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Parking facilities

Part 1: Off-street car parking

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Synopsis:

Notes to editor:

The normative references to figures have been reviewed with Gordana and Alastair and approved

The signs in Clause 5.3 sync up with road signs given in AS 1742.2 and the manual of uniform traffic control devices

All figures will need to be relinked as there has been extensive changes, deletions and insertions

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Preface

This Standard was prepared by the Joint Standards Australia/Standards New Zealand Committee CE-001, Parking Facilities to supersede AS/NZS 2890.1:2004.

A list of all parts in the AS(AS/NZS) 2890 series can be found in the Standards Australia online catalogue.

The objective of this document is to provide planners, designers and regulatory bodies with requirements and recommendations for the design and layout of off-street parking facilities.

The following lists the principal changes and additions to this edition of the document:

(a) A reappraisal of design vehicle characteristics and dimensions which includes, an increase in the dimensions of the B99 design vehicle length and width and consequential increases in the dimensions for parking spaces and access ramps.

(b) Changes to the definitions of vehicle user classes.

(c) Updating the sight distance requirements at access points.

(d) Identification of additional design requirements for mechanical parking.

(e) Re-organization of gradient requirements to consolidate within a single section.

The terms 'normative' and 'informative' are used in Standards to define the application of the appendices to which they apply. A 'normative' appendix is an integral part of a Standard, whereas an 'informative' appendix is only for information and guidance.

PUBLIC COMMENT NOTE

This public comment draft is for New Zealand consultation, and New Zealand stakeholders only. This draft was previously released for Australian consultation through Standards Australia. Any comments received from stakeholders outside of New Zealand will be marked for future work, unless previously resolved.

Introduction

The motor vehicle has become intrinsic to the economic life of communities, whether it is in city central business districts, town business centres, shopping centres, hospitals, department stores, entertainment and sporting facilities, or other traffic generators.

Motor vehicle journey's start and finish with pedestrian movements; from a parking space to commence the journey to a parking space to the destination. Addressing the safety of pedestrian movements is a key part of parking area design.

Many governments are adopting a safe systems approach focusing on safer people, safer roads, safer speeds and safer vehicles. The goal when parking area design adopts this focus is for the parking area to be more forgiving of human or mechanical error and the impact of a mistake does not result in a fatality or serious injury. With a range of different users within a parking area with differing needs, a safe environment for the different users is critical.

The success of a parking development requires an efficient design. It needs to represent a balance between safety, function, economics and aesthetics. Consideration should be given to safety and convenience for pedestrians, motorists and other users, the timeliness and quality of parking service, traffic circulation, access to and from the street, queuing impacts, the external traffic network, car manoeuvring and facilities for people with disabilities.

The basic dimensions for parking spaces, aisles, circulation roadways and other manoeuvring areas given in this document have been determined firstly by an examination of the dimensions of vehicles in the current range, and the selection of an 85th percentile and a 99th percentile vehicle (see Appendix A). Following this, a set of base dimensions based on requirements for the B85 and B99 vehicles has been established, and a set of design dimensions has been derived by the addition of working clearances (see Appendix B). The concept of "parking module" has been adopted to ensure that parking space width and length are properly related to aisle width.

Although it provides minimum requirements, this document should not be taken as a textbook for the design of parking facilities. The services of a competent person experienced in designing car parking facilities should be sought in the application of this document. Moreover, its use does not remove the need to conform with regulatory requirements of government.

1 Scope and general

1.1 Scope

This document sets out the minimum requirements for the design and layout of off-street parking facilities for motor cars, light vans up to 5.4 m long and motorcycles. It includes access and egress requirements for both public and private car parks, and car parking on domestic properties.

1.2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document:

NOTE: Documents referenced for informative purposes are listed in the Bibliography.

<std>AS 1742.1, *Manual of uniform traffic control devices, Part 1: General introduction and index of signs*</std>

<std>AS 1742.2, *Manual of uniform traffic control devices, Part 2: Traffic control devices for general use*</std>

<std>AS 1742.10, *Manual of uniform traffic control devices, Part 10: Pedestrian control and protection*</std>

<std>AS 1742.13, *Manual of uniform traffic control devices, Part 13: Local area traffic management*</std>

<std>AS/NZS 1170.1, *Structural design actions, Part 1: Permanent, imposed and other actions*</std>

<std>AS 2890.6, *Parking facilities, Part 6: Off-street parking for people with disabilities*</std>

<unknown>Waka Kotahi NZ Transport Agency, *The Traffic Control Devices Manual*, 2008</unknown>

1.3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

1.3.1
access driveway
roadway extending from the edge of the frontage roadway to the property boundary to connect with the first ramp, circulation roadway, parking aisle or domestic driveway encountered, and carrying one- or two-way traffic

Note 1 to entry: See Figure 2.1 for terminology clarification.

1.3.2
accessible entrance
entrance to a facility or establishment served by the car park, suitable for pedestrian or wheelchair use by people with disabilities

1.3.3
accessible travel path
uninterrupted path of travel to or within a building providing pedestrian or wheelchair access for people with disabilities from a parking space to all required facilities

1.3.4
arterial road (rural)
A general term for a main road carrying mostly long-distance traffic, as distinct from local traffic

1.3.5
arterial road (urban)
A general term for a main traffic route, but specifically referring to certain streets so designated in a local authority's district scheme

1.3.6
base dimension
value of a particular design dimension before any operating clearances have been added

1.3.7
blind aisle
parking aisle closed at one end

1.3.8
B85 vehicle
design motor car whose physical dimensions represent the 85th percentile class of all cars and light vans on the road

Note 1 to entry: See Clause B.2 for further information for B85 vehicles.

1.3.9
B99 vehicle
design motor car whose physical dimensions represent the 99th percentile class of all cars and light vans on the road

Note 1 to entry: See Clause B.2 for further information for B99 vehicles.

1.3.10
car stacker
<user operated car stacker system>

mechanical parking system that requires some user input to operate and comprises single vehicle palettes

<fully automated car stacker system>

mechanical parking system that comprises a common vehicle receiving/delivery area and requires no/minimal user input

1.3.11
circulation clearance
clearance required in addition to manoeuvring clearances, when a vehicle is moving at speeds greater than those applicable to manoeuvring

1.3.12
circulation roadway
roadway within an off-street car park which is used solely for circulation and to gain access to parking aisles, and on which there is no parking

Note 1 to entry: See Figure 2.1 for terminology clarification.

1.3.13
collector road
non-arterial road which collects and distributes traffic in an area, as well as serving abutting properties

1.3.14
control point
point at or near the entrance to or exit from a car park at which the flow of traffic is retarded by the existence of a boom barrier, with or without ticket or cashier operation, or the location of the first of any spaces on a parking aisle at which entering or leaving a parking space may cause traffic flow to be adversely affected

1.3.15
competent person
person who has, through a combination of training, qualification and experience, acquired knowledge and skills enabling that person to correctly perform a specified task

1.3.16
domestic driveway
vehicular path within a domestic property

1.3.17
domestic property
property comprising three or less domestic units

1.3.18
enclosed space
spaces that are obstructed by features such as walls, mechanical parking structure and any vertical obstruction above a height of 100 mm above the surface of the car park

1.3.19
front overhang
distance between the centre-line of the front axle of a vehicle and the front extremity of the bodywork

1.3.20
local road
road or street used primarily for access to abutting properties

1.3.21
may
indicates the existence of an option

1.3.22
mechanical parking

any parking system that includes the moving of a vehicle without driving input from the driver

1.3.23
parking aisle
roadway or an area used by vehicles to gain access to, and to manoeuvre into and out of parking spaces

1.3.24
parking module
parking aisle together with a single row of parking spaces on one or both sides but excluding any ramps or circulation roadways which take off within the module

Note 1 to entry: See Figure 2.1 for terminology clarification.

1.3.25
parking space
area required to park one vehicle

1.3.26
private car park
car park which is not open to or intended to be used by the public or casual users

EXAMPLE: A residential development or place of employment

1.3.27
queuing area
area of a roadway between the property boundary and the vehicle control point, available for the queuing of vehicles

1.3.28
ramp
circulation roadway which connects an access driveway to an off-street car park on a substantially different level, or which connects two levels in a multi-level car park

Note 1 to entry: See Figure 2.1 for terminology clarification.

1.3.29
rear overhang
distance between the centre-line of the rear axle of a vehicle and the rear extremity of the bodywork

1.3.30
relevant authority
agency authorized by legislation or regulation to issue determinations, orders, or other instructions in respect of any subject covered by this document

1.3.31
residential property
property having more than three domestic units

1.3.32
road
entire width of a right-of-way between property boundaries, and including footpaths

1.3.33
roadway
any one part of the width of a public road or a vehicular traffic path in an off-street car park devoted particularly to the use of vehicles, inclusive of shoulders and auxiliary lanes, but exclusive of parking spaces

1.3.34
shall
indicates that a statement is mandatory

1.3.35

should
indicates a recommendation

1.3.36
sub-arterial road
a road connecting arterial roads to areas of development, and carrying traffic directly from one part of a region to another

1.3.37
user allocated
parking space reserved for a specific person or dwelling

1.4 Classification of off-street car parking facilities

Off-street parking facilities shall be classified according to the user classes listed in the first column of Table 1.1. Dimensional requirements for parking spaces in each user class are specified in in Clause 2.4.

User Class 1 parking shall be restricted to residential, domestic and employee parking. Refer to AS 2890.6 for parking facilities for use by people with disabilities.

Table 1.1 Classification of off-street car parking facilities

Type of space	Class			
	Up to 1 h	1-2 h	2-5 h	> 5 h
User allocated	4	3	2	1
Unallocated	5	4	3	2

2 Design of parking modules, circulation roadways and ramps

2.1 General

This section provides requirements and recommendations for the design of parking modules and circulation roadways within off-street car parking facilities in accordance with the base dimensions specified in Appendix B.

NOTE 1: When designing parking modules, circulation roadways and ramps, consideration should also be given to the vehicle characteristics discussed in Appendix A.

Designers should integrate the elements of the document to produce a car park layout while taking into account requirements for safe movement of pedestrians, bicycles, motorcycles and other traffic.

NOTE 2: For further guidance, refer to Austroads Guide to Traffic Management Part 11 Parking Management Techniques

Where larger vehicles such as delivery vans, mini-buses or heavy vehicles may access the facility, the design for areas used by these vehicles should be in accordance with AS 2890.2.

2.2 General description of an off-street car parking facility

Figure 2.1 illustrates the terms to describe the various elements that make up the parking modules and vehicle access paths.

NOTE: Refer to AS 2890.6 for where parking spaces for people with disabilities need to be located.

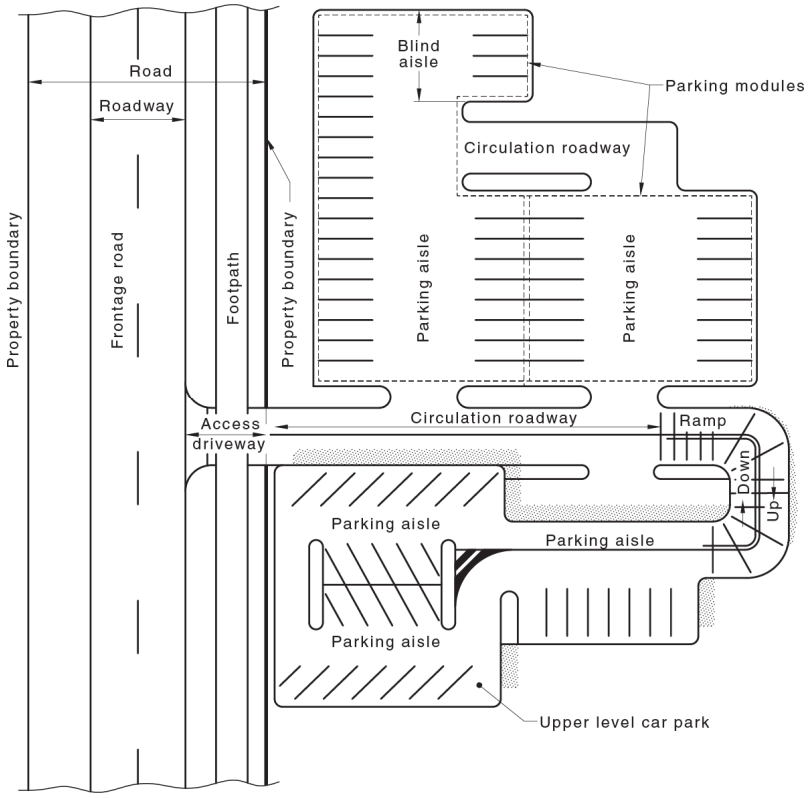


Figure 2.1 Illustration of car park terms

2.3 Preliminary design considerations

2.3.1 Design coordination

The design of the parking facility shall provide for the following:

(a) The need for traffic to move to and from the frontage road with minimum disruption to through traffic and maximum pedestrian safety;

(b) Capacity in circulation roadways and parking aisles to handle peak period movements;

(c) Arrangement of internal roadways to avoid, as far as practicable, conflicts between intersecting streams of circulating traffic;

(d) A low speed environment;

(e) Minimum length travel paths between entry/exit points and parking spaces;

(f) Safe travel paths for pedestrians throughout the facility;

(g) Safe treatment of points of conflict with pedestrians and other road users;

(h) Parking spaces and accessible pedestrian paths for people with disabilities (refer to AS 2890.6 for further information);

(i) The systems used to control entering and exiting traffic from the carpark, including fee for service arrangements; and

(j) Entry and exit control points that allow use by different types of vehicles.

The layout design of an off-street car park should take into consideration the entire facility, including parking modules, circulation roadways, access driveways and, if necessary, frontage road access, as an integrated and coordinated design for vehicles, pedestrians and bicycles.

2.4 Design of parking modules

2.4.1 Angle parking spaces

2.4.1.1 General

This document specifies minimum dimensions of angle parking spaces for different classes of user and for spaces set at different angles (30 degrees, 45 degrees, 60 degrees, and 90 degrees).

User classes are defined in Table 1.1, minimum dimensions are specified in Clause 2.4.1.2, and exceptions to the minimum dimensions are detailed in Clause 2.4.1.4.

NOTE 1: The design envelope requirements for each parking space are defined in Clause 6.3.

Parking angles used in off-street car parks are as follows:

(a) 90 degree angle parking

Parking aisles for 90 degree parking shall be designed as set out in Table 2.4.

NOTE 2: This requirement ensures satisfactory manoeuvring in and out of parking spaces as well as two-way movements in the aisle.

NOTE 3: Imposition of one-way movement for operational reasons in 90 degree parking aisles does not reduce the aisle width requirement.

(b) 30, 45 or 60 degree angle parking

Aisles serving such spaces shall be one-way with forward entry into the spaces only except where parallel parking is allowed on one side. Where space is limited or does not lend itself to 90 degree parking, 30, 45 or 60 degree parking may be used instead.

NOTE 4: Such arrangements can have advantages for high turnover parking provided drivers are discouraged from entering aisles the wrong way and reversing into parking spaces.

(c) Parallel parking

Parallel parking shall be provided as set out in Clause 2.4.4.

2.4.1.2 Minimum dimensions

The minimum dimensions of angle parking spaces are specified using four values (A, B, C and D) of which one (C) has alternative values ($C1$, $C2$, and $C3$) depending on the environment in which the parking space is located. B and D are provided to assist with setting out.

NOTE 1: Space widths of 2.4 m provide constrained pedestrian access besides the vehicles.

NOTE 2: Space widths of 2.4 m or 2.5 m provide limited door opening and should only be adopted in low turnover parking spaces.

Selections between the different dimension *C* options are made on the following basis:

(a) $C1$: where parking is to a wall or high kerb not allowing any overhang. $C1$ is calculated as:

$$C_1 = 5.6 \sin\theta + 1.9 \cos\theta$$

Where:

θ = parking angle

(b) $C2$: where parking is to a low kerb which allows 600 mm overhang in accordance with Clause 2.4.1.4(a)(i). $C2$ is calculated as:

$$C_2 = C_1 - 0.6 \sin\theta$$

Where:

θ = parking angle

(c) $C3$ — where parking is controlled by wheel stops installed at right angles to the direction of parking or where the ends of parking spaces form a sawtooth pattern, e.g. as shown in the upper half of Figure 2.2, is calculated as:

$$C_3 = C_1 + (A - 1.9) \cos\theta$$

Where:

θ = parking angle

A = space width, in metres

2.4.1.3 Layout

The dimensions of angle parking spaces at different angles are:

(a) Angle parking spaces at 30 degrees

Except as outlined in Clause 2.4.1.4, parking spaces that are angled at 30 degrees shall be laid out with the dimensions specified in Table 2.1.

Figure 2.2 depicts in plan view how the measurements correlate to the layout of a 30 degree parking space.

NOTE 1: Attention is drawn to the reduced width requirement for 30 degree parking as shown in Figure 2.2.

