of the vehicle parameters (Table 1) (8), and driver eye heights which were raised to 1.1m (9). For Safe Intersection Sight Distance, the object height of the approaching vehicle was increased from the driver eye height to the top of car, as this was considered to be more realistic of what drivers were looking for.

TABLE 1: Vertical Height Parameters

Vertical height parameter	Previous Height (m)	New Height (m)
Height of eye of driver h_1		
1. Passenger car	1.05 (1.15 in some states)	1.1
2. Truck	2.4	2.4
3. Bus	Not provided	1.8
Headlight height h_1		
1. Passenger car	0.75	0.65
2. Commercial vehicle	Not provided	1.05
Object cut-off height h_2		
1. Road surface	0.0	0.0
2. Stationary object on road	0.2	0.2
3. Front turn indicator	0.6	0.65
4. Car tail light/stop light/turn indicator	0.6	0.8
5. Top of car	1.05 (previously used driver eye height)	1.25

Coefficient of Deceleration

The previous guides used a longitudinal friction factor (coefficient of deceleration) that reduced as the speed increased, based on car braking on a wet, sealed road. Newer research from Fambro et al (10) and Durth and Bernhard (11) for cars, and Di Christoforo et al (2004) (12) for trucks, showed that modern vehicle braking performance could be considered to be uniform across a range of speeds. The new guide provides a range of coefficients, ranging from 0.15 (equivalent to a deceleration rate of 1.5 m/s^2) for buses to ensure passenger comfort, up to 0.61 for heavy braking on a dry, sealed road. The NDD values range from 0.26 for freeways and high standard rural highways to 0.46 on low speed, lower order roads. For all other road types, a value of 0.36 is recommended. Table 2 provides an extract from the AGRD showing the range of values and typical uses.

TABLE 2: Coefficient of Deceleration

Vehicle type	Coefficient of deceleration (d)	Driver/road capability	Typical use
	0.61 [(1)]	Braking on dry, sealed roads.	Specific applications where the normal stopping sight distance criteria applied to horizontal curves produce excessive lateral offsets to roadside barriers/structures – refer Section 5.5 (used in conjunction with supplementary manoeuvre capability).
Cars [(2)]	0.46 [(1)]	Mean value for braking on wet, sealed roads for a hazard. Maximum values when decelerating at an intersection.	Absolute maximum value for stopping sight distance. Only to be used in constrained locations, typically on: ▪ lower volume roads ▪ less important roads ▪ mountainous roads ▪ lower speed urban roads ▪ sighting over or around barriers ▪ tunnels.
	0.36	About a 90th percentile value for braking on wet, sealed roads. Maximum value allowed for deceleration lanes at intersections.	Desirable maximum value for stopping sight distance for most urban and rural road types, and level crossings.
	0.26	Comfortable deceleration on sealed roads. Normal driving event.	Desirable maximum value for stopping sight distance for major highways, freeways and for deceleration in turn lanes at intersections. Maximum value for horizontal curve perception sight distance.
	0.27	Braking on unsealed roads	Stopping sight distance on unsealed roads. This value is very dependent on the surface material and should be verified where possible.
Trucks	0.29[(1)]	Braking by single unit trucks, semi-trailers and B-doubles on dry, sealed roads. Minimum value required by vehicle standards regulations.	Maximum value for truck stopping sight distance for most urban and rural road types, and level crossings.
Buses	0.15		Desirable braking to ensure passenger comfort approaching a bus stop.

Driver Reaction Time

Previous guidance provided by Austroads only included perception-reaction times of 2.0 and 2.5 seconds. The guide now provides for 3 values: 2.5 seconds for unalerted driving on rural freeways, 2.0 s for high speed urban areas, and 1.5 s for highly alerted driving in low speed, constrained urban areas. Table 3 provides details of the reaction times and typical uses. A reaction time of 2.5 seconds is restricted to operating speeds greater than 60 km/h and a reaction time of 1.5 seconds is restricted to a maximum operating speed of 90 km/h.

