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Cross Sections and Headroom

DN-GEO-03036
May 2019

DN Design

Standards

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Updates to TII Publications resulting in changes to

Cross Sections and Headroom DN-GEO-03036

Date: May 2019

Amendment Details:

This document supersedes DN-GEO-03036 published in June 2017. The principle changes in this revised document are as follows:

a) Additional content has been added to Sections 2 and 3 detailing the requirements for applying the Principles of Forgiving Roadsides when designing the road cross section. This includes details of the required Clear Zones to be achieved and methods for achieving these through various approaches.

b) Clear Zone requirements for roads with Design Speeds less than 85kph are included in Section 3.4.

c) Section 4.7 has been updated to include the requirement that piers for overbridges are not permitted within the central reserve of Type 2 or Type 3 Dual Carriageways.

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1. Introduction

1.1 General

This Standard outlines the design principles and factors which shall be considered by Designers in selecting road cross-sections and headroom clearances. The process of design is described together with an approach to developing options. It highlights the Principles of Forgiving Roadsides as a key component for designing a cross section.

1.2 Scope

This Standard gives details of the cross-sections and headroom clearances to be used for all-purpose roads and motorways, both on open roads and at structures.

The information covers rural motorways, rural all-purpose roads, urban motorways, urban all-purpose dual carriageways and urban relief roads, together with associated connector roads. Urban Street cross sections should be designed in accordance with the Design Manual for Urban Roads and Streets. The approaches to urban areas on national roads shall be designed in accordance with DN-GEO-03084 The Treatment of Transition Zones to Towns and Villages on National Roads.

This Standard is not applicable to road tunnels.

For details of pedestrian and pedal cycle subway layouts and dimensions see DN-GEO-03040, and for footbridge design criteria see DN-STR-03005.

1.3 Implementation

This Standard shall be used forthwith on all schemes for the construction and/or improvement of National Roads. Where the scheme has received, prior to publication of this Standard, its statutory approvals to allow it to proceed, and the implementation of this Standard would lead to additional land take requirements, a Departure from Standards may be sought for the use of the previous version of the Standard.

In support of this Standard, where minor improvements are proposed to existing roads, Designers are directed to DN-GEO-03030 Guidance on Minor Improvements to National Roads.

Information is also provided in this Standard on its application to regional and local roads diverted or improved on-line as part of a National Road scheme.

1.4 Definitions

Particular terms used in this Standard are defined as follows:

a) **All-purpose road**: A road for the use of all classes of traffic (e.g. not a Motorway).

b) **Motorway**: A divided multi-lane road as defined in Section 43 of the Roads Act.

c) National, Regional, Local & Public Roads:

   i. A **National Road** is a public road or a proposed public road which is classified or is intended to be classified as a national road under Section 10 of the Road Act (1993).

ii. A **Regional Road** is a public road or a proposed public road which is classified or is intended to be classified as a regional road under Section 10 of the Road Act (1993).

iii. A **Local Road** is a public road or a proposed public road other than a national road or a regional road.

iv. A **Public Road** is a road over which a public right of way exists (or will exist in the case of a proposed public road) and the responsibility for the maintenance of which lies with the Road Authority.

d) **Rural Cycle Scheme Design**: The design associated with the construction of cycle facilities in a rural area.

e) **Cycle Facilities**: Refers to all types of measures which improve conditions for cyclists and include:

i. **Cycleways**: a public road or proposed public road reserved for the exclusive use of cyclists or cyclists and pedestrians.

ii. **Cycle Track**: Part of a road, including part of a footway or part of a roadway, which is reserved for the use of pedal cycles and from which all mechanically propelled vehicles, other than mechanically propelled wheelchairs, are prohibited from entering except for the purpose of access.

iii. **Cycle Lane**: part of the carriageway of a road reserved primarily for use by cyclists. The cycle lane forms part of the road and it is located within the contiguous road surface. A cycle lane can also be referred to as an on-road cycle track.

iv. **Shared Use Cycle and Pedestrian Facilities**: A Cycle Track or Cycleway that is provided for both cycle and pedestrian use.

v. **Shared roads with Motor Vehicles**: A road under low speed/low vehicular traffic flow conditions that is also provided for both cycle and pedestrian use.

vi. **Greenway**: A Cycleway that caters for pedestrian and cyclists in a recreational environment

vii. **Cycle Network**: is a defined collection of routes which connect key origins and destinations in a specified area for cyclists.

f) **Rural Road**: A road outside of built-up areas including:

i. Single Carriageway roads;

ii. All-purpose Dual Carriageway roads; or

iii. Motorways.