NOTE 2: Parking spaces angled at 30 degrees have narrower minimum widths than spaces at other angles because of the reduced chance of open doors hitting adjacent vehicles.

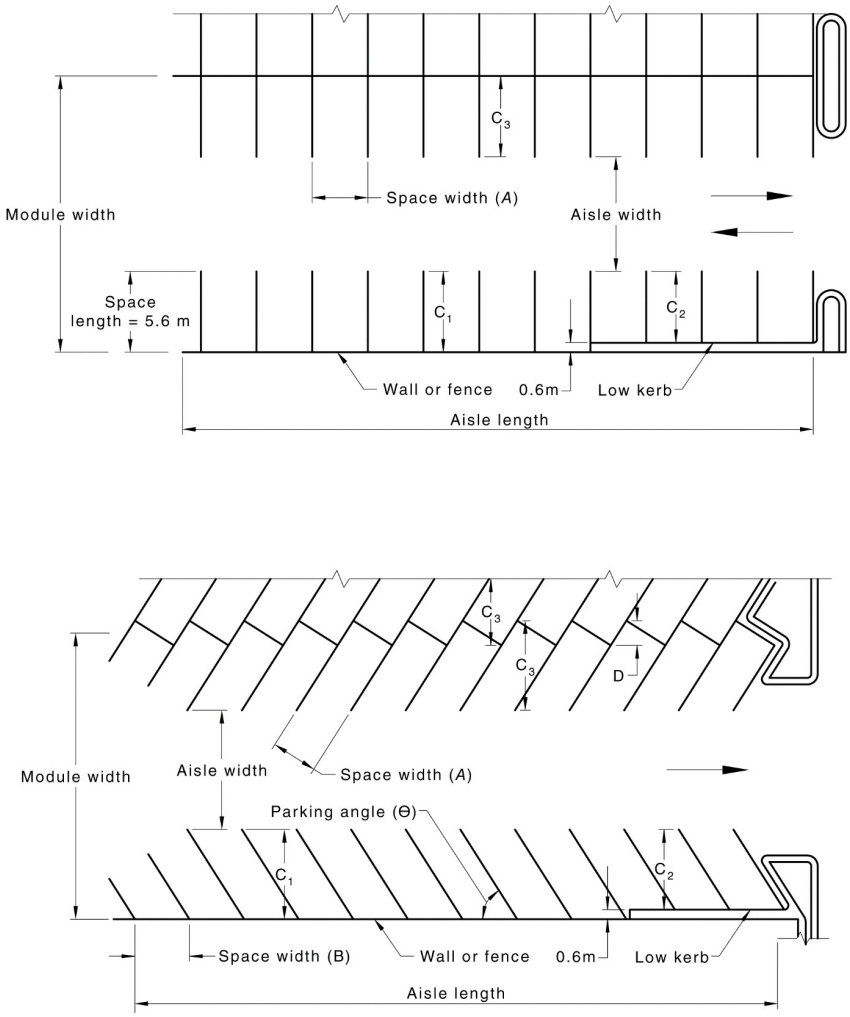


Figure 2.2 Angle parking module diagram

Table 2.1 — Dimensions for 30 degree angle parking spaces

User class	*A*	*B*	*C*1	*C*2	*C*3	*D*	Aisle width
1,2	2.4	4.80	4.5	4.2	4.9	2.08	3.0
3	2.4	4.80	4.5	4.2	4.9	2.08	3.0
4	2.5	5.00	4.5	4.2	5.0	2.17	2.9
5	2.5	5.00	4.5	4.2	5.0	2.17	3.5

(b) Angle parking spaces at 45 degrees

Except as specified in Clause 2.4.1.4, parking spaces that are angled at 45 degrees shall have the dimensions specified in Table 2.2. Figure 2.2 shows an example of the car park layout.

Table 2.2 — Dimensions for 45 degree angle parking spaces

							Dimensions in metres
User class	***A***	***B***	***C*1**	***C*2**	***C*3**	***D***	**Aisle width**
1,2	2.4	3.39	5.3	4.9	5.7	1.70	3.9
3	2.5	3.54	5.3	4.9	5.8	1.77	3.7
4	2.6	3.68	5.3	4.9	5.8	1.84	3.5
5	2.6	3.68	5.3	4.9	5.8	1.84	4.2

(c) Angle parking spaces at 60 degrees

Except as specified in Clause 2.4.1.4, parking spaces that are angled at 60 degrees shall have the dimensions specified in Table 2.3. Figure 2.2 shows an example of the car park layout.

Table 2.3 — Dimensions for 60 degree angle parking spaces

							Dimensions in metres
User class	***A***	***B***	***C*1**	***C*2**	***C*3**	***D***	**Aisle width**
1,2	2.4	2.77	5.8	5.3	6.1	1.20	4.9
3	2.5	2.89	5.8	5.3	6.1	1.25	4.6
4	2.6	3.00	5.8	5.3	6.2	1.30	4.3
5	2.6	3.00	5.8	5.3	6.2	1.30	5.1

(d) Angle parking spaces at 90 degrees

Except as specified in Clause 2.4.1.4, parking spaces that are angled at 90 degrees shall have the dimensions specified in Table 2.4.

Figure 2.2 shows an example of the car park layout.

The two Class 5 options given for 90 degree parking are alternatives of equal standing.

Table 2.4 — Dimensions for 90 degree angle parking spaces

Dimensions in metres							
User class	***A***	***B***	***C1***	***C2***	***C3***	***D***	**Aisle width**
1	2.4 [a]	2.40 [a]	5.6	5.0	5.6	0.00	5.8
2	2.4[a]	2.40 [a]	5.6	5.0	5.6	0.00	6.2
3	2.5	2.50	5.6	5.0	5.6	0.00	5.8
4	2.6	2.60	5.6	5.0	5.6	0.00	5.8
5	2.6	2.60	5.6	5.0	5.6	0.00	6.6
5	2.7	2.70	5.6	5.0	5.6	0.00	6.2
[a] For spaces located between two columns, the minimum width is 2.5 m.							

2.4.1.4 Exceptions

The following exceptions apply for parking space length and width:

(a) Length

The nominal length of a parking space in a parking module shall be 5.6 m minimum except as follows:

(i) *End overhang* — Where a vehicle may overhang the end of a space, provided the first 600 mm immediately behind it is unobstructed, is not another parking space and is not required as a footway or for some similar purpose, the space lengths measured parallel to the parked vehicle may be reduced by 600 mm. Ends of spaces shall be provided with wheel stops if the requirements specified in Clause 2.4.5.4 apply.

NOTE 1: An example of overhang at the end of a space may be at a kerb

(ii) *Spaces for small cars* — The minimum dimensions of a designated space for a small car shall be 2.3 m wide x 5.0 m long.

NOTE 2: The size of such spaces is based on small car vehicle dimensions recommended in Clause A.6. NOTE 2: Small car spaces should only be used where there are additional controls to manage their use.

(b) Width

The requirements in Clause 2.4.1.2 are subject to the following exceptions:

(i) *Spaces for small cars* — The specified minimum width is given in Clause 2.4.1.4(a)(ii).

(ii) *Adjacent obstructions to door opening* — If the side boundary of a space is a wall or fence, or if there are obstructions such as columns placed so as to restrict door opening, 300 mm shall be added to the width of the space on each side the obstruction exists.

(iii) Parking spaces for people with disabilities — refer to AS 2890.6 for further guidance.

In the design of buildings or parts of buildings to be used as parking facilities, the location of obstructions such as columns shall be in accordance with Clause 6.3.

2.4.2 Angle parking aisle

The width of angle parking aisles is determined from either the width needed for circulating traffic or the width needed to manoeuvre into and out of a parking space. In the latter case, the width will vary according to the width of the parking spaces with wider spaces needing less aisle width for the parking manoeuvre. Minimum aisle widths shall be as shown in Clause 2.4.1.3. These widths will cater both for the angle parking manoeuvre

or for circulating traffic: two-way in the case of 90 degree parking and one-way in the case of 30, 45 and 60 degree parking. For requirements for aisles where there is parallel parking on one side, see Clause 2.4.4(a).

When designing for turns between an aisle and a ramp or circulation roadway, or between two aisles, area shall be provided for the turning movements in accordance with Clause 2.5.2(c).

The following requirements also apply:

(a) *Class 1 aisles* — User Class 1 aisles apply to 90 degree parking only. Minimum aisle widths are shown in Clause 2.4.1.3.

NOTE 1: These may be of lesser width than those for user Class 2 aisles and may not allow access into parking spaces in a single manoeuvre by some vehicles.

(b) *Class 5 aisles* —, User Class 5 parking spaces or aisle widths shall be increased in size by 300 mm to cater for expected higher turnover than other User Class 4 parking areas.

(c) *Blind aisles* — At blind aisles, the aisle and end parking space shall be extended a minimum of 1.0 m beyond the last parking space (see Figure 2.3 for an example). In car parks open to the public, the maximum length of a blind aisle shall be equal to the width of six 90 degree spaces plus 1.0 m, unless provision is made for cars to turn around at the end and drive out forwards.

(d) *Single-sided aisles* — Where there is angle parking on one side of an aisle only and the other side is confined by a wall or other high vertical obstruction closer than 300 mm to the nominal edge of the aisle, the aisle width shall be increased by 300 mm measured to the vertical obstruction to provide manoeuvring clearance.

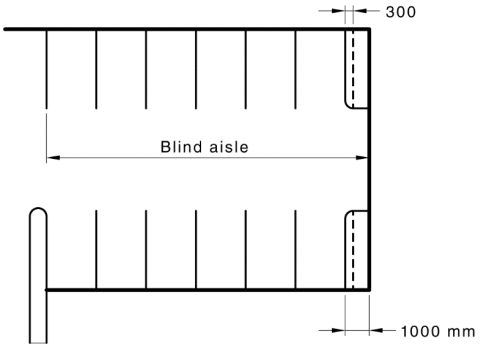


Figure 2.3 Blind aisle extension

2.4.3 Angle parking module layout

Example layouts of typical angle parking modules are shown in in Figure 2.2.

2.4.4 Parallel parking in parking aisles

Where parallel parking is to be provided on one or both sides of a parking aisle, the following apply:

(a) Parallel parking one or both sides, one-way or two-way aisle

(i) Layout for parallel parking on one side of a one-way aisle shall be as set out in Table 2.4.

(ii) For parallel parking on both sides of a one-way aisle, the aisle width shall be at least twice that shown in Table 2.4.

(iii) Where the aisle is two-way, but parking is on one side only, the total aisle width shall be a minimum of 5.8 m.

(iv) Where parallel parking is provided on both sides of a two-way aisle, the aisle widths shown in Table 2.4 shall be provided on each side of the aisle centreline.

(b) Parallel parking one side, angle parking the other, one-way or two-way aisle

(i) Angle parking space depths shall be as shown for dimension C in Clause 2.4.1.3.

(ii) Parallel parking space dimensions shall be as shown in Table 2.4.

(iii) Aisle width shall be that shown in Clause 2.4.1.3 plus an additional 0.5 m.

(iv) Steps shall be taken to discourage reverse-in parking where the angle parking angle is other than 90 degrees.

NOTE: Suitable steps may include making the aisle one-way or signposting the angle parking spaces as front-in only.

If the end of a space is adjacent to any object that could impede vehicle manoeuvring (such as a kerb or bollard), 300 mm shall be added to the length of the space at each end that is obstructed.

In addition, where objects would impede manoeuvrability, spaces shall also be located at least 300 mm clear of obstructions higher than 150 mm such as walls, fences and columns.

Where the opposite side of the aisle is bounded by obstructions higher than 150 mm, the aisle width shall be increased by at least 300 mm.

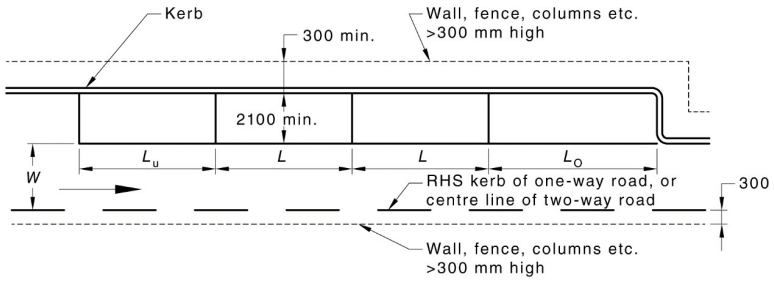


Figure 2.4 Layout for parallel parking spaces

Table 2.5 Dimensions for parallel parking spaces

Dimensions in metres

Aisle width (one-way), *W*	Space length[a], *L*	Space length obstructed end spaces[b], *L*o	Space length unobstructed end spaces[c], *L*u
3.0	6.5	6.8	5.6
3.3	6.3	6.6	5.6
3.6	6.1	6.4	5.6
[a] Obstructed by car spaces at both ends.			

2.4.5 Physical controls

2.4.5.1 General description

Physical controls shall not obstruct accessible travel paths for people with disabilities.

All kerbs, wheel stops, low barriers and other obstructions that could be a tripping hazard to pedestrians shall be surfaced in a colour contrasting with their surroundings.

The need for the following physical controls should be considered for:

(a) *Kerbs* — on one or more sides of a parking space to protect pedestrian walkways, landscaped areas, and any other non-trafficable areas generally at or just above surface level, from encroachment.

(b) *Barriers* — to contain vehicles at the edges of platforms or decks, or to prevent encroachment onto pedestrian facilities.

(c) *Wheel stops* — to limit the travel of vehicles when manoeuvring into a parking space and prevent encroachment onto pedestrian pathways.

NOTE: Wheel stops should be avoided in any situation where they may be in the path of pedestrians or wheelchairs moving to or from parked vehicles or crossing a car park for any other purpose.

(d) *Separators* — to separate vehicle routes, such as on circulation roadways and ramps.

(e) *Other protective devices* — to prevent damage to structural elements or other unwanted vehicle encroachment.

2.4.5.2 Kerbs

Vehicles may be allowed to park overhanging a kerb at the closed end of a parking space, provided that —

(a) the kerb is not less than 90 mm high and not more than 150 mm high;

(b) the area for at least 1.2 m behind the kerb does not exceed 150 mm above the level at the end of the parking space; and

(c) a walkway behind the kerb would not be obstructed. (See also Clause 2.4.1.4(a)(i).)

NOTE 1: See Figure 2.5 for an example of vehicle overhang.

If overhang cannot be tolerated, wheel stops shall be provided (see Clause 2.4.5.4).

NOTE 2: Kerbs in vulnerable locations may require additional devices such as bollards to make them visible to car drivers.

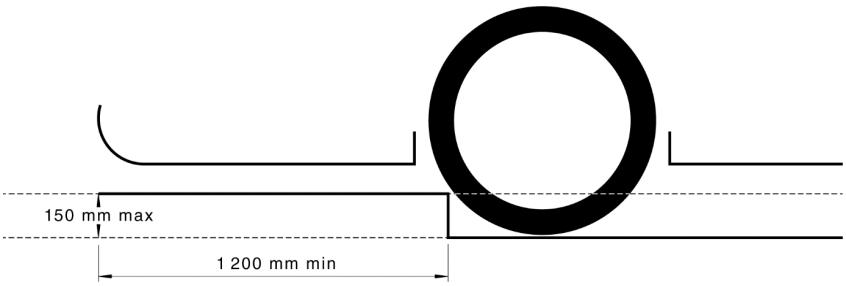


Figure 2.5 Vehicle overhang

2.4.5.3 Barriers

Barriers shall be constructed to prevent vehicles from running over the edge of a raised platform or deck of a multi-storey car park, including the perimeter of all decks above ground level. They shall be used wherever the drop from the edge of the deck to a lower level exceeds 600 mm. At drops between 150 mm and 600 mm, kerbs or wheel stops shall be provided.

Barriers shall conform to the following requirements:

(a) They shall be designed structurally in accordance with the loading requirements of AS/NZS 1170.1.

(b) If barriers are located at the rear of parking spaces, they shall be at least 1.3 m high to ensure they are clearly visible above the rear of the car to drivers reversing into the parking space.

NOTE 1: The upper portion of such a barrier may be a light structure provided for sighting purposes only.

(c) They shall not be made from materials likely to shatter on impact.

NOTE 2: Materials that are likely to shatter on impact include brickwork or unreinforced concrete.

2.4.5.4 Wheel stops

Wheel stops may be provided where it is considered necessary to limit the travel of a vehicle into a parking space or adjacent pedestrian pathway. If used, they shall meet the following requirements:

(a) Wheel stops shall be between:

(i) 90 mm and 100 mm in height; and

(ii) 1650 mm ± 50 mm in width.

(b) Where reverse-in parking is unlikely (e.g. at 30-, 45- and 60-degree angle parking modules with one-way aisles) or where occasional minor (up to 400 mm) encroachment by a reverse-in vehicle can be tolerated (e.g. over a kerb), wheel stop positions shall be set at the *front-in* position.