TABLE 3: Driver perception-reaction times

Reaction time R_T (s)	Typical road conditions	Typical use
2.5	▪ Unalerted driving conditions due to the road only having isolated geometric features to maintain driver interest ▪ Areas with high driver workload/complex decisions ▪ High speed roads with long distances between towns	Absolute minimum value for high speed roads with unalerted driving conditions. General minimum value for: ▪ high speed rural freeways ▪ high speed rural intersections ▪ isolated alignment features
2.0	▪ Higher speed urban areas ▪ Few intersections ▪ Alerted driving situations in rural areas ▪ High speed roads in urban areas comprising numerous intersections or interchanges where the majority of driver trips are of relatively short length. ▪ Tunnels with operating speed ≥ 90 km/h.	Absolute minimum value for the road conditions listed in this row. General minimum value for most road types, including those with alert driving conditions.
1.5[1]	Alert driving conditions e.g.: ▪ high expectancy of stopping due to traffic signals ▪ consistently tight alignments for example, mountainous roads ▪ restricted low speed urban areas ▪ built-up areas – high traffic volumes ▪ interchange ramps when sighting over or around barriers ▪ tunnels with operating speed ≤ 90 km/h.	Absolute minimum value. Only used in very constrained situations where drivers will be alert. Can be considered only where the maximum operating speed is ≤ 90 km/h. Should not be used where other design minima have been used.

Stopping Sight Distance

Given the parameters discussed above, the AGRD provides practitioners with clear and easy to follow guidance for the provision of Stopping Sight Distance for cars and trucks. To assist in providing designs which are tailored to the site conditions for a given operating speed, designers are provided with the choice of seven main design cases based on coefficients of deceleration and driver reaction time. The values are provided in an easy to follow table, an example of which is provided in Table 4.

TABLE 4: Example of Stopping Sight Distance for Cars

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 most urban and rural road types based on d = 0.36			Desirable values for major highways and freeways based on d = 0.26	
	R_T = 1.5s(4)	R_T = 2.0 s(4)	R_T = 2.5s	R_T = 1.5 s(4)	R_T = 2.0 s(4)	R_T = 2.5 s	R_T = 2.0s	R_T = 2.5 s
40	30	36	–	34	40	45	–	–
50	42	49	–	48	55	62	–	–
60	56	64	–	64	73	81	–	–
70	71	81	–	83	92	102	113	123
80	88	99	–	103	114	126	141	152
90	107	119	132	126	139	151	173	185
100	–	141	155	–	165	179	207	221
110	–	165	180	–	193	209	244	260
120	–	190	207	–	224	241	285	301
130	–	217	235	–	257	275	328	346
Corrections due to grade (5) (6)	-8	-6	-4	-2	2	4	6	8
40	5	3	2	1	-1	-2	-2	-3
50	8	5	3	2	-1	-3	-4	-5
60	11	8	5	2	-2	-4	-6	-7
70	15	11	7	3	-3	-5	-8	-10
80	20	14	9	4	-4	-7	-10	-13
90	25	18	11	5	-5	-9	-13	-16
100	31	22	14	6	-6	-11	-16	-20
110	38	26	17	8	-7	-13	-19	-24
120	45	31	20	9	-8	-16	-22	-29
130	53	37	23	11	-10	-18	-26	-34

Sight distance requirements on horizontal curves with roadside barriers, walls or bridge structures

The application of the normal stopping sight distance requirements over/around roadside barriers and structures on horizontal curves may produce excessive lateral offsets in particular circumstances, particularly on loop ramps within freeway interchanges. This may produce some adverse operational effects which include:

- uncontrolled stopping of cars and trucks in the widened area, reducing sight distance
- errant vehicles striking the barriers at a greater angle, increasing the severity of the crash
- the cost of providing the widening becomes prohibitive

Two cases are considered in the AGRD; where sighting over barriers is possible and where no line of sight exists. For the first case, the Guide provides for the use of an object height greater than 0.2m (stationary object) for cars and 0.8m (tail lights) for trucks, through the provision of minimum shoulder widths and manoeuvre times. The aim of the guidance is to ensure that both cars and trucks have an opportunity to manouevre around the hazard through the provision of a full width shoulder, where stopping sight distance is not available due to the presence of a barrier. Table 5 shows the parameter values.

For the situation where no line of sight over a roadside barrier is available, the Guide recommends that the horizontal and vertical geometry be redesigned to provide sight distance. Where this is not possible, the Guide notes that as a minimum, car stopping sight distance on a dry road, supplemented by the required minimum shoulder width and minimum manoeuvre time should be provided. For truck manoeuvre capability only, a minimum shoulder width of 4 m should be provided with a minimum manoeuvre time to a 0.8 m high object equal to the reaction time plus 3.5 seconds.