g) **Urban Road**: A road within a built-up area.

h) **Urban Motorway**: A motorway constructed in a built-up area.

i) **Urban Street**: A road within a built-up area where the primary purpose of the road is to provide direct access to premises.

j) **Urban Relief Road**: An urban road where the primary purpose of the road is to facilitate the movement of traffic and avoid congestion or other obstacles to movement.

k) **Bridge Length**: Is the length of bridge parapet.

l) **Bridleway**: Road (surfaced or unsurfaced) for use on foot or horseback.

m) **Central reserve**: The area which separates the carriageways of a dual carriageway or Motorway. Note that this includes any offside hard strips.

n) **Clear Zone**: The Clear Zone is the total width of traversable land on the nearside or offside which is to be kept clear of unprotected hazards. This width is available for use by errant vehicles. The zone is measured from the nearest edge of the trafficked lane: i.e. the hard shoulder or hard strip forms part of the Clear Zone.

o) **Connector Road**: A collective term for slip roads, link roads, interchange links and loop roads.

p) **Cross-section**: The road cross-section incorporates all elements between the boundaries including carriageways, the central reserve, separation zones, hard shoulders, hard strips, verges including any footway, cycle track or bridleway, fences, barriers, cutting or embankment slopes, berms and maintenance strip. All dimensions are measured square to the line of the road (see Tables 4.1 to 4.6).

q) **Designer**: The organisation responsible for undertaking and/or certifying the design.

r) **Designated Lane**: A lane reserved exclusively for the use by designated vehicles such as cycles, buses and taxis.

s) **People with Disabilities**: Includes individuals with mobility, sight, comprehension or hearing impairment, the ageing population and people with temporary injuries. Includes users of wheelchairs (manual and electric) as well as users of motorised mobility scooters.

t) **Express Road**: An Express Road is a legal category of road designed for motor traffic, which is accessible primarily from interchanges or controlled junctions and which:

   i. prohibits stopping and parking on the running carriageway; and

   ii. does not cross at grade with any railway or tramway track.

u) **Footpath:** A path for use by pedestrians which does not form part of a road.

v) **Footway**: That portion of any road which is provided for use by pedestrians.

w) **Hardened Verge**: An area of the verge set aside for emergency or maintenance situations for vehicles to stand or park. The surface should be sufficiently strengthened to support vehicles.

x) **Headroom**: The minimum distance between surface and structure as defined in Paragraph 6.1.

y) **Interchange**: A grade separated junction that provides free flow of traffic from one mainline carriageway to another. Refer to DN-GEO-03060.

z) **Interchange Link**: A connector road, one or two-way, carrying free flowing traffic within an interchange.

aa) **Loops**: A connector road, one or two-way, which is made up of the elements of the loops shown in DN-GEO-03060 and which passes through an angle in the range of approximately 180 to 270 degrees. The loop is considered to extend to the end of the near straight length of road contiguous with the back of the diverge or merge nose.

bb) **Mainline**: The carriageway carrying the main flow of traffic (generally traffic passing through a junction or interchange).

cc) **Maintaining Organisation**: The organisation which will be responsible for the maintenance of the road after construction.

dd) **Maintained Headroom**: The minimum headroom which shall be available at all times during the road's operation.

ee) **Maintenance strip**: The strip of land between the top of cutting or toe of embankment and the road boundary, also known as the work space or work space strip.

ff) **Nearside**: Left-hand side of vehicle when viewing a forward moving vehicle from behind: typically, the front-seat passenger side of the vehicle in Ireland.

gg) **New Construction Headroom**: The headroom which includes an allowance for resurfacing that is available at the commencement of the road's operation.

hh) **Non-Motorised Users (NMUs)**: Pedestrians, cyclists and equestrians, including people with disabilities (see definition of 'People with Disabilities') and other mobility impaired users (e.g. people with luggage, with children, or pregnant women).

ii) **Offside**: Right-hand side of vehicle when viewing a forward moving vehicle from behind: typically, the driver's side of the vehicle in Ireland.

jj) **Overbridge**: A bridge that spans the road under consideration.

kk) **Pedestrian Access Provision**: That part of the verge on all-purpose roads provided to enable pedestrian movement through or over a structure.

ll) **Road Authority**: The authority responsible for the road construction or improvement scheme.

mm) **Road Tunnel**: A road enclosed for a length of 150m or more. A shorter enclosed length is an overbridge. Refer to DN-STR-03001.

nn) **Separator Zone**: An area that separates traffic flows on the mainline from an adjacent parallel road, e.g. link road.