(c) Where reverse-in parking is likely and encroachment over the end of the parking space cannot be tolerated, wheel stop positions shall be set at the *rear-in* position and all vehicles required to reverse in. The location of wheel stops with respect to the front of parking spaces is given in Table 2.6 and illustrated in Figure 2.6.

(d) If wheel stops are provided to restrain vehicle contact with a kerb higher than 150 mm or a wall, a further 200 mm shall be added to the wheel stop distance to cater for the B99 vehicle, as illustrated in Figure 2.6 (c) and (d).

NOTE 1: Typical uses of wheel stops are as follows:

(a) Control of kerb overhang where inconvenient or hazardous for pedestrians.

(b) Inhibiting contact with an end barrier or high kerb.

(c) Inhibiting encroachment into an opposing parking space.

NOTE 2: Wheel stops should not be located where they may be in the path of pedestrians moving to or from parked vehicles or crossing a car park for any other purpose.

Table 2.6 Wheel stop distances

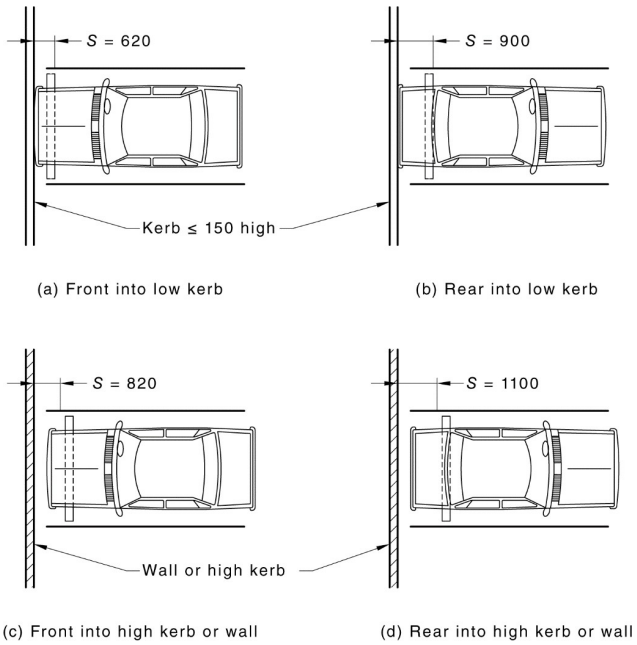
Parking direction	Wheel stop distance to front of parking space			
	Parking to kerb ≤ 150 mm high		Parking to kerb > 150 mm high or wall	
	Wheel stop height mm		Wheel stop height mm	
	90	100	90	100
Front-in	630	620	830	820
Rear-in	910	900	1110	1100

NOTE to Table 2.1: The distances in this table are calculated from the formula:

$$S = C + O - \sqrt{r^2 - (r - d - H)^2}$$

where

S	=	wheel stop distance (measured to point of contact with vehicle tyre)
C	=	clearance (to low kerb — nil; to high kerb or wall — 200 mm)
O	=	overhang of B85 vehicle (front — 820 mm; rear — 1100 mm)
r	=	radius of wheel (225 mm)
d	=	tyre deflection under load (20 mm)
H	=	wheel stop height



S = wheel stop distance (measured to point of contact with vehicle tyre).

NOTE 1: Wheel stop distances shown in this figure are for 100 mm high wheel stops (see also Table 2.6).

NOTE 2: Wheel stop distances are set for the B85 vehicle. Some kerb overlap may occur if either a longer vehicle or, in the case of Figure 2.6(a), an occasional reverse-in vehicle, uses the space.

NOTE 3: Wheel stop distances are set to allow 200 mm clearance to the wall for the B85 vehicle. The clearance will be almost zero for the B99 vehicle.

Figure 2.6 Location of wheel stops

2.4.5.5 Separators

If used, a separator shall meet one of the requirements below:

(a) Raised median - a raised island with a minimum width of 600mm and a maximum height of 150mm above the pavement surface. Where a median island terminates near a change in grade, the island shall provide for at least 125mm ground clearance for all turning vehicles through the change in grade. In all other locations the raised median shall have a minimum height of 90mm, Median islands shall be terminated with a radius of at least 300mm. Where a change in grade reduces visibility of the median island by approaching drivers (such as at the top of a ramp) flexible delineators shall be installed on the island.

(b) Flush median – a flush island marked with edge lines and hatching, with a minimum width of 900mm.

(c) Flexible delineators - a series of flexible or frangibly mounted delineator posts fixed along a marked centreline with a minimum width of 100 mm at regular intervals of no less than 0.5 m and no more than 2 m. The delineators shall have a minimum height of 800 mm, have a conspicuous colour, and be fitted with a reflective surface or band.

Where a separator is located at an intersection or a change of grade, the end of the separator shall provide for the movement of vehicles through the area.

2.4.5.6 Other protective devices

Protective devices shall be provided as necessary to protect parts of the building or other fixed objects or equipment from damage by vehicles. Such protection shall include devices to prevent vehicle encroachment into areas such as pedestrian ways, stairs, doorways or lifts. Protective devices shall be clearly visible to drivers when in their normal driving position, having a minimum height of 800 mm where vehicles are travelling in a forward direction and 1.3 m where vehicles are travelling in any other direction.

NOTE 1: Appropriately located bollards are suitable for these purposes.

NOTE 2: Refer to AS/NZS 1170.1 for design impact forces.

2.4.6 Provision for motorcycles

Where motorcycle parking spaces are marked, their size shall be a minimum of 1.0 m wide by 2.0 m long. This applies to both parallel and angle parking.

NOTE: See Figure 2.7 for plan view examples of parallel and perpendicular parking.

Where a motorcycle parking space is adjacent to a wall or other obstruction, the width of the space shall be increased by 100 mm on each side where there is a wall to allow space to manoeuvre and to place the motorcycle onto the side stand.

The minimum headroom over a marked motorcycle space shall be 2.0 m.

Surface grades shall be less than 1 in 20 (5 %) to avoid parked motorcycle capsizing.

To support the weight of the motorcycle, the surface needs to be capable of carrying a load of 10 kg/cm^2 to avoid penetration by the stand.

NOTE 1: Providing motorcycle parking reduces the need for motorcycles to park in car spaces, improving the efficient use of the available space.

NOTE 2: Small or spare areas that would otherwise be unused for parking should be considered for motorcycle parking. Similarly, where available space for car parking would allow for oversize car spaces, consideration should be given to providing standard sized car spaces and using the resulting additional space for motorcycle parking.

NOTE 3: Consideration should be given to provision of access paths to motorcycle parking spaces including kerb ramps and path width. Access paths should be at least 1.5 m wide for one-way paths and at least 2.5 m wide for two-way paths.

NOTE 4: Motorcycle parking areas should be located so that parked motorcycles are not likely to be struck by a manoeuvring car.

NOTE 5: IHIE *Guidelines for Motorcycling* provides additional information related to motorcycle parking.

NOTE 6: Where larger motorcycles are to be expected, for example in residential, tourist, or recreational areas, the length of the space should be increased to 2.3 m.

NOTE 7: Where sight distance for road users is a factor motorcycle parking in preference to car parking should be provided as both drivers and pedestrians can see over parked motorcycles.

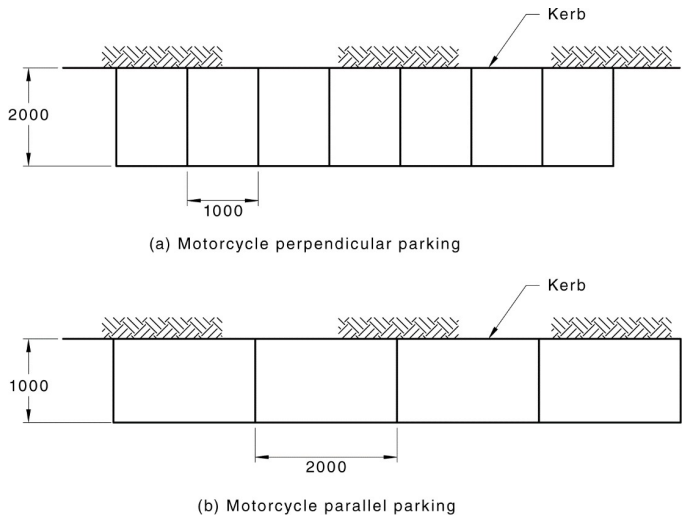


Figure 2.7 Examples of motorcycle parking provision

2.4.7 Parking aisle length

If a parking aisle exceeds 100 m in length, (i.e. more than about 40 × 90 degree parking spaces on either side) speed control devices such as humps (see Clause 5.7) shall be placed along the parking aisle to control vehicle speeds.

NOTE: To limit traffic volumes and consequent congestion in parking aisles to acceptable levels, it is good practice not to have parking aisles provide access for circulating traffic to other parking aisles where those aisles together have more than 50 parking spaces for a Class 4 or 5 facility, 75 for a Class 3 facility or 100 for a Class 1 or 2 facility. Circulation roadways should be provided in lieu.

2.4.8 Assignment of user class to parking modules

A single module catering for a mixture of classes may be used provided that the spaces for each separate class are grouped together.

NOTE: Examples of a mixture of classes may include employees and visitors.

2.5 Design of circulation roadways and ramps

2.5.1 General

Circulation roadways and ramps provide access between the car park entry/exit points and parking modules. They also provide for traffic circulating between parking modules. In small car parks, not larger than 50 parking spaces, access from a frontage road may be direct to the parking module.

Parking aisles should not be used to provide access to other parking aisles where the restrictions recommended in the Note to Clause 2.4.7 apply.

2.5.2 Layout design of circulation roadways and ramps

Cross sections of circulation roadways and ramps shall be as illustrated in Figure 2.8. Design requirements and dimensions shall be:

(a) Straight roadways and ramps — as follows:

(i) One-way roadways or ramps — 3.0 m minimum between kerbs (see also Item (c)).

(ii) Two-way roadways or ramps — 5.5 m minimum between kerbs (see also Item (c)).

(iii) Double roadways or ramps — where there are to be two parallel roadways or ramps, with a separator, each roadway or ramp shall be designed as a one-way roadway or ramp. See Clause 2.4.5.5 for separator requirements.

Where there is to be a kerb or barrier higher than 150 mm and closer than 300 mm from one edge of the roadway or ramp, the roadway or ramp shall be widened to provide a minimum of 300 mm clearance to the obstruction. If there is to be a high kerb or barrier on both sides, the width increase shall be sufficient to provide 300 mm on both sides.

(b) *Curved roadways or ramps* — Curved roadways and ramps will usually be designed as circular curves. Limiting dimensions shall be as shown in Table 2.2 and Figure 2.9. A separator shall be provided on two-way curved roadways or ramps where the radius to the outer kerb (dimension R_O on Figure 2.9(b)) is less than 15 m. A separator is optional at larger radii but if not provided, a centre-line marking shall be provided on ramps serving User Class 3 and 4 facilities (see Table 1.1).

(c) *Intersections and passing areas* — Intersections between circulation roadways and ramps, and with parking aisles shall be designed so that both the approach roadways and the intersection area are wide enough to accommodate turning vehicles.

Intersection areas designed for use by one vehicle at a time shall be designed for use by the B99 vehicle.

Areas in which it is necessary for two vehicles to pass one another shall be designed for a B85 vehicle to pass a B99 vehicle.

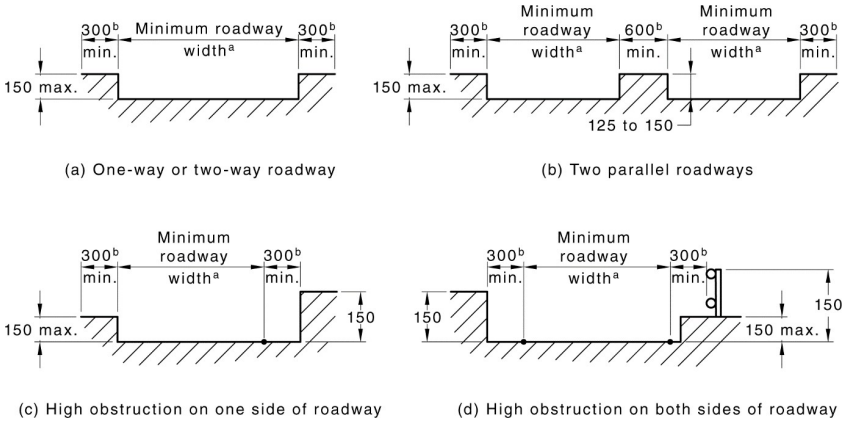
In both cases, areas shall be checked using single turn swept path assessment for the B99 vehicle and the B85 vehicle in accordance with Clause B.3, which include the swept path clearances specified in Clause B.3.2. The swept path clearances shall clear any kerbs or separators at the boundary of the intersection area. Where there is to be provision for two vehicles to pass, B99 and B85 swept path assessment with clearances incorporated are used in combination.

NOTE 1: Where sight distance is a factor, motorcycle parking in preference to carparking should be provided as both drivers and pedestrians (including mobility impaired) can see over the parked motorcycles. This concept can be applied for driveways and other entrances where vehicles regularly cross the footpath or bicycle path. See Clause 2.4.6 for further requirements and information relating to motorcycle parking.

NOTE 2: The turn radii for the swept paths need not be the same.

If a boundary of the intersection area is an obstruction, such as a wall, barrier or kerb higher than 150 mm, a further clearance of 300 mm shall be provided where the swept path template approaches the obstruction.

Dimensions in millimetres



Key

a Minimum roadway width: One-way roadway — 3 000 mm

Two-way roadway — 5 500 mm

On curve — see Table 2.2

b Increase clearance to 500 mm if on the outside of a curve

Figure 2.8 Circulation roadway and ramp cross sections

Table 2.7 Minimum roadway widths on curved roadways and ramps

Dimensions in metres

Turn radius *Ro*[a]	**Single lane**		**Two-way, no separator**
	Public facilities[b]	**Domestic property**	**All cases[c]**
7.6 to 11.7	4.1	3.8	—
11.8 to 19.9	3.7	3.4	7.0
20.0 to 50.0	3.4	3.2	6.3
> 50.0	3.0	3.0	5.5

[a] See Figure 2.9 for Dimension *Ro*.

[b] For parallel roadways with a separator, each roadway width shall be determined separately as a single lane.

[c] Applies to *Ro* range 15.0 m to 19.9 m only (see Clause 2.5.2(b)).

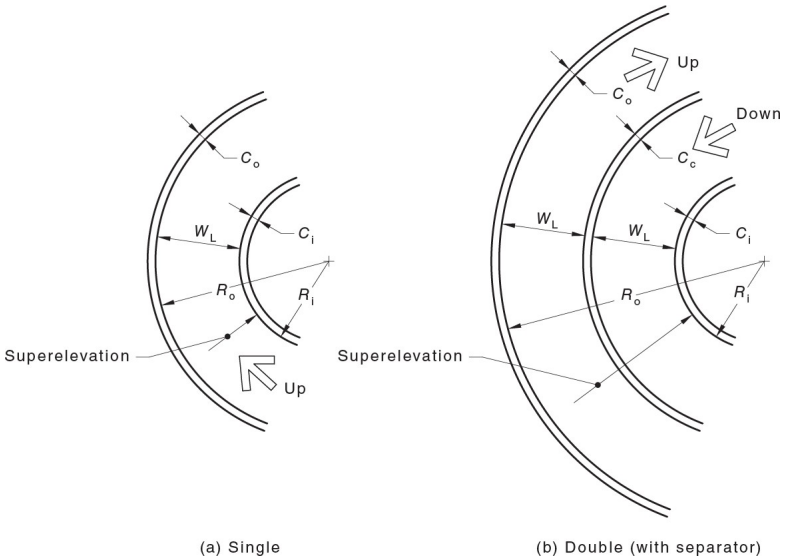


Table 2.8

Characteristic	Limiting dimensions, m			
	Public facilities		Domestic Property	
	One-way	Two-way	One-way	Two-way
Outside radius, *R*o	8.1min.	12.1min.	7.8 min.	11.8 min.
Inside radius, *R*i	4.0 min.	4.0 min.	4.0 min.	4.0 min.
Lane width, *W*L	See Table 2.2	See Table 2.2	See Table 2.2	See Table 2.2
Clearance to obstruction —				
(a) inside, *C*i	0.3 min.	0.3 min.	0.3 min.	0.3 min.
(b) outside, *C*o (see Note)	0.5 min.	0.5 min.	0.5 min.	0.5 min.
I between paths, *C*c	—	See Clause 2 .4.5.5	—	See Clause 2 .4.5.5
Superelevation	1 in 20 (5 %) max.	1 in 20 (5 %) max.	1 in 20 (5 %) max.	1 in 20 (5 %) max.

NOTE: This clearance will allow the outside front wheel to touch the kerb before the vehicle body can contact the obstruction.

Figure 2.9 Dimensions of curved circulation roadways and ramps

2.6 Design of domestic driveways

2.6.1 Width

The minimum width of domestic driveways shall be 3.0 m. On curved driveways other than at turns into garages or parking spaces, the width shall be increased as given for domestic property in Table 2.2.