TABLE 5: Sight distance and shoulder width requirements where there is restricted visibility on horizontal curves

Case	Object height adopted for stopping capability 'h2' (m)	Minimum shoulder width on inside of horizontal curve for manoeuvring (m)(1)	Minimum manoeuvre time at the 85th percentile vehicle speed (s)(2)
Car stopping sight distance	$0.2 < h_2 \leq 1.25$	2.5	Reaction time plus 2.5 s to a 0.2 m high object.
Truck stopping sight distance	$0.8 < h_2 \leq 1.25$	3.5	Reaction time plus 3.0 s to a 0.8 m high object

1. The minimum shoulder width enables vehicles to manoeuvre around objects lower than the chosen object height. The minimum shoulder width must be the greatest dimension that satisfies both the car and truck stopping sight distance cases given in this table. It is preferred that the shoulder is fully sealed.
2. The minimum manoeuvre time provides drivers with sufficient time to react and take evasive action.

Note: Where a sight line passes over a median barrier, the line of sight should not be interrupted by vehicles in the on-coming carriageway. Typically, this means that the line of sight should not intrude more than 0.5 m into the closest on-coming traffic lane.

Superelevation

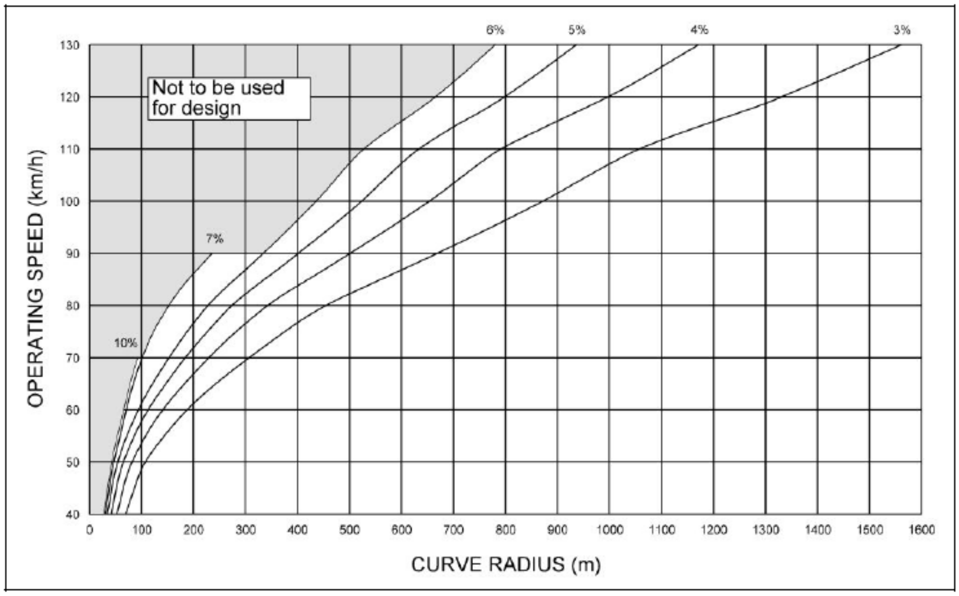
The AGRD continues with the existing practice of linearly distributing superelevation and side friction. The guide provides maximum values of superelevation to be used for different road types (Table 6), which then influences how the superelevation is distributed.

TABLE 6: Maximum values of superelevation for different road types

Road type	Speed range (km/h)	Maximum superelevation (e_{max})
Urban	All speeds	5%
High speed rural	Greater than 90	6%
Intermediate speed rural	Between 70 and 89	7%
Low speed rural	Less than 70	10%