oo) **Slip Road**: A connector road within a junction between a mainline carriageway and the local road network, or vice versa, which meets the local road network at-grade. Traffic using a slip road usually has to yield to traffic already on the mainline or on the local road network.

pp) **Subway**: Underground passageway or tunnel for use by pedestrians, cyclists and equestrians.

qq) **Type 1 Dual Carriageway**: A divided all-purpose road with a minimum of two lanes and hard shoulder in each direction constructed to the geometric standards of DN-GEO-03031 and CC-SCD-00006.

rr) **Type 2 Dual Carriageway**: A divided all-purpose road with two lanes and hard strip in each direction constructed to the geometric standards of DN-GEO-03031 and CC-SCD-00005.

ss) **Type 3 Dual Carriageway**: A divided all-purpose road with two lanes in one direction of travel and one lane in the other direction, constructed to the geometric standards of DN-GEO-03031 and CC-SCD-00004. The two-lane section alternates with a one-lane section at intervals of 2km approximately.

tt) **Type 1 Single Carriageway**: An all-purpose road with a 3.65m lane in each direction constructed to the geometric standards of DN-GEO-03031 and CC-SCD-00001.

uu) **Type 2 Single Carriageway**: An all-purpose road with a 3.50m lane in each direction constructed to the geometric standards of DN-GEO-03031 and CC-SCD-00002.

vv) **Type 3 Single Carriageway**: An all-purpose road with a 3.00m lane in each direction constructed to the geometric standards of DN-GEO-03031 and CC-SCD-00003.

ww) **Underbridge**: A bridge that carries the road under consideration.

xx) **Verge**: The part of a road cross-section alongside a carriageway but not including embankment or cutting slopes. Note that this includes hard strips but not hard shoulders.

1.5 Relaxations and Departures

The standards contained in this document represent the cross-sections and headroom whose incorporation in the design would achieve a desirable level of performance in average conditions in terms of traffic safety, operation, economic and environmental effects and sustainability. At some locations on new roads or major improvements, however, it may not be possible to justify even the lowest levels of design parameters in economic or environmental terms, due to high costs, low traffic levels, and environmental damage, etc. In such cases, sufficient advantages might justify either a Relaxation within the standards or, in more constrained locations, a Departure from the standards. Relaxations and Departures should be assessed in terms of their effects on the economic worth of the scheme, the environment, and the safety of the road user. Further information in relation to Departures and Relaxations, including the process for submitting an application for a Departure from Standard can be found in GE-GEN-01005.

1.5.1 Relaxations within Standard

In difficult circumstances, the Designer may relax a standard set out in this document, where specifically provided for within the text. Refer to DN-GEO-03031 for permitted Relaxations and combinations of Relaxations. The Designer shall record the fact that a Relaxation has been used in the design and the corresponding reasons for its use. The record shall be endorsed by the Designer's senior engineer responsible for the scheme. The Designer shall report all Relaxations incorporated into the design as part of the project report at the end of each project management phase (refer to the TII Project Management Guidelines, PE-PMG-02041).

1.5.2 Departures from Standard

In exceptional situations, TII may be prepared to agree to a Departure from Standard where the standard, including permitted Relaxations, is not realistically achievable. Designers faced by such situations and wishing to consider pursuing this course shall discuss any such option at an early stage in design with TII. Proposals to adopt Departures from Standards must be submitted by the Designer to TII and formal approval received BEFORE incorporation into a design layout.

2. Forgiving Roadsides

2.1 General

This chapter provides details on the application of Forgiving Roadsides, the principles of which may have a significant impact on the road cross section to be adopted and on the safety and operation of the proposed road in service. It shall be read in conjunction Chapter 3 Design Principles.

2.2 Principles of Forgiving Roadsides

The verge width on either side of the paved area may be a factor affecting the severity of collisions where errant vehicles run off the carriageway. With the implementation of appropriate treatment measures to mitigate against hazards, roadsides can be made more forgiving in the event of loss of control incidents, thereby reducing the number of fatalities and serious injuries. Consideration shall be given to roadside hazards and the provision of a Clear Zone as discussed in Section 3.4 at an early stage in the scheme development to decrease the need for VRS and create a more Forgiving Roadside.

Designers shall therefore endeavour to provide a hazard free verge and roadside area which can allow errant drivers to regain control of their vehicles and safely bring their vehicle to a halt within the Clear Zone or to safely re-join the carriageway.