The additional minimum clearances of 300 mm or 500 mm to vertical obstructions higher than 150 mm, as set out in Clause 2.5.2 (a) and Figure 2.10, can be omitted or reduced if swept path assessment in accordance with Clause B.3 confirms unimpeded vehicle movements.

For apron widths at turns into enclosed garages, see Clause 6.5.2.

Minimum aisle or apron widths for turns into open sided parking shall be in accordance with user Class 1 or 2 requirements in Clause 2.4.1.3.

3 Access facilities for off-street parking areas and queuing areas

3.1 General

3.1.1 Access design principles

All accesses between off-street car parks and frontage roads shall be formed in such a way as to be clearly recognized by road users as *either* an access driveway *or* as an intersection.

For access driveways, kerbs and footpaths shall be continuous along the frontage road and across the access driveway. The appearance and character of the driveway shall be such that it will be clear to vehicle drivers that pedestrians and frontage road traffic have priority of movement.

If intended as an intersection, the entry and exit shall be designed as if for a public roadway, subject to the design requirements of the relevant authority.

Category 5 facilities in Table 3.1 shall be provided as intersections. Category 3 and 4 facilities may also be considered for provision as intersections.

NOTE: Guidance on capacity provision at entry and exits at large car parks is given in Appendix D.

Where the frontage road is two-way and has more than two lanes, any provision for right turns, either into or out of an access driveway, shall be subject to the design requirements of the relevant authority.

3.1.2 Categories of access facilities

To determine the access facility type and for access driveways, widths and restrictions on their location along frontage roads, this section categorizes accesses according to:

(a) the class of parking facility as shown in Table 1.1;

(b) the frontage road type, either arterial (including sub-arterial) or local (including collector); and

(c) the number of parking spaces served by the access facility.

These categories are set out in Table 3.1.

3.2 Access driveways — width and location

3.2.1 Access driveway widths

Except as specified in Clause 3.2.2, where traffic flow data on an access driveway is either known or can be determined by separate means more accurately than by use of the categories in Table 3.1, such data may be used to determine driveway widths by accepted design procedures. In the absence of such data, the widths given in Table 3.2 shall be used.

Access driveways may need to be widened where they meet the frontage roadway to allow turning movements from the kerbside lane without adversely affecting traffic flows in the frontage roadway.

Where separate entry and exit roadways are provided, they shall be at least 1.0 m apart.

Table 3.1 Selection of access facility category

Class of parking facility (see Table 1.1)	Frontage road type	Access facility category				
		Number of parking spaces [a]				
		< 25	25 to 100	101 to 300	301 to 600	> 600
1, 2	Arterial	1	2	3	4	5
	Local	1	1	2	3	4
3	Arterial	2	2	3	4	5
	Local	1	2	3	4	4
4, 5	Arterial	2	3	4	4	5
	Local	1	2	3	4	4

[a] When a car park has multiple access points, each access should be designed for the number of parking spaces effectively served by that access.

NOTE: This table does not imply that certain types of development are necessarily suitable for location on any particular frontage road type. In particular, access to arterial roads should be limited as far as practicable, and in some circumstances it may be preferable to allow left-turn-only movements into and out of the access driveway.

Table 3.2 Access driveway widths

Dimensions in metres

Category	Entry width	Exit width	Separation of driveways
1	3.0 to 5.5 (See Clause 3.2.2)	(Combined) (see Note)	N/A
2	6.0 to 9.0	(Combined) (see Note)	N/A
3	6.0	4.0 to 6.0	1 to 3
4	6.0 to 8.0	6.0 to 8.0	1 to 3
5	To be provided as an intersection, not an access driveway, see Clause 3.1.1.		

NOTE: Driveways are normally combined, but if separate, both entry and exit widths should be 3.0 m min.

3.2.2 Width requirements at low volume (Category 1) access driveways and connecting roadways

Where the circulation roadway connecting to a Category 1 access driveway fronting an arterial or sub-arterial road, both the access driveway and the circulation roadway for at least the first

6.0 m from the property boundary, shall be a minimum of 5.5 m wide if:

(a) The combined length of the access driveway and circulation roadway is 30 m or longer; or **(b)**

The sight distance from one end to the other is restricted.

In other instances, lesser widths down to a minimum of 3.0 m at a domestic property may be provided.

NOTE 1: These instances are subject to consideration of traffic volumes on a case-by-case basis.

NOTE 2: As a guide, 30 or more movements in a peak hour (in and out combined) would usually require provision for two vehicles to pass on the driveway, i.e. a minimum width of 5.5 m. On long driveways, passing opportunities should be provided at least every 30 m.

Reversing movements to public roads shall be prohibited wherever possible.

3.2.3 Access driveway location

To minimize conflicts between frontage road traffic and car park traffic, the following apply:

(a) *Driveway Categories 1 and 2* At unsignalized intersections of sub-arterial, collector or local streets with each other or with an arterial road, access driveways in Categories 1 and 2 (see Table 3.1) shall not be located in the sections of kerb shown by heavy lines in Figure 3.1. This requirement shall not apply to accesses to domestic driveways in the kerb section opposite the entering road at any intersection, including signalized intersections. Furthermore, it shall not apply to any access driveway serving a property which would otherwise be denied access due to the physical impossibility of meeting the requirement.

At signallized intersections, the minimum distance from the intersection, measured from the property boundary along both legs, should be increased so that driveways are located beyond the influence of normal queue lengths at the intersections. If this is not practicable, it may be necessary to provide —

(i) an arrangement which confines traffic to turning left when either entering or leaving the car park;

(ii) a signalized driveway with signals coordinated with the intersection signals; or

(iii) other traffic management means of providing for safe and efficient operation of the driveway.

(b) *Driveway Categories 3 and 4* Driveways in categories 3 and 4 (see Table 3.1) shall not be located —

(i) on arterial roads unless entrances and exits are designed and constructed as intersection treatments catering for all projected traffic flows;

(ii) closer to intersections than permitted for Category 1 and 2 driveways (see Clause 3.2.3(a));

(iii) opposite other developments generating a large amount of traffic, unless all projected traffic flows are provided for in a properly designed and constructed intersection treatment, such as traffic signals;

(iv) where there is a heavy and constant pedestrian movement along the footpath, unless this can be catered for by some form of positive control, e.g. traffic signals;

(v) where right turning traffic entering the facility would obstruct through traffic; or

(vi) where traffic using the driveways will interfere or block the operations of bus stops, taxi ranks, loading zones or pedestrian crossings.

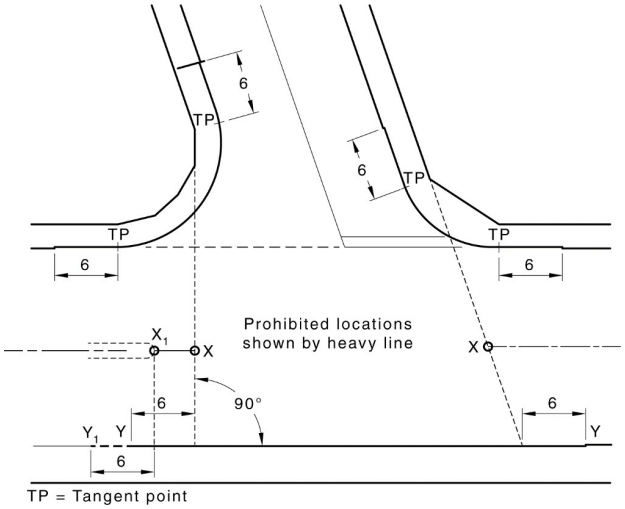
NOTE: In these instances, it may be appropriate to move the bus stop or other facility if this would result in the best overall design.

Entry for left turning vehicles into driveways in Categories 3 and 4 should be achieved by the first vehicular driveway reached, and by using the kerbside lane.

NOTE 1: Guidance on capacity provision at entry and exits at large car parks is given in Appendix D.

NOTE 2: The location of an access should consider proximity to other accesses and the design requirements of the relevant authority.

Dimensions in metres



NOTE 1: Accesses to domestic driveways are excluded from the prohibition in respect of the kerb section marked *Y-Y* (see Clause 3.2.3(a)).

NOTE 2: The points marked *X*1 and *X* are respectively at the median end on a divided road and at the intersection of the main road centre-line and the extensions of the side road property lines shown as dotted lines, on an undivided road. On a divided road, dimension *Y-Y* extends to Point *Y*1·

Figure 3.1 Prohibited locations of access driveways

3.2.4 Sight distance at access driveway exits

Access driveway exits shall be designed to manage the interaction between vehicles and path users on the frontage road. The design of the access driveway may be determined from consideration of sight distances to vehicles on the frontage road and sight distance to users on paths along the site frontage - see Appendix E for further guidance on sight lines.

Unsignallized access driveways shall be located so that the sight distance between drivers leaving the parking facility and vehicles on the frontage road is at least the distance shown in Tables 3.3(A) and 3.3(B).

NOTE 1: Drivers leaving the parking facility are typically at a height of 1.1 m above the driveway surface

NOTE 2: Vehicles on the frontage road are typically at a height of 1.25 m above the road

Table 3.3(A) Minimum sight distance along frontage road from driveways

Frontage road speed, km/h	Distance along frontage road [a,b] (m)				
	Access category				
	1	2	3	4	5
30	20	20	20	22	22
40	30	30	30	36	36
50	42	42	49	49	62
60	64	73	73	81	81
70	71	81	81	102	151
80	99	126	126	181	181
90	119	151	151	214	226
100	141	179	183	262	262

[a] Centreline or centre of road (undivided road), or right-hand edge of right hand through lane (divided road).

[b] A check to the left is not needed at a divided road where the median is wide enough to shelter a vehicle leaving the driveway.

NOTE 1: The speed referred to is the posted or general speed limit unless the 85th percentile speed is more than 5 km/h above the limit in which case the tabulated speed nearest the 85th percentile should be adopted.

NOTE 2: Values in this table are for gradients along the road below 2 %.

Table 3.3(B) Adjustments to sight distance for frontage road gradient

Frontage road speed,	Correction, m

km/h (see Note 1)	Upgrade				Downgrade			
	2%	4%	6%	8%	2%	4%	6%	8%
40	–1	–2	–2	–3	1	2	3	5
50	–1	–3	–4	–5	2	3	5	8
60	–2	–4	–6	–7	2	5	8	11
70	–3	–5	–8	–10	3	7	11	15
80	–4	–7	–10	–13	4	9	14	20
90	–5	–9	–13	–16	5	11	18	25
100	–6	–11	–16	–20	6	14	22	31

[a] The frontage road gradient is the average gradient where braking occurs, which can be taken as half of the minimum sight distance from Table 3.3(A).

[SOURCE: Austroads GTRD4a Table 3.4, modified (110-130km/h rows removed)]

3.2.5 Sight distance between driveway and path

Access driveways shall be located so that the sight distance (visibility triangle) between drivers leaving the parking facility and the adjacent path is at least the distance shown in Table 3.4.

NOTE 1: Drivers leaving the parking facility typically have an eye height of 1.1 m above the driveway surface

NOTE 2: The adjacent path user is typically at a height of 0.8 m above the path

As greater sight distances reduce risk, longer sight distances should be provided so far as practicable.

NOTE 3: For path user speeds greater than 25 km/h, assessment from first principles is needed - see Appendix E for further information.

Any object permanently located within the visibility triangle shown in Figure 3.2 shall be:

(a) Less than 800 mm high or above 2.0m high; or

(b) Visually permeable so an object, 800 mm in height and 150 mm in diameter, can be identified from a driver's view.

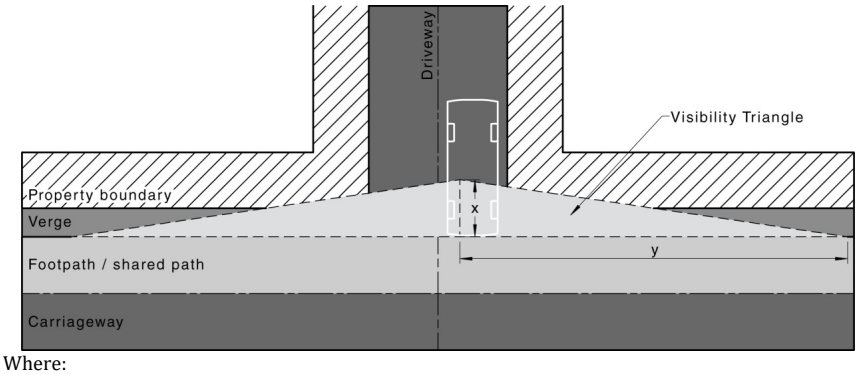
NOTE 4: These object dimensions are intended to approximate the size of a small child.

The visibility requirements in Table 3.4 can also apply where there is no formal footpath or shared path, but where there is demonstrated use by vulnerable road users (e.g. berm)

NOTE 5: Parking on this side of the frontage road may need to be restricted on either side of the driveway so that the sight distance required by Table 3C to an approaching path user is not obstructed.

Where the distances in Table 3.4 cannot be achieved mitigation measures shall be used.

NOTE: Suitable mitigation measures may include devices to reduce vehicle speed on the driveway, measures to reduce the speed of path users or measures to alert users to approaching vehicles.



Where:

X = Distance along driveway from edge of path in meters

Y = Distance along path from driveway in meters

[SOURCE: Modified from State of Queensland (Department of Transport and Main Roads) under the CC BY 4.0 licence (Figure 3.2.2 from *Guideline Treatment options to improve safety of pedestrians, bicycle riders and other path users at driveways* https://www.tmr.qld.gov.au/business-industry/Technical-standards-publications/Cycling-guidelines]

Figure 3.2 Illustration of sight distances to path users

Table 3.4 Minimum sight distance along frontage path from access driveway

Path user speed, km/h (maximum)	Examples where speed may be typical	Distance along driveway from edge of path (X), m		Distance along path from driveway (Y), m
		Domestic driveways	Other driveways	
5	Walking speed –pedestrian only paths Typically, a 1-1.5 m wide path	2.5	5	3

10	Jogging speed - wide paths or child cyclists near schools near shopping centres near recreational facilities. Paths used by cyclists or mobility devices Typically, a 1.5-2 m wide shared path	2.5	5	7
15	Interrupted cycling flow - Formal shared pedestrian and cyclist path on urban streets with high level of roadside development and frequent intersecting streets Typically, a 2-2.5 m wide path shared path	5	5	12
20	Busy formal shared path or cyclist- only path on urban streets Typically, a ≥ 3 m shared path or segregated path	5	5	18
25	Cyclist-only path with few intersecting streets or driveways Typically, a segregated path or wheeled path users only	5	5	26

3.3 Queuing areas at entrances

The queuing area between the vehicular control point and the property boundary shall be designed to minimize queueing onto the road.

The length of the queuing area at a vehicle control point (controlled by devices such as boom gates and/or ticket issuing devices) can be calculated using:

(a) Table 3.5; or

(b) The methodology identified in Appendix D where specific guidance is available.

The number of cars calculated by methods (a) or (b) shall be rounded up to the next whole number and a minimum length of 6.0 m per vehicle allowed for.

Table 3.5 Minimum queuing length at a car park with control points at entrances

Capacity of car park[a]	Peak hourly in-flow of traffic	
	Up to 75 % of capacity [b]	More than 75 % of capacity [C]
Not more than 100 cars	The greater of a minimum of 2 cars or 3 % of capacity	The greater of a minimum of 2 cars or 4 % of capacity
More than 100 cars	1st 100 cars: 3 % of capacity 2nd 100 cars: 2 % of capacity Additional cars: 1 % of capacity A minimum queuing length of 3 cars/lane[d]	1st 100 cars: 4 % of capacity 2nd 100 cars: 2 % of capacity Additional cars: 1.5 % of capacity A minimum queuing length of 3 cars/lane[d]

[a] Equal to the total number of parking spaces served by the entrance (proportioned where several entrances service a common parking area).

[b] Generally casual (short-staying) and mixed patronage.

[C] Tidal traffic typical of car parking for a special event.

[d] The queuing area in car parks using attendant parking shall be at least twice as large as that given in Table 3.4.

For the design of queuing areas to accommodate the queue lengths determined above, the following principles apply:

(a) Queuing across pedestrian paths and onto adjacent roads at vehicle entry points shall be minimized;

(b) Parking space manoeuvres shall not be permitted to take place within the queuing area;

(c) A minimum 2.7 m lane width where multiple queuing lanes are present shall be provided;

(d) The volume of traffic being carried on the adjacent road should be considered; and

(e) The expected volume of traffic served by each entry point where multiple control points exist.

NOTE: See Clause 4.3 for guidance on gradients at queuing areas.

3.4 Vehicle Control Points

3.4.1 General

Where a vehicle access point is controlled by a physical barrier that requires manual interaction with an external control interface, the following requirements apply for the design of vehicle control points:

(a) The control interface shall be located on the right-hand side and be accessible by a driver in a seated position within a vehicle.