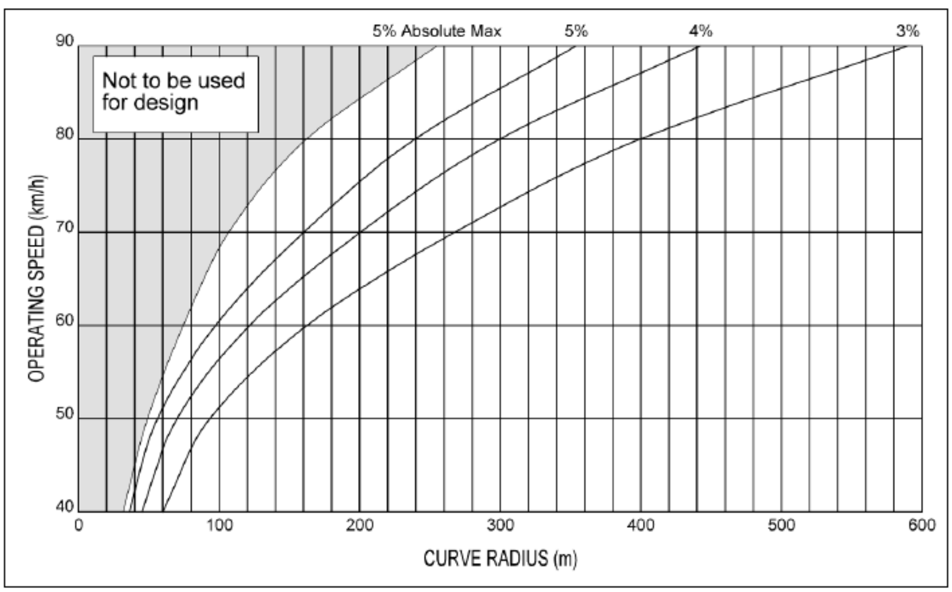
In combining the Austroads Urban and Rural guides, the RDRP agreed to condense the number of superelevation charts to just two – one for urban roads and another for rural roads. Previously, superelevation charts which provided the relationship between speed, radius and superelevation were provided for cases of desirable and maximum side friction for rural roads with a separate single chart for urban roads. Little guidance was provided to designers as to when to use which chart. The AGRD removes this uncertainty by only providing a single chart each for urban and rural roads.

The AGRD implemented this by adopting desirable side friction values up to 6% for rural roads, then using maximum side friction values for superelevations of 7% and 10% (Figure 4). For urban roads, the desirable side friction values were chosen up to 5%, with an additional curve provided for 5% absolute maximum side friction (Figure 5). In choosing the desirable values of side friction as the basis for the charts, the RDRP considered that it was more desirable to provide a larger amount of superelevation on the horizontal curve, than rely on a higher side friction which may vary depending on environmental conditions, the condition of the surfacing on the road or vehicle tyres.



Note: Based on a desirable maximum side friction for e ≤ 6%, absolute maximum side friction for e > 6%, and a linear distribution of side friction for e ≤ 6%.

FIGURE 4: Rural roads – Relationship between speed, radius and superelevation



Note : Based on a desirable maximum side friction for e ≤ 5%, absolute maximum side friction for e = 5%, and a linear distribution of side friction for e ≤ 5%.

FIGURE 5: Rural roads – Relationship between speed, radius and superelevation

Sag Vertical Curves

The AGRD presents the guidance for sag curves in a different form to that previously published. Instead of publishing tables of values relating to the criteria of comfort (both 0.01g and 0.05g), headlight sight distance, and aesthetics, the guide illustrates this with a chart (Figure 6). The lower bounds of the chart have been established using the criteria noted previously and the designer is restricted to minimum sag curve K values, based on the specific road type, which is consistent with the guidance provided for other parameters in the AGRD.