It is key that proper consideration be given to providing a Forgiving Roadside from the initial stages of any road scheme. In doing so, the need for the installation of Vehicle Restraint Systems (VRS) to protect form roadside hazards can be reduced. This is beneficial from a road safety point of view as although VRS are tested to achieve particular performance criteria, they can still be hazardous to errant road users.

The range of possible treatments to provide a more Forgiving Roadside has been categorised and should be implemented in order of preference as follows:

1. Mitigation of hazards through the removal or relocation of any obstacle to provide an adequate Clear Zone width;
2. Modifying road layout or roadside elements to provide a passive roadside where the removal or relocation of hazards cannot be reasonably achieved;
3. Shielding obstacles through the use of a VRS where mitigation or modification measures cannot be reasonably implemented.

In situations where hazard mitigation or modification cannot be reasonably achieved when considered in conjunction with economic, environmental and engineering constraints, through techniques such as those described in Sections 2.4 and 2.5, the provision of a VRS can be warranted. The Designer shall consider the lifetime cost of providing a VRS versus the cost of mitigation/ modification measures. While the initial cost of such measures may be higher than the installation of a VRS, the whole life costing of a VRS solution should be taken into account. To assist with this process, the SAVeRS tool can be used to provide an estimate of the whole life costing of a VRS including construction, maintenance and repair costs of the system, plus potential injury costs based on the predicted crash rate calculated. The SAVeRS tool, guideline document and user manual can be downloaded from the Downloads section of the TII Publications website.

2.3 Roadside Hazards

A roadside hazard is any physical obstruction which may, in the event of an errant vehicle leaving the carriageway, cause harm to the occupants of the vehicle in the event of a collision.

Full details and guidance on what constitutes a hazard, along with the ranking of hazards is provided in DN-REQ-03034 The Design of Road Restraint Systems (Vehicle and Pedestrian) for Roads and Bridges.

2.3.1 Categories of Roadside Hazards

The general categories of roadside hazards include but are not limited to the type and examples included in the following sub-sections. When reviewing all potential hazards in a design, the Designer shall consider the long-term implications of the hazard e.g. for planting of trees, the mature tree size shall be considered rather than the planted tree size.

2.3.1.1 Single Fixed Objects / Point Hazard

- Sign supports
- Lighting columns
- Trees
- Culvert ends / headwalls
- Substandard VRS ends
- Bridge abutments
- Bridge piers

2.3.1.2 Continuous / Linear Hazards

- Embankments and slopes
- Rock cuts / retaining walls
- Other roads
- Railway lines
- Central reserves
- Water hazards / ditches
- Rows of trees
- Non-passively safe fencing
- Non-conforming VRS

2.3.1.3 Special Considerations

In addition to those listed above, several other conditions may require special consideration:

- Locations with high collision histories
- Locations with regular pedestrian and bicycle usage
- Playgrounds, monuments, and other locations with high social or economic value

2.3.2 Earthworks Slopes

A cut slope steeper than 1:2 as shown in Figure 2.1 is considered a hazard. Embankment Slopes where the slope is steeper than 1:3 and the height of the embankment is greater than 0.5m, or where slopes are within the range of 1:3 to 1:5 but the embankment height is ≥ 6m as shown in Figure 2.2 are also considered hazards.