(b) The control interface shall be positioned laterally 50 ± 25 mm behind the face of the adjacent kerb.

(c) The control interface shall be positioned at a height between 1.0 m to 1.2 m above the driveable surface.

(d) The control point shall be located on a straight or right-hand curve approach to allow a vehicle body to access within 300 mm of the adjacent kerb.

(e) A minimum standing length of 6 m clear of any crossing, footpath and/or road shall be provided.

NOTE: See Clause 4.3 for guidance on gradients at control points.

3.4.2 Design considerations of technology

Technology solutions adopted to manage the activation of vehicle control points should be designed to consider the various needs of user that are permitted to access the parking area, including:

(a) The height of different vehicle types requiring access;

(b) The mobility needs of different users in reaching and operating equipment (such as intercom buttons);

(c) The location of cameras to capture vehicle details (such as motorcycles which only have a number plate located at the rear)

(d) The location of magnetic loops to cater for different vehicle types (for example motorcycles); and

(e) Boom gate widths to maintain access by users that are not required to activate vehicle control systems (such as cyclists).

3.5 Access to mechanical parking installations

Access to mechanical parking installations, such as car stackers, shall be by means of access driveways and circulation roadways designed in accordance with this document.

Vehicle storage should be provided to ensure that queues of vehicles awaiting service by the installation do not extend beyond the property boundary of the parking facility under normally foreseeable conditions. When determining the amount of vehicle storage required, queue lengths shall be calculated by applying conventional queuing theory to estimated mean arrival rates during normal peak periods, and mean service rates under continuous demand, determined as closely as possible from observing the operation of similar facilities. The storage area shall be designed to accommodate the 98th percentile queue under such conditions. The queue lengths given in Table 3.5 shall not be used in this case.

4 Ramps and Gradients

4.1 Parking Modules

4.1.1 Maximum gradients

The maximum gradients within a parking module, including a motorcycle parking area, shall be:

(a) Measured parallel to the angle of parking — 1 in 20 (5 %).

(b) Measured in any other direction — 1 in 16 (6.25 %).

(c) Within parking spaces for people with disabilities — refer to AS 2890.6.

NOTE: See Clause 2.4.6 for further requirements and information relating to motorcycle parking.

4.1.2 Minimum gradients

The minimum gradient shall be 1 in 100 (1.0 %) for outdoor areas and 1 in 200 (0.5 %) for covered areas to allow for parking floor drainage.

4.2 Circulation Roadways and Ramps

Limiting requirements for grades on circulation roadways and ramps shall be:

(a) *Straight ramps: public car parks* —

(i) Longer than 20 m — 1 in 6 (16.7 %) maximum.

(ii) Up to 20 m long — 1 in 5 (20 %) maximum. The allowable 20 m maximum length shall include any parts of grade change transitions at each end that exceed 1 in 6 (16.7 %).

(iii) A stepped ramp comprising a series of lengths each exceeding 1 in 6 (16.7 %) grade shall have each two lengths separated by a grade not more than of 1 in 8 (12.5 %) and at least 10 m long.

(b) Straight ramps: private or residential car parks (other than domestic driveways, see Clause 4.5) —

(i) Longer than 20 m — 1 in 5 (20 %) maximum.

(ii) Up to 20 m long — 1 in 4 (25 %) maximum. The allowable 20 m maximum length shall include any parts of grade change transitions at each end that exceed 1 in 5 (20 %).

(iii) A stepped ramp comprising a series of lengths each exceeding 1 in 5 (20 %) grade shall have each two lengths separated by a grade of not more than 1 in 8 (12.5 %) and at least 10 m long.

(c) *Curved ramps* — as for straight ramps, except that the grade shall be measured along the inside edge, i.e. the line marked with radius R_i in Figure 2.9.

(d) *Changes of grade* — To prevent impact to underside of vehicles, a grade transition shall be provided where the change exceeds —

(i) 12.5 % algebraically (1 in 8) for summit grade changes; or

(ii) 15 % algebraically (1 in 6.7) for sag grade changes.

NOTE 1: Grade transitions may also be required where there are successive grade changes less than 3 m apart.

NOTE 2: See Figure 4.1 for an illustration of grade measurements.

NOTE 3: Grade transitions may be required at lesser changes in grade where vehicles with unusually low ground clearance are to be catered for.

(e) *Grade transitions* — Grade changes shall ensure adequate ground clearance – see Appendix C for a recommended method.

NOTE 4: Transitions of 2.0 m to 2.5 m in length will usually be sufficient to correct bottoming or scraping at grade changes up to 18 %. For grade changes of more than 18 %, a transition of up to 3 m may be needed. They may be in the form of a simple chord with grade calculated as half the algebraic sum of the two adjacent grades, as illustrated in Figure 4.1, but for vehicle occupant comfort may be constructed as short vertical curves.

(f) *Sloping floors* — In some parking structures the floor is sloped to provide the connection between parking levels. Maximum gradients for such floors shall be as specified in Clause 4.1.1.

(g) *At and near access driveways* — Limiting grades across footpaths and property boundaries, and at vehicular control points and queuing areas near entry and exit points are specified in Clause 4.3 and 4.4.

(h) *Domestic driveways* — see Clause 4.5.

NOTE 5: Refer to AS 2890.2 for further guidance where heavy vehicles may use the facility.

Key

Lr	=	length of ramp, in metres
Hr	=	height of ramp, in metres
Ramp grade	=	percent

The grade change is computed by subtracting one grade from the adjacent grade, both expressed as percentages and taking account of algebraic sign which, for a given direction of travel, is either uphill — positive or downhill — negative

Figure 4.1 Changes of grade on ramps

4.3 Queuing areas and vehicle control points

The maximum gradient at vehicle control points shall be 1 in 20 (5 %) for at least 4.0 m prior to the control point.

The maximum gradient in a queuing area shall be 1 in 10 (10 %) for not less than 80 % of the queue length determined in Clause 3.3.

4.4 Transitions at access driveways

At entry and exit points, the access driveway grades should take into account the maximum gradient requirements of other users of the footpath and roadway.

Grade changes between the access driveway and circulation roadways or ramps within the property shall ensure vehicles will not impact their undersides when negotiating them. See Appendix C for a suggested method of checking the ground clearance.

Maximum gradients for the transition between circulation roadways and access driveways, other than at domestic properties (see Clause 4.5), shall be:

(a) Within the property:

(i) Where the grade is upgrade for vehicles leaving the property:

Maximum of 1 in 20 (5 %) into the property

(A) for car parks with less than 25 spaces and for User Classes 1, 2 and 3 only - for at least the first 4.0 m into the property

(B) for all other car parks - for at least the first 6.0 m into the property.

(ii) Where the grade is downgrade for vehicles leaving the property:

Maximum of 1 in 8 (12.5 %) into the property

(A) for car parks accessed from arterial or sub-arterial roads, with less than 25 spaces and for User Classes 1, 2 and 3 only - for at least the first 4.0 m into the property

(B) for car parks accessed from local or collector roads, with 100 spaces or less and for User Classes 1, 2 and 3 only - for at least the first 4.0 m into the property

[C] for all other car parks - for at least the first 6.0 m into the property.

(b) *Across footpaths* — where the driveway crosses a footpath, the driveway grade shall be 1 in 33 (3.3 %) or less.

NOTE: The advice of the relevant roads authority should be sought to obtain grade requirements for footpaths.

4.5 Domestic Driveways

The maximum gradient of domestic driveways shall be 1 in 4 (25 %). The maximum gradient across a footpath shall be in accordance with Clause 4.4(b).

Grade changes between the domestic driveway and the access driveway shall ensure that vehicles will not impact their undersides when negotiating them. Transitions may be required (see Clause 4.2(d)). Checks may be required along one or both edges of a driveway as well as along the centre line if there are changes in the cross slope at or near a grade change.

NOTE 1: It is recognized that limiting domestic driveway grades to 25 % maximum may not be practicable in some particularly hilly residential locations. The services of a competent person may be required to make a judgement as to whether a particular grade line design is safe and effective in the expected environment.

NOTE 2: Gradients steeper than 1 in 5 (20 %) may require high friction surfacing to maintain traction.

5 Other considerations

5.1 Pedestrian service

5.1.1 General

Parking areas shall be designed so that through-traffic is excluded, and pedestrian entrances and exits are separate from vehicular entrances and exits.

Where pedestrians are required to cross busy circulation roadways, they shall be guided to a safe crossing point with the relevant signs and markings. Pedestrian crossing points shall have adequate sight distance.

NOTE 1: Refer to AS 1742.10 (in Australia) or Traffic Control Devices Manual (in New Zealand) for further guidance on signage and markings.

NOTE 2: Refer to Austroads Guide to Road Design for guidance on adequate sight distances. NOTE 3: A busy circulation roadway is considered to carry 150 vehicles per hour or more.

Where pedestrians are required to travel along a circulation roadway, ramp or access driveway, pedestrian paths shall be provided to separate vehicular and pedestrian movements.

NOTE 4: Parking aisle widths are designed to accommodate vehicle manoeuvring requirements.

NOTE 5: It is desirable to separate vehicle and pedestrian movements within parking aisles where possible however, it is recognized that most car parks make use of the parking aisle for pedestrian movements to the building entrance.

Within a parking aisle serving User Classes 1,2, 3 and 4, where pedestrian movements are unable to be separated from vehicle movements, the parking aisle shall be designed as a low speed environment.

NOTE 6: A low speed environment is considered to be less than 20 km/h

This shall include physical speed control measures, such as:

(a) Humps as specified in Clause 5.7.

(b) The limiting of parking aisle length to less than 100 m (see Clause 2.4.7). Pedestrian paths shall be provided across parking aisles where:

- **(i)** The orientation of parking aisles requires pedestrians to travel across parking aisles to access building entrances or pedestrian paths; and
- **(ii)** Where pedestrian access cannot be reasonably achieved between parked vehicles (i.e. where shopping trolley access between aisles is required).

Within a parking aisle serving User Class 5, a pedestrian path shall be provided along at least one side of the parking aisle (to the rear of the parking spaces) to facilitate separated pedestrian and vehicle movements.

Where pedestrian paths cross a parking aisle, a provision of a minimum clear sight line of 10 m between vehicle and pedestrian movements shall be provided.

NOTE 7: This reflects the stopping distance needed for a vehicle travelling at 10 km/h

5.1.2 Parking structures

In split-level car parks, a stairway or pedestrian ramp shall be located at the split-level for pedestrian access between levels so that pedestrians do not have to use vehicular ramps.

NOTE: Requirements for pedestrian access and egress including stairs, lifts and exits are given in relevant building codes and Standards.

5.1.3 Surface car parks

When considering pedestrian provisions in the planning of surface car parks, the following principles apply:

(a) Pedestrians should be directed and encouraged to cross circulating aisles and roadways at right angles at points where there is acceptable sight distance to circulating traffic.

NOTE: Crossing points should be provided at locations remote from the major concentrations of vehicular movement.

(b) Service yards should be accessed separately from the car park.

(c) Pedestrian movements should be able to be made safely throughout the car park.

(d) Pedestrian desire lines, generally the shortest route, into and out of the surface car park should inform entry points and internal paths.

5.2 Bicycle parking

Refer to AS 2890.3 for provisions regarding the parking and safe storage of bicycles at a car park.

5.3 Signposting

5.3.1 General

All operations in a car park shall be directed by directional, informative, regulatory or warning signs.

NOTE 1: The term "regulatory signs" relates to the descriptions and functions of these types of sign given in AS 1742.1 and Traffic Control Devices Manual (NZ).

Signs can be used for the following purposes:

(a) To control traffic movement and driver behaviour (e.g. speed).

(b) To warn against hazards to personal safety or potential damage to vehicles.

(c) To identify sections or rows of parking spaces so that pedestrians can easily find their parked vehicles.

(d) To direct and inform drivers entering and circulating within the car park about vehicular entry points, exits and parking locations.

(e) To direct pedestrians to lifts, stairs, amenities and other parts of the building.

NOTE 2: This clause does not cover EXIT signs required for emergency evacuation of buildings.

Where possible, the design and usages of signs should be consistent with those used for the street network in accordance with AS 1742 (in Australia) or the Traffic Control Devices Manual (in New Zealand). Subject to the requirements of Clause 5.3.6, it is acceptable to use signs smaller than those used on the roads.

As signs for the main vehicle routes within a car park are a vital part of the traffic control system, especially at locations where confusion is likely to arise, they shall be clearly visible, easy to read and simple to follow.

NOTE: An excessive number of signs can be an unnecessary distraction and can lead to confusion.

Sign numbers are shown against most of the signs as follows:

(i) Numbers marked "(Aust.)" or "(Aust. only)" — as specified in AS 1742.1.

(ii) Numbers marked "(NZ)" — as specified in the Traffic Control Devices Manual.

5.3.2 Vehicular guide signs

Guide signs for vehicular traffic should in both description and use, be generally as indicated by the examples given below. Subject to the minimum sign size requirements of Clause 5.3.6, the layout and dimensional

proportions may be adjusted to suit the site. The colour, basic shape, letter style and symbol used (if any) shall conform to the principles in AS 1742 (in Australia) or the Traffic Control Devices Manual (in New Zealand). Signs may fit with one of the following functional categories:

(a) Entry to parking area

This sign can be used on a public street to indicate the entrance to a car park. If the entrance is in a side street, the sign can also be repeated at the main street intersection.

G7-3-1 (Aust. only) (white on blue)

NZ only (white on blue)

(b) Entrance and exit instruction

This sign can be used to advise drivers of any action required of them at point of entry or exit to or from the park. The legend can be varied to suit.

G9-54 (Aust. only) (Black on white)

(c) Circulation direction

This sign can be used to indicate the route a driver should take while searching for a vacant space. It should be located at each point where a driver is confronted with a choice of routes or has to make a turn.

G7-11 (white on blue) (Aust. only)

(d) Way out

This sign can be used to indicate the route the driver is to take when leaving the car park. A direction name should be added at any location where there is a choice of routes leading to different exits. Way Out signs should be located so as to be visible to a driver in a parking aisle, circulation aisle or roadway.

NOTE: The word EXIT should be reserved for use on emergency evacuation signs only.

G9-55 (white on green) (Aust. only)

G9-56 (white on green) (Aust. only)

(e) Electric and other alternate fuel stations

Where electric and other fuel stations are provided within a facility, signs and markings should be installed to inform drivers to their location.

5.3.3 Pedestrian direction signs

These may be provided as follows:

(a) General direction sign

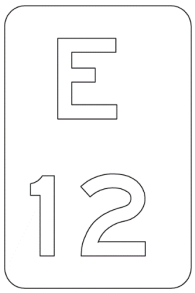
These signs are used to indicate lifts, stairs, directions to facilities being served by the car park, disabled user facilities etc. Where there are no standard symbols for a particular message, words should be used.

NOTE: The word EXIT should be reserved for use on emergency evacuation signs.

G5-8 (white on blue) (Aust. only)

(b) Location identification signs

These signs are used to mark parking modules to help drivers find their vehicle. One unique identification number for each parking module of standard size or less (approx. 40 spaces, see Clause 2.4.7), should be provided. Numbering of modules should be arranged in a logical progression which is apparent to users on foot inside the car park.



Example only

5.3.4 Regulatory and warning signs

Regulatory and warning signs are used as follows:

Low clearance signs — Low clearance signs shall be used where vehicles may encounter an overhead obstruction where the clearance in either case is 4.5 m or less.

Low clearance signs shall be positioned prior to an obstruction to provide warning to drivers of over-height vehicles, enabling the obstruction to be avoided without hindering traffic flow.

NOTE: It is recommended that the low clearance signs be provided at the entry to the facility.

The sign to be used shall take one of the forms shown in Figures X to Y or be rearranged to suit a particular site. If rearranged, the colour and legend shall always be as shown in Figures X to Y below.

R6-16 (black on white) (Aust. only)

R6-11 (black on white) (Aust. only)

The height shown shall be the measured minimum clearance (see Clause 6.4) *rounded down* to the nearest 0.1 m. The height should consider change of grade that would present height constraints to overhead structures etc. The height shown shall be adjusted whenever roadway resurfacing, or other activity reduces the clearance.

WW32 (black on yellow)(NZ. only)

(c) For NZ – WW32 *STOP* and *GIVE WAY* signs

They shall be used in accordance with the relevant requirements of AS 1742.2 (in Australia) or TCDM (in New Zealand).

NOTE 1: These may be required where an access driveway intersects with a frontage roadway and there are no traffic signals.

NOTE 2: They may also be needed within the car park at any intersecting roadway at which hazards could arise if right of way is not assigned or approach speed controlled. Stop or give-way lines alone may be adequate in many cases. Layouts should be designed to avoid such situations wherever practicable.

R1-1 (Aust) RP1 (NZ)

R1-2 (Aust) RP2 (NZ)

(d) Speed limit signs

Speed limit signs may be used to indicate the general speed desired in a car park. The limit should not be unrealistically low as speed limit signs on their own will not generally be effective in controlling excessive speeds.