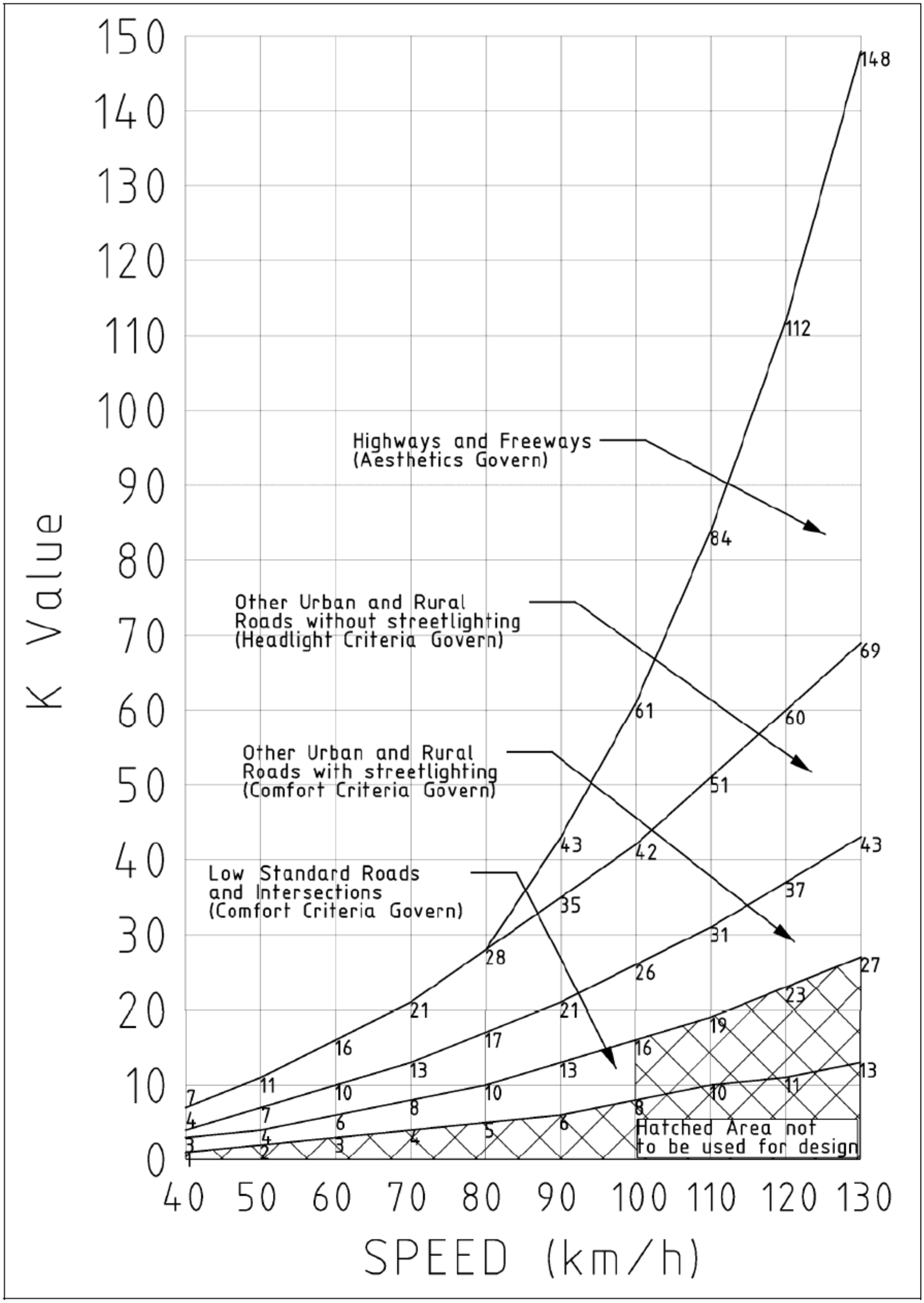


FIGURE 6: K values for sag curves

One of the strengths of the previous guide was that it promoted a series of standard un-signalised intersection types, referred to as basic (BA), auxiliary turn lane (AU) and channelised turn lane (CH) for both left and right turns and for urban and rural situations (Figure 7).