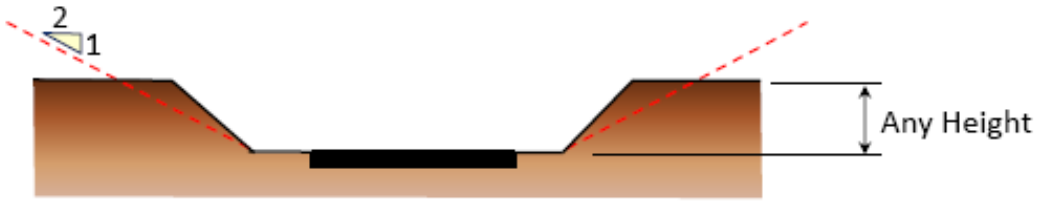


Figure 2.1 Cut Slopes

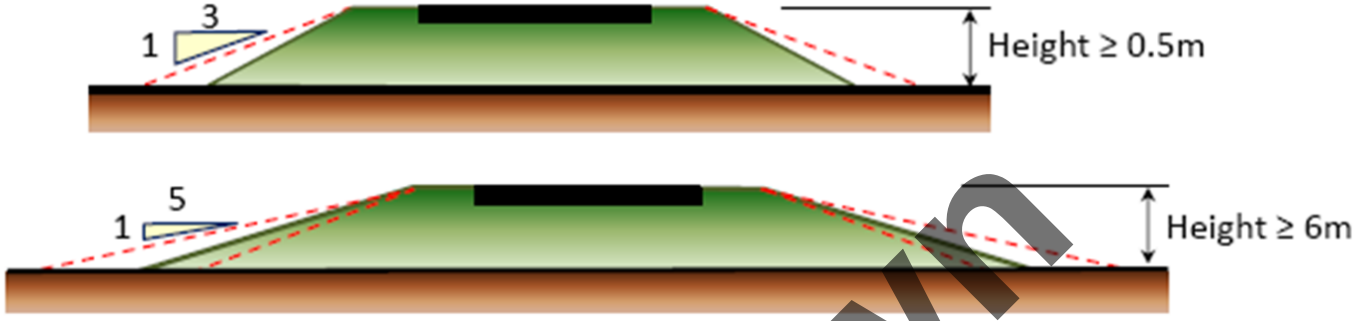


Figure 2.2 Embankment Slopes

2.4 Mitigation of Hazards

Hazards located within the Clear Zone, as described in Section 3.4, should be mitigated where it is deemed practical to do so when assessed in conjunction with economic, environmental and engineering considerations. Where this is not deemed practical, provision of a VRS to protect from hazards within the Clear Zone may be necessary. In some situations, it may be necessary to provide a VRS to protect a particularly high-risk hazard outside the Clear Zone.

Hazard mitigation measures shall be considered by the Designer prior to designing a VRS. A VRS shall only be introduced if the hazard cannot be mitigated as it will itself present a hazard to errant vehicles and occupants. The mitigation measures for hazards within the Clear Zone are listed below in order of preference:

a) Remove;

b) Relocate;

c) Re-design the hazard to reduce the risk to road users (e.g. introducing a passively safe sign post);

d) Revise the road layout or cross-section to lower the risk (e.g. verge widening, improve the road alignment, etc.);

e) Reduce impact severity (e.g. by using a forgiving feature or by setting a culvert flush with the existing ground);

f) Provide a suitable VRS.

Delineation and signage may be considered as treatments if the mitigation measures listed above are deemed inappropriate for a particular location. Whilst these treatments can alert a driver to roadside hazards, they will not protect an errant vehicle from a roadside hazard and hence should be used with caution. They may be appropriate solutions for urban scenarios, low speed environments or where limited space is an issue. Further guidance is included within DN-REQ-03079, Design of Road Restraint Systems for Constrained Locations (Online Improvements, Retrofitting and Urban Settings).

2.4.1 Hazard Mitigation at Junctions

Specific consideration shall be given early in the design to hazards located in close proximity to a junction.

The Designer shall consider relocation of introduced hazards such as signs or lighting columns, away from junctions or slip roads if deemed practical to avoid the need for VRS. Provision of a suitable VRS at a hazard located close to a junction can be problematic. The barrier's performance can be influenced by the constraints presented by the junction e.g. a tight radius barrier around a bend at the junction may not perform as tested or a lack of space for suitable termination of a barrier at a diverge slip road. If mitigation or modification cannot be achieved when considered in line with economic, environmental and engineering constraints, the Designer shall endeavor to design a road layout, and ensure there is sufficient land take, that can facilitate a fully compliant VRS.

2.5 Modification of Roadside Elements

In some cases, it is not possible to remove hazardous obstacles from the Clear Zone. In such circumstances, the designer shall consider modifying single and continuous hazards to minimise the risk of personal injury and property damage in the event of a collision. Examples of suitable modifications may include:

a) Forgiving devices;

b) Suitable drainage ditch and embankment/ cutting slope treatments;

c) Forgiving masonry structures;

d) Shoulder modifications;

e) Modification of retaining walls and rock cuts.

In modifying road elements, the Designer shall consider whether any such proposed mitigations require a Departure from Standard.

2.6 Shielding of Roadside Hazards through Installation of VRS

Where mitigation or modification measures are not deemed feasible for the treatment of hazards in the Clear Zone when considered in line with economic, environmental and engineering constraints, and the risk to road users remains, it will be necessary to provide a VRS in accordance with DN-REQ-03034 The Design of Road Restraint Systems (Vehicle and Pedestrian) for Roads and Bridge or DN-REQ-03079 Design of Road Restraint Systems for Constrained Locations (Online Improvements, Retrofitting and Urban Settings). Justification for the installation of a VRS shall be recorded by the Designer in accordance with the VRS Justification template included in Appendix C of DN-REQ-03034.