R4-1 (Aust. only) RS1 (NZ)

(e) Hump warning sign

This sign shall be used at a road hump if there is some doubt as to whether the hump will be visible in time for a driver to slow down to negotiate it.

W5-10 (Aust) WN2 (NZ)

(f) Steep grade warning signs

These signs shall be used in public car parks at the beginning of steep ramps, up or down, where drivers may find the ramps to be unexpectedly steep.

NOTE 3: Grades in the order of 1 in 6 (16.6 %) or steeper may require such signs.

W5-10 (Aust) WN4D (NZ)

W5-13 (Aust) WN4U (NZ)

5.3.5 Signs for people with disabilities

Signs for people with disabilities shall conform to the requirements of AS 2890.6.

5.3.6 Sign size

Signs shall be made large enough so that they meet the following provisions:

(a) They shall be sufficiently conspicuous to attract the attention of car park users at the distances at which they need to be seen.

NOTE 1: Whether a sign is sufficiently conspicuous will depend upon its design (e.g. use of colour), size, illumination, and the amount of visual distraction in its vicinity.

NOTE 2: These factors can generally be only judged subjectively but conspicuity is enhanced if the sign is on or close to the observer's line of sight.

(b) They shall have legends large enough to be legible to users at the distances at which they need to be read.

NOTE 3: Minimum required letter size can be calculated by determining the maximum distance at which the sign needs to be read and allowing 10 mm of letter height for each 5 m of legibility distance required.

NOTE 4: This calculation applies to letters which are no narrower than Series D capital letters as specified in AS 1744 (in Australia) and TCDM (in New Zealand) and for signs having not more than four message elements, either words, symbols or a combination.

NOTE 5: Legibility distances for other letter types and widths are given in AS 1742.1 (in Australia) and TCDM (in New Zealand).

5.3.7 Sign location

Signs shall not be placed in positions where they may obstruct sight lines to approaching or crossing traffic or to pedestrians.

5.3.8 Variable message signs

Variable message signs can be provided at the entry to and within public car parks for the following purposes:

(a) Guiding drivers to locations where there are vacant spaces.

(b) Indicating the number of spaces vacant in a particular location at a particular time.

(c) Providing other information of use to users of the facility.

The following requirements relate to the use of variable message signs displayed to vehicle drivers:

(i) Symbols other than arrows shall not be used on signs unless they meet minimum public comprehension requirements in the form they are presented on the variable sign.

(ii) Signs with words only that are required to be read by a moving vehicle shall be limited to not more than four words on any one screen.

(iii) Scrolling of messages shall be limited to a maximum of two screens. Running messages shall not be used.

(iv) Changing messages (other than the updating of car space availability numbers) shall not be displayed to drivers within or approaching a vehicle or pedestrian conflict area.

(v) Signs shall not reduce the minimum height clearance requirements of this document (see Clause 6.4).

(vi) Signs shall be clearly visible on approach and not obscured by other obstructions.

5.4 Markings

5.4.1 Marking of parking spaces

Parking spaces, other than those for people with disabilities, shall be delineated by means of white or yellow lines 80 to 100 mm wide, or white or yellow pavement markers in one or other of the forms and patterns illustrated in Figure 5.1 for angle parking or Figure 5.2 for parallel parking. Pavement markers, if used, shall be designed to minimize tripping hazards.

NOTE 1: Marking of parking spaces for people with disabilities is specified in AS 2890.6.

NOTE 2: Pavement markers more than 3 mm in height may cause a tripping hazard for pedestrians.

Dimension *C* in Figure 5.1 shall be as specified in Clause 2.4.1.

In any one car park facility, all parking spaces of the same type shall be marked in the same way.

The use of two lines to separate adjacent angle parking spaces is desirable whenever users appear not to be centring vehicles in the spaces. It should be considered for high turnover situations, especially where minimum width spaces have been used. Where used, the nominal width of the parking space shall be measured from the centreline of the pair of marked lines.

Where used, there should be no less than 3 pavement markers to delineate parallel parking spaces and no less than 4 for all other spaces.

Dimensions in millimetres

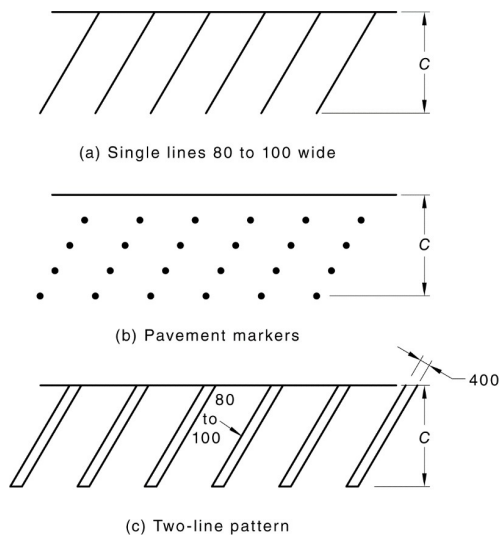
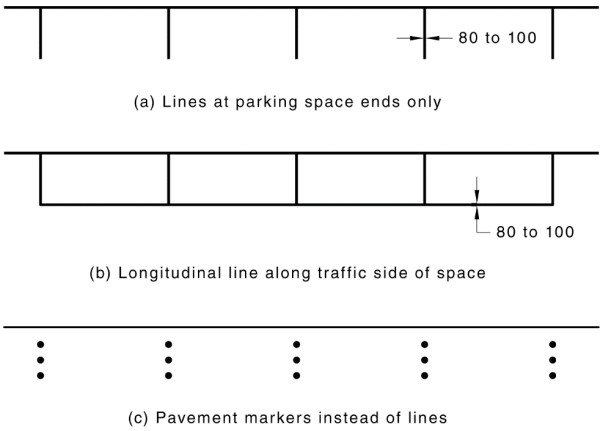


Figure 5.1 Marking of parking spaces — angle parking

Dimensions in millimetres



NOTE: A longitudinal line as in (b) should be used where edge delineation for moving traffic is required.

Figure 5.2 Marking of parking spaces — parallel parking

5.4.2 Pedestrian crossing markings

Pedestrian crossing markings shall comprise a series of white or yellow bars. The markings shall:

(a) Be 600 mm wide by 1.2 m to 3.5 m long;

(b) Have gaps of 600 mm wide to form a “zebra” crossing marking;

(c) Be placed parallel to the direction of approaching vehicular traffic; and

(d) Be slip resistant.

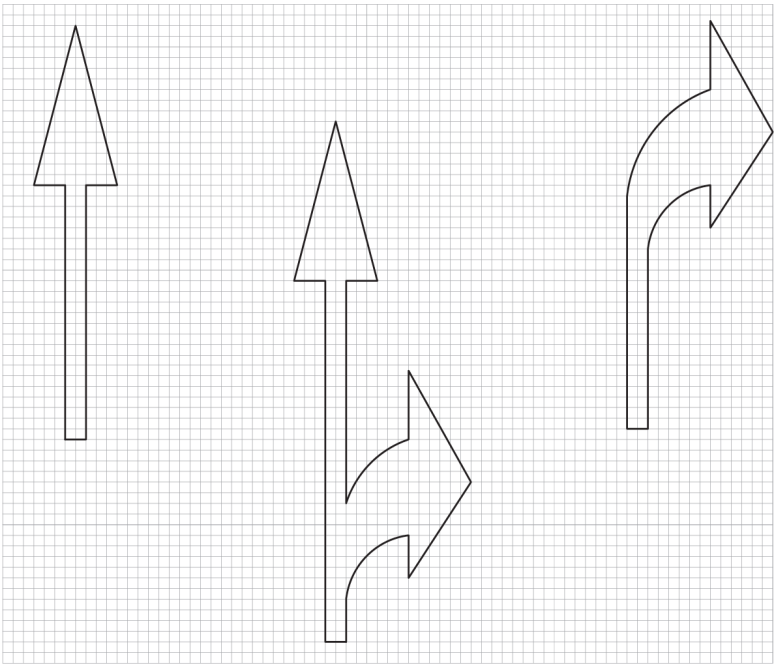
NOTE 1: The slip resistance of the marking should be no worse than Class W (wet pendulum test) as specified in AS/NZS 4586 if the crossing is on an accessible travel path for people with disabilities, or Class X in other cases.

NOTE 2: The corresponding slip resistances (British Pendulum Number) are: Class W — 45 to 54; Class X — 35 to 44.

NOTE 3: Requirements for the location of pedestrian crossings are specified in Clause 5.4.

5.4.3 Arrow markings

Recommended shapes and sizes for arrow markings for the control and direction of circulating traffic within a car park and associated circulating roadways are illustrated in Figure 5.3.



(a) Straight ahead

(b) Combination — straight ahead and turn

(c) Exclusive turn

NOTE: Minimum length of arrows:

(a) Straight ahead and turn arrow = 3.0 m

(b) Combined arrow = 3.75 m.

Figure 5.3 Arrow markings for use in car parks

5.5 Lighting

Parking areas and circulation areas, together with pedestrian pathways including those used by people with disabilities shall be adequately lit.

NOTE 1: Minimum lighting levels for roofed car parks should be as specified in AS 1680.2.1.

NOTE 2: Minimum lighting levels for open air, including roof-top, car parks should be as specified in AS/NZS 1158.3.1.

5.6 Landscaping

When providing trees and shrubs, safety aspects shall not be compromised at any time during the life of the plantings.

NOTE 1: Safety aspects may include sight distances to both pedestrians and other vehicles.

NOTE 2: As well as improving the appearance of an area, the judicious placement of trees provides shade and screening for both surface car parks and structures should be encouraged. Landscaping also assists in delineating areas.

5.7 Humps

Where positive speed control is necessary within a car park, road humps as specified below shall be used.

Humps may be of the following forms depending on their location and the range of speed reduction required. They are illustrated in Figure 5.4 and used as follows:

(a) *Type* 1 — A longer feature appropriate for use on long aisles (see Clause 2.4.7) and circulating roadways as in large outdoor surface car parks, where it is desired to reduce speeds generally in excess of 30 km/h to about 25 km/h or less.

NOTE 1: Type 1 humps are usually formed in bituminous concrete. If so, they may be unsuitable for installation on Portland cement concrete surfaces.

(b) *Type 2* — Appropriate for use in relatively confined areas of covered and multi-storey car parks where it is desired to further check the speed of vehicles mostly travelling at 30 km/h or less.

NOTE 2: If a greater level of control is required on longer roadways, other vertical deflection devices such as those specified in AS 1742.13 for local area streets may be more appropriate.

If delineation of the hump is required, Types 1 and 2 shall be delineated by means of the marking illustrated in Figure 5.5. If the larger AS 1742.13 hump is used, the markings specified in that Standard shall be used. Hump markings shall be either white or yellow.

Road humps shall be spaced at not less than 30 m for Type 1, or 10 m for Type 2, along any one aisle or roadway. Maximum spacing, where required to control speeds continuously along a roadway, should be approximately 50 m. Humps should be located clear of intersections and curved roadways.

Humps shall not impede pedestrian or wheelchair traffic on any accessible travel path provided for people with disabilities. An accessible path of travel shall be a minimum of 1 m wide.

Dimensions in millimetres

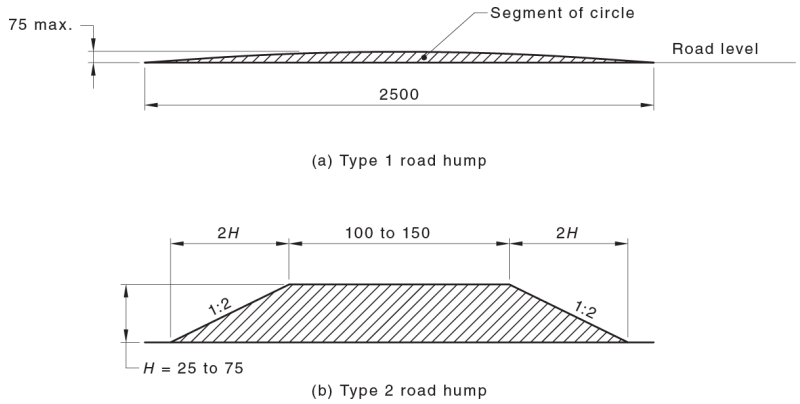


Figure 5.4 Cross sections of road humps for use in car parks

Dimensions in millimetres

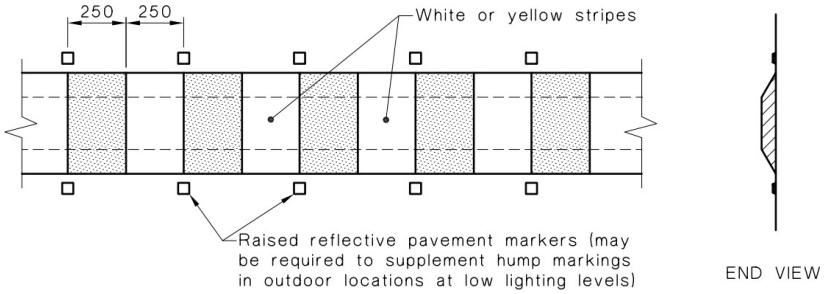


Figure 5.5 Markings for road humps used in car parks

5.8 Special loading/unloading parking spaces

Special areas may be required as indicated below. Where they are to be provided for the indicated purpose, they shall meet the following requirements:

(a) *Parcel pick-up* - Parcel pick-up areas shall be designed so that queues do not interrupt the flow of vehicles in the circulation roadways. Pedestrians shall be able to move freely around vehicles in the pick-up zone without being endangered by traffic entering or leaving the parcel pick-up area.

(b) *Shopping trolley storage* - Areas shall be set aside for trolleys to be stored to assist in the orderly operation of parking areas in large retail centres. Facilities for the easy manoeuvring of trolleys should be provided in the major pedestrian paths, such as lipless kerb crossings.

(c) *Unloading/loading of prams, strollers, bulky parcels etc* — The space shall be a minimum of 0.5 m wider than the standard space for the relevant user class and a minimum of 2.0 m longer. The added width may be shared with a footway, parking aisle or other adjacent unobstructed space.

NOTE 1: Parking spaces provided for these purposes should be located where they best serve the purpose and the usage limited to short-stay, e.g. 5 min maximum.

6 Additional requirements for car parking structures

6.1 General

This section provides consistency across all parking spaces where obstructions are involved, including but not limited to:

(a) Multi-level car parks;

(b) Garages and caged spaces;

(c) Vehicle lifts/hoists;

(d) Mechanical parking systems; and

(e) Car ports.

6.2 Manoeuvring

The manoeuvring area required to use an enclosed parking space is the result of a direct relationship between the width of the doorway or space opening, the aisle width and the aisle extension where at a blind aisle.

Manoeuvring for enclosed parking spaces shall be designed using swept path analysis in accordance with Appendix B.

There are many dimensional combinations, but the following criteria shall be met:

(a) A minimum of 300 mm clearance to all obstructions above a height of 150 mm; and

(b) A maximum of three movements to enter and exit the space for the B85 vehicle (or five movements for the B99 vehicle).

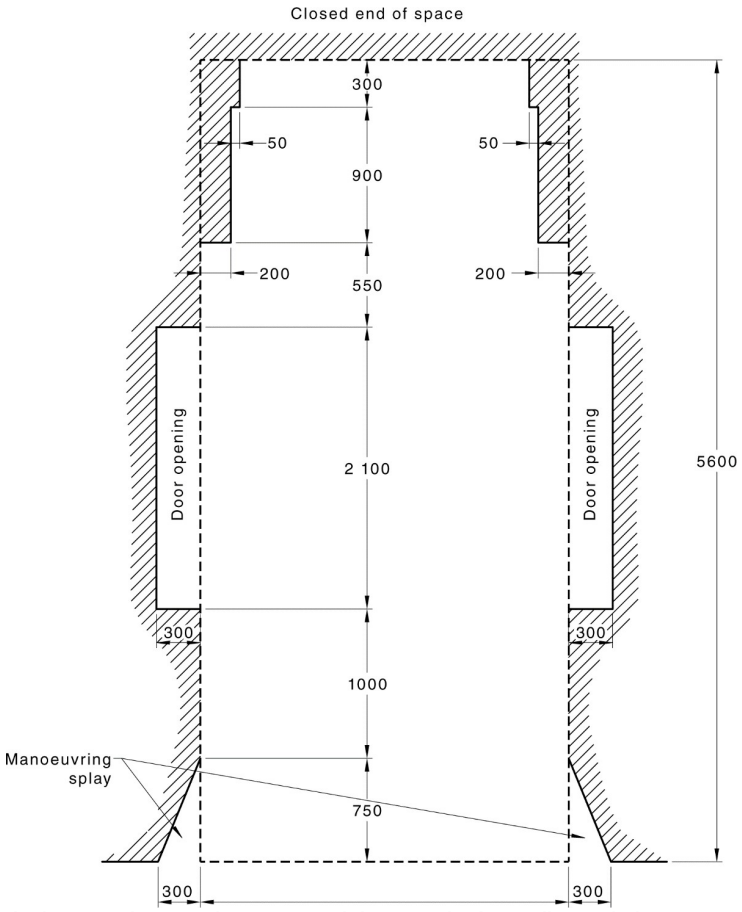
NOTE 1: The shorter lock-to-lock times in Table B.1 may be used.