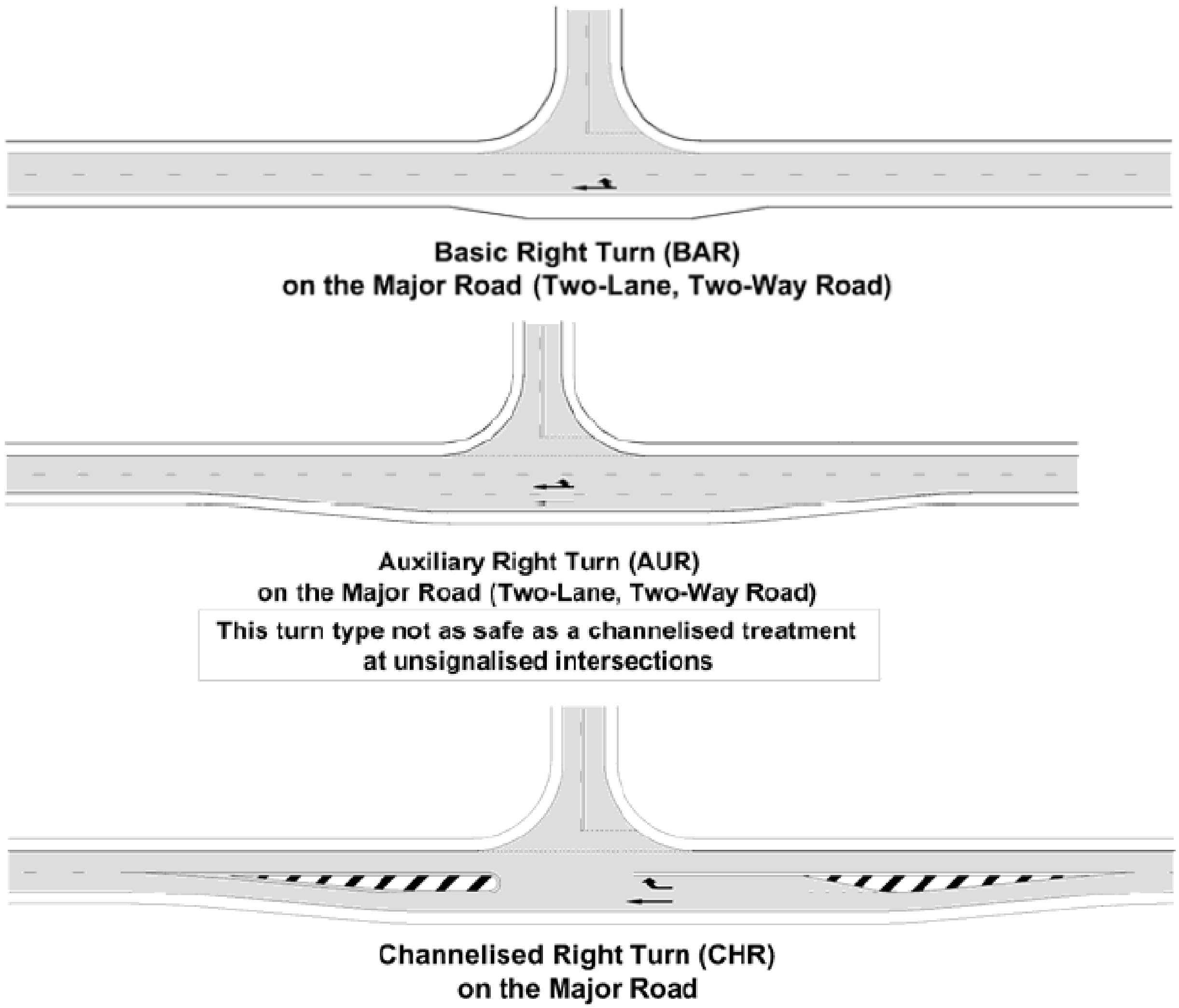


FIGURE 7: Unsignalised intersection turn treatment types (Rural)

The guide provided warrants for designers to assist them to choose the appropriate form of intersection. The warrants were developed with consideration to the volumes of through and turning traffic and the corresponding acceptable gaps in the through traffic that turning vehicles would accept. This led to a consistent application of design forms for these unsignalised intersections.

The new guide has continued with this approach, but with more emphasis on crash evidence to determine the warrants. A comprehensive study (13) that examined over 200 intersections with over 1000 crashes concluded that there was a link between the type of intersection treatment, volumes and crashes. This led to the development of a new set of warrants (14), one for high speed roads and another for low and intermediate speed roads. The warrants still use turning and through volumes to select the intersection type, but the basis is now linked to crash benefit/cost ratio. Given the evidence provided by the intersection crash investigation study, the RDRP was keen to promote this with the introduction of these revised warrants into the AGRD. As can be seen in Figure 7, channelised intersections are recommended when there are about 5 right turning vehicles in one hour, turning against 1000 vehicles per hour, which is a much lower volume compared with the previous warrants. The study also indicated that the same relationship could not be established with left turning vehicles, and as such the revised warrants provide for similar values as previously published.

The crash study also identified a safety deficiency with the auxiliary right turn lane treatment. The research showed that it resulted in a significantly higher number of rear end crashes when compared with the channelised treatment. The study also showed that channelised treatments that were not constructed to the appropriate standard (ie too short for full deceleration within the turn lane) still provided a safer outcome compared with auxiliary right turn lanes. Given the results of this study, a shortened form of the channelised intersection has been included and promoted in lieu of the auxiliary turn lane within the new guide.