2.7 Life Cycle Cost Analysis

When assessing measures required to implement a forgiving roadside it is important to consider the whole life cycle cost analysis of the scheme. While the initial cost of mitigation measures may be higher than shielding a hazard through the installation of a VRS, e.g. purchasing additional land to allow removal of the hazard from the Clear Zone, the whole life costing of a VRS solution should be considered when carrying out the cost benefit analysis.

The SAVeRS (Selection of Appropriate Vehicle Restraint System) tool can be used as part of this justification process. The tool was developed as part of the CEDR Call 2012 (Refer to DN-REQ-03079 for a worked example). It is a spreadsheet-based tool whichallows the Designer to:

- Assess the lifetime cost of VRS on a scheme.
- Select the most appropriate VRS to be installed.
- Justify up front mitigation costs which would allow for the removal of the need for a VRS.

The SAVeRS tool, guideline document and user manual are available for download from the 'Downloads' Section of the TII publications website.

3. Design Principles

3.1 General

This chapter describes the principles to be followed when designing the road cross-section and headroom for new and improved all-purpose roads and motorways. The underlying principle is that Designers are given the maximum choice, so that there is flexibility to develop layout options that will meet TII requirements.

When choosing the appropriate cross-section and headroom, the Designer should balance considerations of safety, environmental impact, sustainability, economic impacts, buildability of the road elements, operation and maintenance.

Recent studies have shown that approximately 30 per cent of fatal road crashes in the European Union are single vehicle incidents. These incidents are generally classified as run-off-road crashes, where the vehicle leaves the road and collides with a roadside hazard. Mitigation of roadside hazards at an early stage in the design process can have a significant positive effect on road safety. Designers shall consider the principles of providing a Forgiving Roadside environment for errant vehicles when choosing cross-sections as discussed in Chapter 4.10 hereafter.

3.2 Range of Choice

The widths of paved elements of the cross-section, i.e. running lanes, hard shoulders and hard strips, vary between different types of road. Dimensions have been selected on the basis of research, experience in Ireland, and comparison with other countries' standards in order to provide new and improved roads that maximise safety and are operationally efficient and cost effective. The Designer is not given choices over the widths of running lanes, hard shoulders and hard strips for a particular type of road.

The Designer does, however, have some flexibility over the width of maintenance strip, berms, side slopes, verges and central reserves, although a reduction of verge or central reserve width below the minimum requirements outlined in Chapter 4 will require a Departure from Standard. The width between the back of the verge and the road boundary will depend on the terrain, the need to accommodate environmental mitigation measures, the engineering or geotechnical measures used to accommodate changes in ground levels, and any need to include differing types and widths of drainage features and other services in the maintenance strip. The Designer shall consider the Principles of Forgiving Roadsides when determining the width of these elements.

3.3 Design Process

For the purposes of developing initial layouts, the Designer's objective should be to determine the appropriate width for the road cross-section, and any variation in width required. Features included in the cross-section can affect the choice of width. Features that commonly occur within the road may include:

- Agricultural cattle/horse crossings;
- Animal tunnels;
- Anti-dazzle fences;
- Apparatus of utility companies and other authorities;
- Bridleways;

- Communication equipment;
- Cycle Facilities;
- Culverts;
- Drains;
- Emergency telephones;
- Fencing;
- Footbridges;
- Footways;
- Foundations;
- Garda observation platforms;
- Geotechnical monitoring equipment;
- Geotextiles;
- Hardened Verge;
- Kerbing;
- Landscaping;
- Lay-bys;
- Lighting columns;
- Loop detectors;
- Noise barriers / bunding;
- Overbridges;
- Parapets;
- Pedestrian guardrails;
- Retaining walls;
- VRS;
- Sign/signal gantries;
- Subways;
- Tracks for equestrians;
- Traffic signals and control and equipment;
- Traffic signs including posts;
- Underbridges;
- Vehicle arrester beds;
- Visual barriers / bunding; and
- Weather monitoring equipment.

Details and design requirements for many of these features are contained in other TII Publications (Standards) and in various other technical guidance documents. Some features, VRS and large traffic signs for example, can have a significant effect on the cross-section width whilst other features, sign gantries for example, are usually accommodated within the side slopes and maintenance strip.

The preferred locations for features in verges and the central reserve may often coincide or overlap, and the Designer should be aware of the potential for such conflicts.

Generally, there is far more below the surface of verges and central reserves than is apparent on the surface, and some underground features must be readily accessible for maintenance purposes. Engineering solutions can usually be designed to overcome conflicts where space is limited, but these may increase costs. The sizes and extents of features above and below ground in the verge and central reserve of rural roads can vary widely. Therefore, details should be designed individually for each situation.