NOTE 2: See Table 2.4 for minimum aisle widths.

6.3 Parking space envelope

The design envelope around a parked vehicle, shown in Figure 6.1, shall be kept clear of all obstructions. Where there are columns on both sides of a parking space, the minimum space width shall be 2.6 m.

NOTE: The door opening area shown in Figure 6.1 can overlap with the door opening area of an adjacent parking space or a shared area.



NOTE 1: The design envelope provides for structural elements to be clear of all four side doors.

NOTE 2: Space width is taken from Figure 2.2

NOTE 3: The manoeuvring splay may be reduced for aisle widths that are wider than the minimum.

Figure 6.1 Design envelope around parked vehicle to be kept clear of columns, walls and obstructions

6.4 Headroom

6.4.1 General requirements

To permit access for both cars and most light vans, the headroom shall be a minimum of 2.2 m. See Clause A.5 for further information regarding van heights.

Headroom at a “sag” type grade change shall be measured as illustrated in Figure 6.2. It shall be measured perpendicular to a chord of length equal to the wheelbase of the B99 vehicle (see Appendix B) located longitudinally such that the dimension *H* is a minimum. Elsewhere, the headroom shall be measured perpendicularly to the finished ground level. Clearances shall be measured to the lowest projection from the roof, e.g. fire sprinkler, lighting fixture, sign.

NOTE 1: A considerable amount of inconvenience can be caused by collisions with overhead appurtenances such as fire sprinklers. Care should be exercised in the location of these devices where headroom is limited.

NOTE 2: Road humps should not be located near points where the headroom is critical.

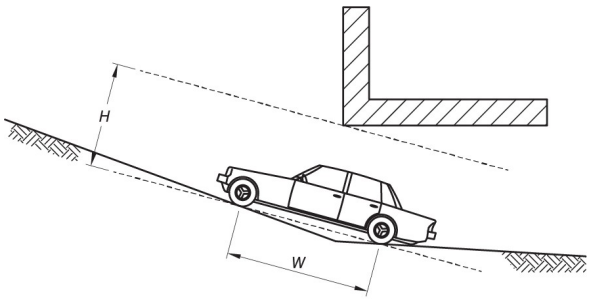


Figure 6.2 Critical headroom measurement at a grade change

The minimum available clearance shall be signposted at all entrances where the minimum clearance is less than 4.5 m. Low clearance signs shall be in accordance with Clause 5.3.4.

Warning devices shall also be provided wherever the clearance is less than 2.5 m. The device shall be positioned at least 500 mm prior to the obstruction.

NOTE 3: A greater distance between the warning device and the obstruction may be needed to allow vehicles to stop.

NOTE 4: Warning devices can include flexible striker bars.

6.4.2 Parking spaces and vehicular access for people with disabilities

Headroom above parking spaces for people with disabilities and above vehicular access paths to and from those spaces is specified in AS 2890.6.

6.5 Design of Enclosed Spaces

6.5.1 General

The following list presents examples of common enclosed parking:

(a) Garages and caged spaces (including domestic garages)

(b) Mechanical parking systems

(c) Lifts and hoists

(d) Car ports

6.5.2 Garages and caged spaces

Fully enclosed parking spaces shall meet the requirements given below.

(a) *Single parking space* — The internal width shall be a minimum of 3.0 m. A minimum doorway width of 2.5 m shall be provided.

(b) *Multiple parking spaces with no internal walls* — Parking spaces shall be a minimum of 2.4 m wide. These shall be spaced as follows:

  (i) *Single door for all spaces* - the width of the spaces adjacent to the end walls shall be increased by 300 mm along the entire length of the space. The door shall have a minimum width equivalent to the combined widths of the associated parking spaces, less the additional 300 mm at the end spaces.

  (ii) *Separate door for each space* — the parking spaces shall be designed with the door widths determined by the associated aisle width. The width of the spaces adjacent to the end walls shall be increased by 300 mm along the entire length of the space.

(c) The minimum length of a space that is able to be enclosed at both ends shall be:

  (i) 5.8 m where pedestrian access is not required from one side of the space to the other.

  (ii) 6.2 m where pedestrian access is required from one side of the space to the other.

6.5.3 Car ports

Car ports shall be designed in accordance with the dimensional requirements of Clause 6.3.

6.6 Vehicle lifts / hoists

The minimum length of vehicle lift or hoist shall be 5.8 m. The minimum width shall be 3 m for a single car lift or hoist and 5.4 m for a double car lift or hoist.

The requirement for a passing area, which allows a vehicle exiting the lift or hoist to pass a vehicle waiting to enter, shall be determined based on site conditions and the frontage road type. A passing area should be provided where the frontage road is an arterial road.

NOTE 1: See Clause 2.5.2(c) for design requirements for passing areas.

The capacity of the entry queuing area shall be designed to reduce the potential for queuing into a frontage road or circulation roadway.

NOTE 2: The queuing capacity may be calculated using analytical methods or computer software modelling.

NOTE 3: See Clause 3.3 for design requirements for queuing areas.

Lifts and hoists should be supported by an Operational Management Plan (OMP) detailing the method of use and methods to clearly display the operating rules and instructions in the vicinity of the lift/hoist.

6.7 Mechanical parking

6.7.1 Car stackers

Some car stacker systems may not be able to accommodate some vehicle heights or masses. This should be considered in the design of facilities utilizing car stackers.

6.7.1.1 User operated car stacker system

User operated systems shall only be used in Class 1 and 2 parking facilities.

The stacker/palette space shall have a minimum width of 2.7 m for each parking space.). The system shall provide an unimpeded non-slip walkway between the aisle and the driver's door.

NOTE: The driver's door is the side on which this is provided and will depend on whether the space has been designed as forward-in or reverse-in.

6.7.1.2 Fully automated car stacker system

The vehicle storage areas of a fully automated car stacker system should accommodate the B99 vehicle.

The area where the occupants enter or exit the vehicle shall be designed to meet the minimum dimensional requirements of Clause 6.5.2 and shall have a gradient in accordance with Clause 4.1.1.

6.7.2 Turntables

Turntables shall only be used in Class 1 or Class 2 facilities. The turntable shall have a minimum diameter of 4.6m.

The turntable shall be located in the centre of a turning area. The turning area shall have a minimum diameter of 6.8 m clear of any obstructions greater than 150 mm high as measured from the centre of the turntable.

NOTE 1: These dimensions are based on a 360 ° turn for a B99 vehicle with a 300 mm clearance to any obstruction.

NOTE 2: Manoeuvring of vehicles driving onto, rotating and leaving the turntable should be checked using vehicle manoeuvring software. The turntable shall have a gradient in accordance with Clause 4.1.1.

Appendix A (informative)

A.1 Design vehicle characteristics and dimensions

A.1.1 A.1 Scope

This appendix provides data on design vehicle characteristics and dimensions on which the base dimensions given in Appendix B have been determined and subsequently developed into design criteria. The base dimensions are considered to apply to both Australia and New Zealand.

NOTE: This appendix is based on a study of the New South Wales, Queensland, and New Zealand motor vehicle fleets. It is presumed that the characteristics of the motor vehicle fleet in other Australian states would be substantially the same.

A.2 Study of vehicle dimensions

A study has been made of the significant characteristics of all sedans, station wagons and light commercial vehicles that operate on New South Wales and New Zealand roads. The light commercial vehicle category was included because it contained a significant number of four- wheel drive vehicles that are used primarily as passenger vehicles. Most other (but not all) light commercial vehicles that were included in the data, such as utilities and most vans, would still make regular use of car parking facilities.

Databases of all registered vehicles in New Zealand, and in New South Wales were obtained, along with earlier work undertaken in Queensland. All motorcycles, heavy vehicles, trailers, agricultural and special-purpose vehicles were removed from the databases leaving light vehicles such as cars and vans.

The primary dimensions of length, width, height, and wheelbase of most vehicles were obtained, either from proprietary source of manufacturer data or internet sources. Dimensions for others could not be reliably determined from the vehicle registration information. Dimensions do not include wing-mirrors, and do not include optional or after-market accessories and equipment such as roof-racks, roof-top cargo boxes, towbars, or bull-bars.

The 85^{th} percentile vehicle is defined as the vehicle which is larger than or equal to 85 % of the passenger and light commercial vehicles that operate on Australian and New Zealand roads.

Similarly, the 99.8^{th} percentile vehicle is defined as the vehicle which is larger than or equal to

99.8 % of the passenger and light commercial vehicles that operate on Australian roads. This analysis showed the current vehicle fleets are similar to the 2000 fleet analysed in the previous edition of this document at the 85^{th} percentile level, with the 85^{th} percentile length and width being within 1 % of previous dimensions.

The analysis showed there were significant increases in the length and width of the fleet for percentiles above the 85^{th} percentile. Upon inspection, this appeared to be driven by the increased popularity of longer vehicles such as double-cab utility vehicles, and by the inclusion of long-wheelbase vans in the fleet databases.

A.3 The B85 vehicle

The dimensions of the B85 Vehicle which have now been adopted for the purposes of this document are for a vehicle 4.9 m × 1.9 m overall. The full dimensions of the design vehicle are shown in Appendix B, Table B.1. These dimensions have been rounded slightly further than the previous edition of this document. The effective front and rear overhang dimensions for determining swept path have been determined by studying the dimensions of a small number of vehicles with dimensions close to the 85^{th} percentile.

The minimum turning circle diameter (kerb to kerb) for the B85 vehicle is 11.5 m. This is based on a maximum angle turned by the inner front wheel of 40 degrees. Some modern four-wheel drive wagons that are within the scope of the B85 vehicle have a slightly smaller maximum angle of turn (about 37.5 degrees) but are

accommodated by their slightly smaller wheelbase and/or width. The maximum angle of turn is applicable only to parking manoeuvres.

A.4 The B99 vehicle

The previous edition of this document defined the 99.8th percentile vehicle as the vehicle which is larger than or equal to 99.8 % of the passenger and light commercial vehicles that operate on Australian roads, and referred to that vehicle as the B99 vehicle.

Inspection of the database found that vehicles longer than the 99.0th percentile were almost exclusively longer wheelbase vans. While these vans can be used privately or domestically, they are predominantly used for the commercial carriage of freight or passengers. While such vehicles may need to access parts of a parking facility, it was considered unreasonable to use these vehicles as the basis for parking module dimensions. For that reason, this document has adopted the 99.0th percentile dimensions for the B99 vehicle.

The dimensions of the B99 vehicle which have been adopted for the purposes of this document are for a vehicle 5.4 m × 2.1 m overall. The full dimensions of the design vehicle are shown in Appendix B, Table B.1.

The B99 vehicle has increased in size from the B99 vehicle in previous editions of this document, despite the change from the 99.8th percentile to the 99.0th percentile.

The minimum turning circle diameter (kerb to kerb) for the B99 vehicle is 12.7 m. This is based on a maximum angle turned by the inner front wheel of 40 degrees. Some four-wheel drive wagons that are within the scope of the B99 vehicle have a smaller maximum angle of turn.

These vehicles are usually accommodated by their smaller wheelbase and/or width but some may have to turn in a confined space means of a three-point turn. The maximum angle of turn is applicable only to parking manoeuvres. Turns on circulating roadways and ramps should not have a radius less than 8 m so that the angle turned by the inner front wheel is less than 30 degrees.

A.5 Vans

The longest vehicles in the light vehicle databases were vans. Most vehicles used as passenger vehicles are less than 5.4 m in length. The most common vehicles that are longer than 5.4 m are vans and four-wheel drive vehicles including the Nissan Navara double cab utility vehicle at 5.6 m, the Ford Transit van with options ranging between 5.5 m and 6.7 m, and the Mercedes-Benz Sprinter van with options ranging between 5.9 m and 7.0 m.

Most vehicles that are commonly used as passenger vehicles have a height less than 2.3 m and most taller vehicles are vans. The most common vans with a height greater than 2.3 m the Ford Transit van with a range of heights from 2.5 m to 3.0 m.

Where larger vehicles including vans are expected to access the parking facility it is recommended that design of the access routes refer to AS 2890.2 for appropriate design vehicles where the SRV Small Rigid Vehicle would encompass the larger vans found in the light vehicle database.

A.6 Small vehicles

In previous editions of this document, the length of the 50th percentile vehicles in the Australian and New Zealand fleets were used as the basis for the small car space. The previous Australian 50th percentile vehicle length of 4.5 m and width of 1.7 m informed the minimum specified dimension for a small vehicle space (2.3 m × 5.0 m), and limited data from New Zealand giving a 50th percentile length of 4.2 m was considered to warrant a small car space length of 4.5m.

The 50th percentile dimensions are now larger with length of 4.6 m and width of 1.8 m leading to the retention of the previous small vehicle parking space dimensions of 2.3 m by 5.0 m.

A.7 Sources of data

The following lists the sources of data used in reaching the above conclusions:

(a) Database of 4.3 million light vehicles registered in New South Wales in October 2021 and dimensions obtained from vehicle data from proprietary sources, with 94 % of vehicles validated for statistical analysis

(b) Database of 4.2 million light vehicles registered in New Zealand in November 2020 and dimensions obtained from vehicle manufacturer and other internet sites with dimensions matched to 94 % of vehicles (98 % of vehicles first registered in 2000 or later)

(c) Database of 3.4 million vehicles from a study conducted by the Department of Transport and Main Roads Queensland.

A.8 Derivation of parking dimensions

A.8.1 Angle parking space design

Angle parking space widths are derived from the base dimensions of the B85 design vehicle by adding door opening widths to the base width. Different amounts of door opening are used to provide differing levels of service (i.e. ease of access into a vehicle) for various user classes. The minimum widths to provide door opening will also be sufficient to meet manoeuvring clearance requirements.

Table A.1 sets out the minimum overall space width to achieve various door openings.

Table A.1 Minimum space widths related to door openings (B85 vehicle)

Open door position	Space width (m)
Front door — first stop	2.4
All doors — full open	2.6

The angle parking space length of 5.6 m has been derived by adding a 0.2 m positioning tolerance to the length of the B99 vehicle.

A.8.2 Design of parking aisle for manoeuvring

Constant radius swept turning paths, based on the design vehicle's minimum turning circle, are not suitable for determining the aisle width needed for manoeuvring into and out of parking spaces. Drivers can manoeuvre vehicles within smaller spaces than swept turning paths would suggest. Wider parking spaces need a slightly smaller aisle width.

A field study involving vehicles similar to the B85 design vehicle with an experienced driver was therefore carried out to determine minimum aisle widths for a range of three parking space widths encompassing those in Table A.2.

The study involved marking parking spaces and parking vehicles in the centre of adjacent spaces so that the distance between adjacent vehicles was equal to the door opening needed. All vehicles were parked so that either the front or the rear extremity of the vehicle was located at the extremity of the space nearest the aisle, to provide for the worst situation. Similarly, vehicles were parked at the extremity of spaces on the opposite side of the aisle to simulate the minimum aisle width.

The aisle width was varied until the design vehicle could be parked in the space in one manoeuvre. Both drive-in and reverse-in manoeuvres were checked for each parking space/aisle combination.

The combination of parking space width and aisle widths needed for the parking manoeuvres is shown in Table A.2 based on a parking space length of 5.6 m.

NOTE: The figures in Table A.2 cannot be extrapolated to other space width/aisle width combinations.

The aisle width in Table A.2 may not allow for:

(a) requirements for circulating vehicles (see Clause A.4.5); or

(b) room to make a small radius turn into or out of a circulation roadway, from or to the end of the parking aisle.

Table A.2 Aisle widths for 90 degree angle-parking manoeuvres (B85 vehicle)

Nominated parking space width (m)	Base aisle width (m)	Minimum aisle width including manoeuvring clearance (2 × 300 mm) (m)
2.4	5.6	6.2
2.5	5.2	5.8
2.6	4.8	5.4 [a]

[a] This applies only to one-way aisles. This document requires aisles for 90 degree parking to be always two-way, i.e. 5.8 m wide, see Table 2.4. Note also that Table 2.4 provides for some greater aisle width and space width options than in this Table for some user classes.

A.8.3 Design of parking aisle for manoeuvring

Constant radius swept turning paths, based on the design vehicle's minimum turning circle, are not suitable for determining the aisle width needed for manoeuvring into and out of parking spaces. Drivers can manoeuvre vehicles within smaller spaces than swept turning paths would suggest. Wider parking spaces need a slightly smaller aisle width.

A field study involving vehicles similar to the B85 design vehicle with experienced driver was therefore carried out to determine minimum aisle widths for a range of three parking space widths encompassing those in Table A.3.