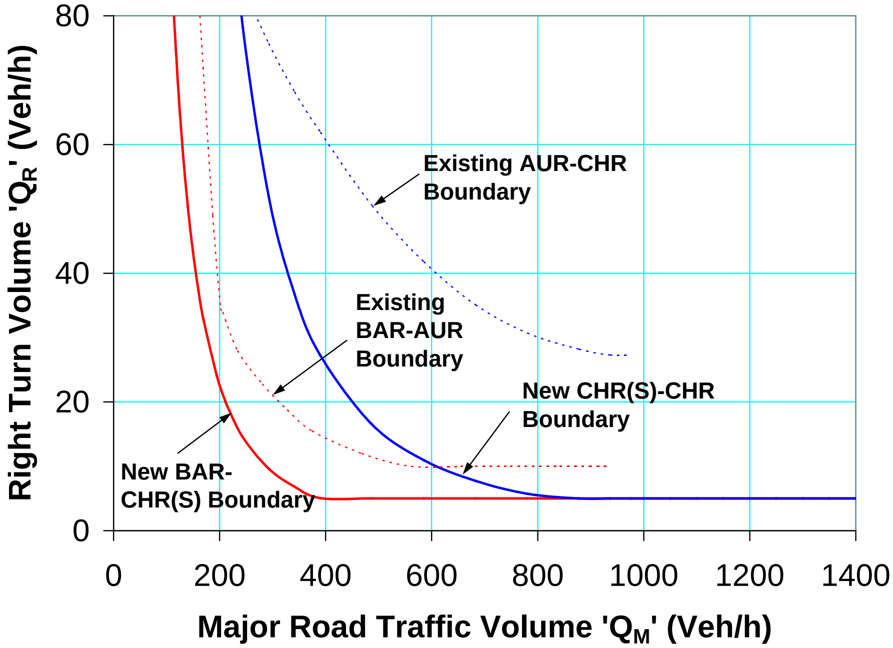


FIGURE 8A: Comparison showing revised intersection turn treatment warrants for design speed ≥100km/hr

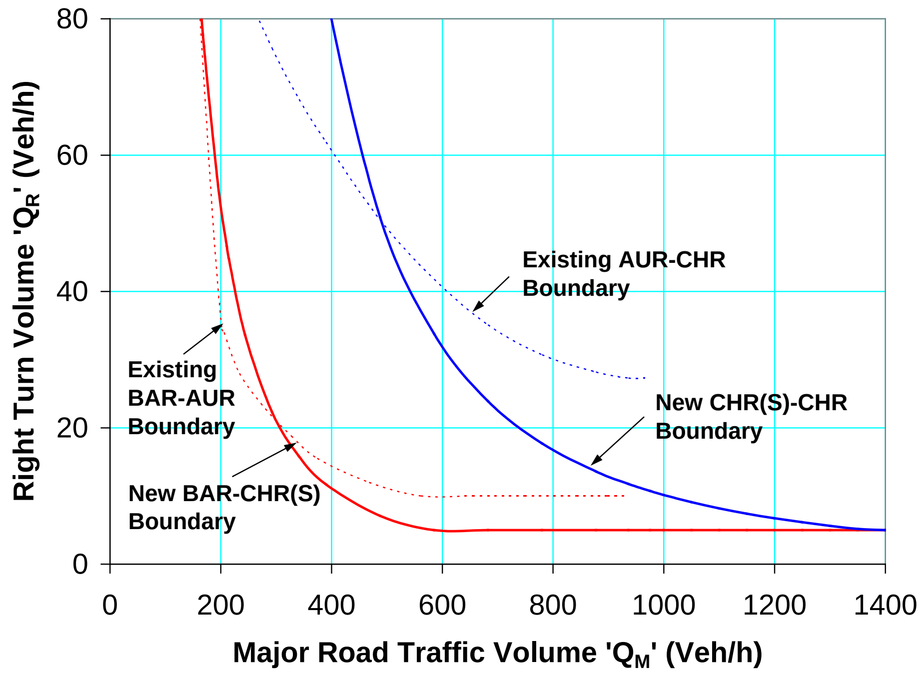


FIGURE 9B: Comparison showing revised intersection turn treatment warrants for design speed < 100 km/hr

Intersection Sight Distances

The Guide has removed the requirement to provide Entering Sight Distance (ESD) which was included in the former guide. ESD is the sight distance required for minor road drivers to enter a major road via a left or right-turn, so that traffic on the major road is unimpeded. It defines the most desirable set of circumstances that could be provided for traffic entering a major road. However, on high speed roads, this distance could be up to 500 m long, which was often impractical to achieve and was not a realistic model of how drivers behaved. The new Guide retains Safe Intersection Sight Distance (SISD), Approach Sight Distance (ASD) and Minimum Gap Sight Distance (MGSD).