3.4 Clear Zone

3.4.1 Clear Zone Concept

The Clear Zone is a vital component of a Forgiving Roadside. The Clear Zone is the total width of traversable land on the nearside or offside which is to be kept clear of unprotected hazards. This width is available for use by errant vehicles. The zone is measured from the nearest edge of the trafficked lane: i.e. the hard shoulder or hard strip forms part of the Clear Zone.

In some circumstances, the Clear Zone extends beyond the extents of the road works boundary or fence line. Where hazards occur in this area, the Designer shall assess the hazards for VRS provision.

Where provision of a hazard free Clear Zone cannot be fully achieved through measures as described in Sections 2.4 and 2.5, a VRS designed in accordance with DN-REQ-03034 may be provided.

3.4.2 Clear Zone Width

Several factors influence the path of an errant vehicle which leaves the carriageway. The most notable of these are the vehicle speed, the horizontal curvature of the road and the terrain over which the vehicle passes. Table 3.1 below indicates the Clear Zone width required for various design speeds and curvatures on National Roads.

Table 3.1 Clear Zone Widths

Horizontal radius (m)	Design Speed (km/h)							
	40	50	60	70	80	85	100	120
	Required width of Clear Zone (m)							
Inside of bend or Straight	**2.2**	**3.0**	**4.5**	**5.2**	**6.1**	**6.5**	**8.0**	**10.0**
Outside of bend ≥ 1,000m	2.2	3.0	4.5	5.2	6.1	6.5	8.0	10.0
Outside of bend ≥ 900m	2.4	3.3	4.9	5.6	6.9	7.1	8.8	12.4
Outside of bend ≥ 800m	2.6	3.4	4.9	5.8	7.1	7.7	9.6	14.9
Outside of bend ≥ 700m	2.6	3.4	5.0	6.1	7.7	8.3	10.4	17.5
Outside of bend ≥ 600m	2.5	3.5	5.2	6.3	7.9	8.8	11.2	20.0
Outside of bend ≥ 500m	2.6	3.5	5.3	6.6	8.5	9.4	12.0	
Outside of bend ≥ 400m	2.8	3.8	5.6	6.7	9.0	10.0	12.8	
Outside of bend ≥ 300m	2.9	3.9	6.0	7.4	9.6	10.6		
Outside of bend ≥ 200m	3.4	5.1	7.2					
Outside of bend ≥ 100m	4.8	7.5						

Notes:

1. *The Clear Zone widths indicated in Table 3.1 above are intended for use on rural sections of national roads or local and regional roads being upgraded as part of a national road scheme and are not intended for application to typical urban scenarios. The installation of a VRS on national roads in urban locations should be avoided, see DN-REQ-03079 for guidance in relation to VRS in urban settings.*
2. *Slip roads forming part of a major road scheme shall adopt the Clear Zone widths for an 85 km/h section of road listed in Table 3.1.*
3. *The Clear Zone widths in Table 3.1 can be applied to the Operational Speed of legacy national roads where retrofitting new or replacement VRS, and the existing road cross section is not being changed i.e. VRS works only. See DN-REQ-03079, Design of Road Restraint Systems for Constrained Locations (Online Improvements, Retrofitting and Urban Settings).*

3.4.2.1 Terrain classes

Figure 3.1 and Figure 3.2 indicate how to determine the Clear Zone width available where different classes of terrain exist within the roadside cross section. Where the ground is reasonably flat (Terrain Class 1), the width of the embankment or cutting slope can be included in the available Clear Zone. Where there is a medium embankment slope (Terrain Class 2), it is considered that a vehicle can cross the slope without overturning but cannot slow down. In such terrain, therefore, the available Clear Zone does not include the width of the slope. Where the slope is steep enough to form a hazard in itself (Terrain Class 3), the available Clear Zone does not extend onto or across the slope.

The Terrain Classes are defined as:

Class 1: Slope is equal to or less steep than 1:5 (falling) or 1:2 (rising).

The area is considered as level terrain.

If the total change in level is less than 0.5m the area can be judged as level terrain regardless of the angle of the slope.