The study involved marking parking spaces, and parking vehicles in the centre of adjacent spaces so that the distance between adjacent vehicles was equal to the door opening needed. All vehicles were parked so that either the front or the rear extremity of the vehicle was located at the extremity of the space nearest the aisle, to provide for the worst situation. Similarly, vehicles were parked at the extremity of spaces on the opposite side of the aisle to simulate the minimum aisle width.

The aisle width was varied until the design vehicle could be parked in the space in one manoeuvre. Both drive-in and reverse-in manoeuvres were checked for each parking space/aisle combination.

The combination of parking space width and aisle widths needed for the parking manoeuvres is shown in Table A.2 based on a parking space length of 5.6 m.

NOTE: The figures in Table A.3 cannot be extrapolated to other space width/aisle width combinations.

The aisle width in Table A.3 may not allow for:

(a) requirements for circulating vehicles (see Clause B.4.5); or

(b) room to make a small radius turn into or out of a circulation roadway, from or to the end of the parking aisle.

Table A.3 Aisle widths for 90 degree angle-parking manoeuvres (B85 vehicle)

Nominated parking space width	Base aisle width (m)	Minimum aisle width including manoeuvring clearance

(m)		(2 × 300 mm) (m)
2.4	5.6	6.2
2.5	5.2	5.8
2.6	4.8	5.4 [a]

[a] This applies only to one-way aisles. A minimum width of 5.8 m is required for two-way aisles. . Note also that Table 2.4 provides for some greater aisle width and space width options than in this Table for some user classes.

A.8.4 Angle parking at other than 90 degrees

The field trials for the previous edition of this document also encompassed parking angles other than 90 degrees. Table A.4 shows as an example, the aisle widths that are needed for a parking space width of 2.5 m.

Table A.4 Base dimensions for angle parking other than 90 degrees

Parking angle degrees	Space width, (m)	Base aisle width, (m)	Aisle width including manoeuvring clearances (2 × 300 mm), (m)
30	2.5	2.2	2.8
45	2.5	3.1	3.7
60	2.5	4.0	4.6

Appendix B (normative)

B.1 Base dimensions and design standards

B.1.1 B.1 Scope

This appendix gives the derivation and specifies the use of base dimensions by indicating the clearances which are to be added to the base dimensions to create design standards.

B.2 The base dimension

B.2.1 General

The base dimension for the B99 and B85 vehicles referred to in this document are specified in Table B.1 and illustrated in Figure B1.

NOTE: These base dimensions have been developed from the vehicle survey in Appendix A.

Design dimensions are derived from these base dimensions by the incorporation of operating clearances. These clearances have been determined from various trials and allow for different levels of driver skill combined with other factors such as frequency of turnover, type of facility and clientele served. They are applicable to those dimensions in which the driver is required to make a judgment such as turning, manoeuvring and parking, or where slight variations in mechanical or structural attributes of vehicles require a safety margin to be allowed.

Table B.1 Design vehicle dimensions

	B85	**B99**
Track width [a]	1.8m	2.0m
Overall width	1.9m	2.1m
Front overhang	0.9m	0.9m
Wheel base	2.9m	3.2m
Rear overhang	1.2m	1.3m
Overall length	4.9m	5.4m
Corner rounding – front	170 mm	150mm
Corner rounding - rear	90 mm	50mm
Height	1.8m	2.2m
Ground clearance [b]	120mm	120mm
Maximum approach angle	10 degrees	10 degrees
Maximum departure angle	10 degrees	10 degrees
Minimum turning radius (kerb to kerb)	5.8m	6.35m

[a] Track width is measured between the outer side of the tyres.

[b] Some vehicles, such as sports cars, may have less ground clearance. Where lower vehicles are expected, the ground clearance should be reduced to 100 mm.

Dimensions in millimetres

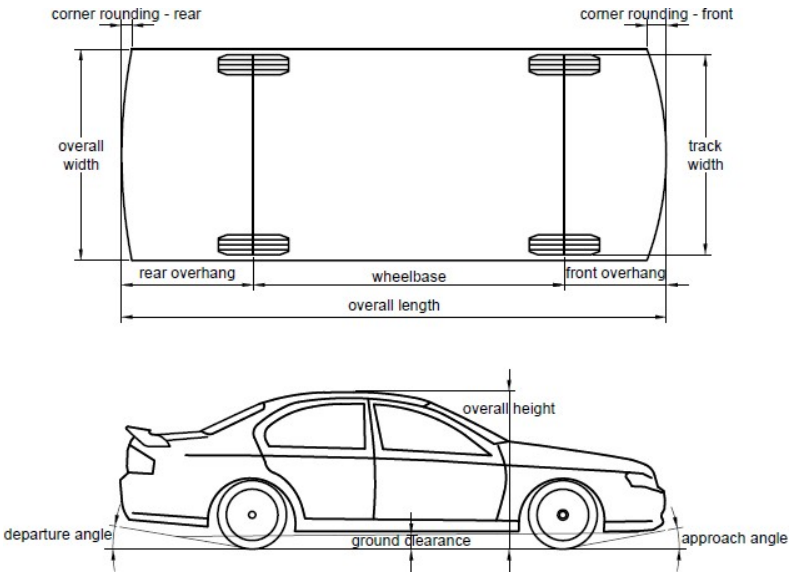


Figure B.1 Vehicle dimensions

B.2.2 The B99 vehicle

Dimensions in millimetres

Design dimensions based on the B99 vehicle shall be used at all locations where failure of a vehicle to be able to physically fit into the facility would occasion congestion and possible hazard.

NOTE: Such locations include all access driveways, ramps and circulation roadways.

B.2.3 The B85 vehicle

Design dimensions based on the B85 vehicle shall be limited to manoeuvring in parking spaces and parking aisles. Design dimensions for access driveways, ramps, and circulation driveways shall not be based on the B85 vehicle except as permitted in Clause 2.5.2(c).

NOTE: This is based on the philosophy that the statistical chance of two or more larger vehicles seeking to occupy adjacent parking spaces at the one time is relatively low, and where this does occur, a driver can divert to an alternative space with only minor disruption to other users.

B.3 Design vehicle turning paths

B.3.1 General

Swept paths shall be used to check that the paths of vehicles travelling in the forward direction are able to be accommodated when negotiating access driveways, ramps, and circulation roadways.

Swept paths shall also be used to check the movement in and out of parking spaces in constrained situations including spaces in small parking facilities and small aisles, and spaces located at the end of a row closest to a circulation roadway.

The production of suitable swept paths relies on accurate vehicle characteristics and a scale base plan. The swept paths for B85 and B99 design vehicles shall be in accordance with the vehicle data shown in Table B.1 and Table B.2.

Table B.2 Minimum Steering Lock-to-Lock Time

User Class	Minimum steering lock-to-lock time (seconds)
1	2
2	3
3	4
4	4
5	4

NOTE 1: Shorter lock-to-lock times are used to allow for tighter turning for user classes involving lower turn-over and improved driver familiarity.

NOTE 2: Shorter lock-to-lock times may be used at the start of each movement when accessing a car parking space.

B.3.2 Swept path clearances

Clearances shall be added to swept path of the vehicle body to provide the required design standard as follows:

(a) *Manoeuvring clearance* — To cater for slow moving vehicles travelling within parking aisles or manoeuvring into parking spaces, i.e. at 10 km/h or less, a clearance of 300 mm shall be added to *both* sides of the turning path. Where two vehicles pass, the clearance between them shall be a minimum of 600 mm.

(b) *Circulation clearance* — For circulating vehicles travelling at speeds higher than 10 km/h, i.e. those travelling on access roadways, ramps, circulation roadways and circulation aisles, a further clearance of 300 mm shall be added to one side only for curves with an outside radius of 20 m or less. For an outside radius between 20 m and 50 m the further clearance shall be 200 mm. No further clearance is required for curves with an outside radius greater than 50 m.

NOTE: Clearances provide space between a vehicle and the edge of the carriageway or other obstruction, allow for wing mirrors, allow for some variation between real vehicles and the design vehicle, and allow for variation between drivers.

B.3.3 Swept path speed

The design speed of a swept path in a manoeuvring area and parking space shall be no less than 5km/h.

The design speed of a swept path in access driveways and, circulation roadways shall be in accordance with Table B.3.

Table B.3 Design speed vs turn radius

Turn radius (m)	Minimum turn speed (km/h)
5.8 to 8	5
8 to 12	10
12 to 20	20
Over 20	30

Appendix C (informative)

C.1 Suggested method of checking vertical alignment for adequacy of ground clearance and overhead clearance

C.1.1 C.1 Scope

This appendix provides a suggested procedure for checking the vertical alignment in a manoeuvring or circulation area for adequacy of ground clearance and overhead clearance.

C.2 Principle

A longitudinal section of the vehicle path is drawn to a suitable scale (e.g. 1 to 50 or similar) and a diagram representing the elevation of the design vehicle is applied to the longitudinal section to establish if there will be adequate clearance above and below the vehicle.

Computer software providing vertical alignment checks for ground clearance and overhead clearance are available and are the recommended method for checking vertical alignment.

C.3 Procedure using computer software

The following procedure should be undertaken using CAD software or specialist vehicle tracking software:

(a) Prepare a longitudinal section along the vehicle path. On sharp curves or elsewhere where the slope of the crossfall along the vehicle path varies noticeably, it is advisable to check longitudinal sections of the paths of the vehicle wheels as well as the centreline.

(b) Prepare the relevant CAD model to match the design vehicle dimensions given in Table B.1 and apply it to the longitudinal section by moving it progressively along the profile and checking for points where the clearance becomes inadequate.

C.4 Manual procedure

Ground clearance diagrams representative of the design vehicles specified in this document are given in Figure C.1. These templates provide for a minimum ground clearance of 120 mm. Where it is desired to provide for a lesser clearance (see Table B.1), the template should be adjusted by lowering the level of the underside of the vehicle.

NOTE 1: Similar templates can be drawn to the dimensions of the design vehicles to check for vertical clearance to overhead obstructions.

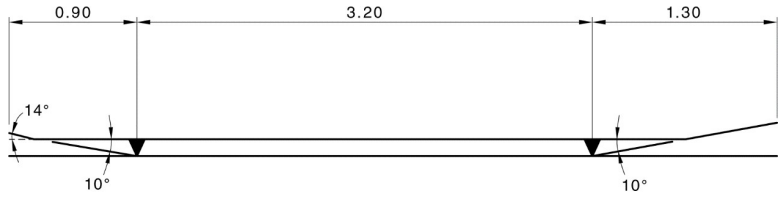
The templates should be used as follows:

(a) Prepare a longitudinal section of the grade change or irregularity to natural scale, and to the same scale as the template.

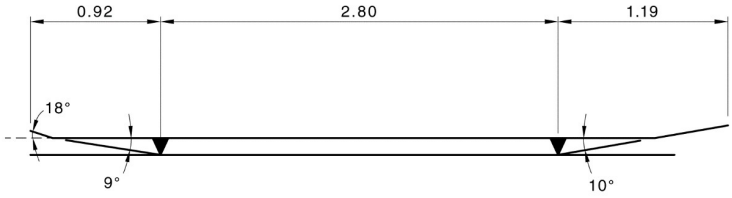
(b) Apply the template to the longitudinal section plot so that the two triangles representing the vehicle wheels sit on the plot. Move the template back and forth along the plot, ensuring that the line, representing the underside of the design vehicle, does not fall below the plot at any point.

NOTE 2: It will normally be necessary to photocopy Figure C.1 onto transparent film.

Dimensions in millimetres



(a) B99 Vehicle — for use in all cases except domestic driveways



(b) B85 Vehicle — for domestic driveways only

Figure C.1 Ground clearance templates

Appendix D (informative)

D.1 Capacity provision at entry and exits at large car parks

Large car parks operate most efficiently if they are planned in such a way that they operate in units of up to approximately 500 cars. Entry and exit points should be designed so that the facility can be adequately serviced in the peak period of the car park.

The number of entry and exit lanes needed in a large car park will depend on the following:

(a) The total number of peak hour vehicle movements, estimated from the total number of parking spaces in the car park multiplied by the mean expected turnover per parking space.

(b) The proposed number of entry/exit locations.

(c) The vehicular capacity of the lanes at the entry/exit point (see below).

(d) Any additional lanes needed to meet capacity requirements at the access driveway/frontage road intersection.

In the absence of alternatively researched data, the following maximum lane capacities should be used in determining the number of entry or exit lanes needed:

(i) Entry point —

(A) free flow — 600 vehicles/hour/lane;

(B) number plate recognition (without entry boom gate) – 600 vehicles / hour / lane;

(C) number plate recognition (with entry boom gate) – 450 vehicles / hour / lane;

(D) card reader — 400 vehicles/hour/lane;

(E) automatic ticket issue and boom gate — 300 vehicles/hour/lane;

(F) manually controlled — 250 vehicles/hour/lane.

(ii) Exit point —

(A) free flow — 600 vehicles/hour/lane;

(B) number plate recognition (with exit boom gate control) – 450 vehicles / hour / lane

(C) ticket or token acceptance unit and boom gate — 300 vehicles/hour/lane;

(D) cashier controlled — 200 to 250 vehicles/hour/lane, depending on the parking fee structure.

Locations where high-volume entry and exit points join frontage roads, i.e. generally, driveways or intersections in Categories 3 to 5, should be analysed to ensure that traffic operating characteristics are satisfactory. In particular, unsignallized driveways and intersections should be checked to ensure that the absorption capacity for traffic entering or crossing the frontage road stream is adequate during times of peak activity. Likewise, the capacity of signallized intersections should be checked using accepted techniques.

NOTE: For further information regarding accepted techniques, refer to Austroads Guide to Traffic Management Part 3.

Appendix E (informative)

E.1 Visibility splays between driveways and paths

E.1.1 E.1 General

Vehicles entering and leaving a carpark via a driveway that crosses a path (footpath or shared path) need to give way to path users. It is important that sight distance (visibility splay) is provided along the path so both the driver and the path user can see each other and assess if it safe to proceed.

Path users include pedestrians and people using other faster moving devices such as skateboards, scooters, and powered mobility devices.

The splay requirements in Table 3.4 are based on the travel speeds of these users in a range of different path characteristics such as path width and frequency of intersecting streets which can influence path user speed.

Table 3.4 and the supporting figure is intended to provide minimum clear sight lines for a driver about to exit a carpark and cross a path, to judge whether they can do so without conflict with a path user. The following should be noted:

(a) The sight distance (X) is measured from the from the nearest edge of the path towards the property.

(b) The distance along the driveway (X) provides the driver approaching the path at a very low speed (5km/hr or less) time to see an oncoming path user and stop to avoid a crash.

(c) The distance along the path (Y) is measured from the centreline of each exit lane where it crosses the path and is the safe stopping distance for path users.

(d) The path distance (Y) values in the table take into account path user speed in a range of environments.

(e) While the sight distances also provide path users opportunity to take evasive action if the vehicle does not give way, some path users such as young children and those with vision or hearing impairment or cognitive difficulties may not be able to do so.

E.2 Sight distances

The sight distances are derived as follows:

$$X, Y = V^2/(254*(f+(G/100))) + RTV/3.6$$

[SOURCE: Austroads Guide to Road Design: Part 4a signallised and unsignallized intersections (2021) and Part 6 a: Paths for walking and cycling (2021)]

Where:

X = sight distance along the driveway
Y = distance along the path

V = speed (km/h)

f = friction coefficient
G = gradient (%)

RT = reaction time (s)

Table E.1 Sight distance parameters

Parameter		To calculate X	To calculate Y
V	Speed km/h	Speed of vehicle exiting driveway	Speed of path user

f (Note 1)	Friction coefficient	0.36	0.16
G (Note 2)	Gradient (%)	Gradient of driveway over 4m length prior to path	Gradient of path over 8m distance prior to driveway
RT (Note 3)	Reaction time (s)	1.5	1.5

NOTE 1: These values assume a wet hard surface such as asphalt or textured concrete. Lower values should be used for surfaces with poorer surface friction.

NOTE 2: Use zero for flat grades. Surfaces sloping up to the driveway path crossing have positive gradient.

NOTE 3: These reaction times are suitable for alert vehicle drivers and path users in most urban environments. Rural environments or paths frequently used by young children or older persons should use a reaction time of 2.0s.

It is important that the vehicle in position X is travelling at or below 5km/h as this allows the vehicle to safely stop before entering the path. The following design factors should be considered:

(a) The driveway should be narrow to encourage slow speeds

(b) The driveway crossing should be designed with the footpath continuous across the driveway so it is not confused with an intersection,

(c) Parking on the driveway side of the road may need to be restricted so the driver of a vehicle entering the parking facility from the road can see path users

(d) Different values for surface friction (f); gradient (G), Reaction time (Rt) and path user speed may be used to take into account local conditions.

NOTE: For further background information regarding sightlines, refer to *Guideline: Treatment options to improve safety of pedestrians bicycle riders and other path users at driveways*.

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