ROUNDABOUTS

A new comprehensive method of designing roundabouts has now been introduced, following extensive research of existing Australian and international design practices. The existing guide previously used the deflection of a vehicle through the roundabout to control the speed, which was based on the practice published by the UK Department of Environment in 1975. The new method uses the vehicle entry curve as the most important parameter in the design of roundabouts to limit the speed of the entering traffic. Other methods that were examined included those from the UK, USA and the Australian State of Queensland, which all used the vehicle entry path to control speeds through the roundabout.

The new method adopted in the AGRD is comprehensive in minimising accident types, requires little design effort and enables repeatable vehicle path construction. The Guide provides guidance to designers for the selection of minimum central island radii and circulating carriageway widths for various design vehicles through tabulated values. The carriageway widths range from 5 m for a single unit truck on a single-lane roundabout with a 30 m central island radius, up to 14 m for a triple road train on a two lane roundabout with a 16 m central island radius.

Specific guidance is provided to practitioners on the construction of the vehicle entry paths for each approach and acceptable maximum radii are listed in a table. Generally, a maximum entry path radius of 55 m, regardless of the speed prior to the roundabout, will ensure that safety parameters have been met. Absolute values up to 100 m radius are permitted, dependent on the approach speed. For two lane roundabouts, the designer is also required to check the entry path radius for vehicles cutting across the lanes, and a correction factor for that is provided. For roundabouts on high speed (80 km/hr +) roads, the guide provides a method of ensuring that there is gradual reduction in speed prior to the entry curve. This is achieved by providing two reverse approach curves in advance of the entry curve to limit the decrease in speed between successive elements to 20 km/hr. This works best on single-lane approaches but also performs well on two-lane approaches.

Provision for cyclists at roundabouts has also been addressed, showing how on-road bicycle lanes can be incorporated in the approaches, and even provided in the circulating carriageway. Where multi-lane roundabouts carry high volumes of both heavy vehicles and bicycles, details are provided for an island that can be installed to physically separate the bicycle lane from the general traffic lanes on the approaches. The RDRP recognised that there are a number of solutions appropriate for cyclists at roundabouts which are dependent on site conditions, traffic volumes and vehicle mix. In trying to address this issue, a number of solutions have been provided to assist designers to provide a solution that addresses the needs of all road users.

INTERCHANGES

The previous range of Austroads publications did not provide any specific guidance that dealt with freeway interchanges. Whilst some individual State Road Authorities had local design guides covering this issue, the other States and Territories were required to adapt the geometric guidance that was given mainly for arterial roads. This new part which has been introduced to address this specific need, provides for the geometric design of interchanges on freeways and on major arterial roads. It covers the design of interchanges between:

- freeways and major/minor arterial roads
- two freeways
- two major arterial roads

The Guide will enable practitioners to produce a satisfactory design for an interchange, for a range of traffic and physical conditions that may apply at a site, including stage construction of the freeway.

The Guide includes the geometric design of all the elements of an interchange:

- the alignment and cross section of the freeway in the vicinity of the interchange
- the intersecting road and the ramps
- the merge and diverge area of the entry and exit ramps at the ramp nose
- the ramp terminals between the freeway ramps and intersecting roads
- cyclist treatments for freeway ramps and terminals

ROADSIDE DESIGN

In accordance with Safe Systems principles, a new part has been added to the AGRD which provides guidelines for the hazard identification and mitigation process for roadside hazards. Although previous publications had included basic clearzone principles, this new guide specifically provides guidelines on:

- the rationale of errant vehicle management
- assessment and treatment of hazards on the roadside
- guidance on the selection and location of road safety barriers
- a road design process that implements errant vehicle management principles and risk management.

The guide has essentially adopted the clear zone approach developed by AASHTO (15), with clear zone distances determined by the road speed, volume of traffic, horizontal curvature of the road and the properties of the batters adjacent to the road.

DESIGNING FOR CYCLISTS

The previous set of guides had one document (16) dedicated to all aspects of designing on-road lanes and off-road paths for safe and efficient cycling. Whilst this concentrated all relevant cycling information into one document with the effect of being an advocate for cycling, it meant that for the road designer, cycling was regarded as an add-on; something that was considered after the design of the road for motor vehicles was completed. The aim of the new AGRD is to encourage the designer to consider all road users during the design process, so every relevant part of the AGRD now includes the specific cycling requirements as integrated topics.

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