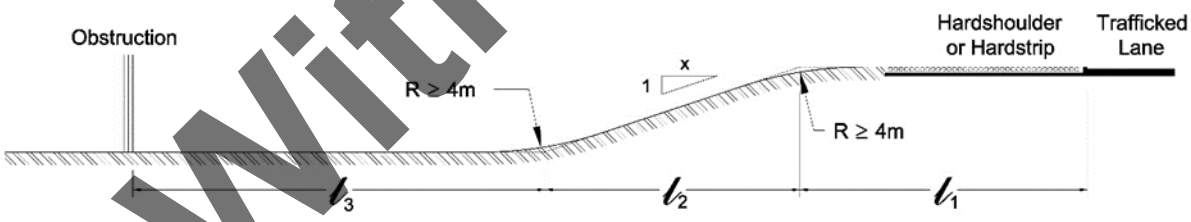
Class 2: Slope is between 1:3 and 1:5 (falling).

It is possible to drive on such a slope without overturning, provided the transition to the slope is rounded off, but vehicles cannot decelerate on the slope. The slope width can be part of the Clear Zone but cannot be included in the determination of the necessary width of the Clear Zone.

Class 3: Slope rises sharply (steeper than 1:2) or falls sharply (steeper than 1:3).

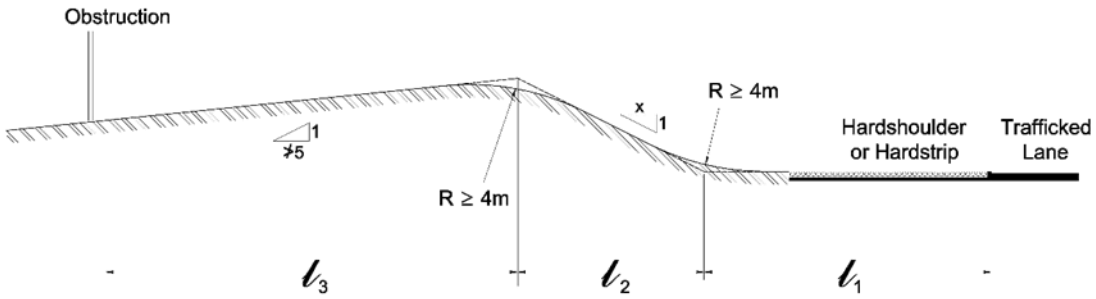
These inclinations present a danger of overturning or sudden halting of the vehicle. These areas are considered hazards if it is not possible to remove the risk in some way.

A fundamental concept in the design of embankments is to round the top and bottom of the slope such that vehicles do not become unstable or prone to overturning as they traverse the embankment or cutting. The slope rounding should generally have a radius of at least 4m.



Embankment or Falling Terrain	Terrain Class	Clear Zone Width
Slope flatter or equal to 1:5	1	$\ell_1 + \ell_2 + \ell_3$
Slope between 1:5 and 1:3	2	$\ell_1 + \ell_3$
Slope steeper than 1:3	3	ℓ_1

Figure 3.1 Land Included in Clear Zone: Embankments



Cutting or Rising Terrain	Terrain Class	Clear Zone Width
Slope flatter or equal to 1:2	1	$\ell_1 + \ell_2 + \ell_3$
Slope steeper than 1:2	3	ℓ_1

Figure 3.2 Land Included in Clear Zone: Cuttings

3.5 Environmental Design

Environmental design features are an integral aspect of the design of any road and many features can have a significant effect on the required overall width of the road.

3.6 Network Objectives

The aim is to deliver an economic, accessible, integrated, safe, reliable, sustainable, efficient and environmentally acceptable network for all users. This includes the need for safe, efficient and effective maintenance as well as the necessity to adapt and improve some roads for the benefit of non-motorised users. The Designer shall take these factors into account throughout the design process.

3.7 Designated Lanes

With integrated and sustainable transport policy now guiding transport planning, the need to consider and accommodate bus facilities and other designated lanes within the cross-section is likely to increase. The reallocation of road space to buses and other designated vehicles can greatly improve journey times and reliability, thereby encouraging modal shift.

In many instances, the provision of a designated lane will be achieved through the adaptation of the existing carriageway, especially in urban areas. This will often result in a lane being lost for general-purpose traffic. The Road Authority should therefore be fully satisfied of the net benefits to be derived from any proposed alterations. It is important to consider these aspects at an early stage in the project appraisal so as to ensure the most sustainable use of the road network.

Any proposal to install a designated lane on a National Road is a Departure from Standard.

3.8 Non-Motorised Users

It is essential that Designers integrate facilities for non-motorised users (NMUs) in the design at an early stage so that they are not overlooked when allocating space.

This will help to ensure the most sustainable cross-section is selected. To do this effectively, Designers must be able to understand the road environment from the NMUs' perspective and the relationship of NMUs to the various road design components.

During project appraisal involving new construction or improvement of an existing road, the Designer must determine and make adequate provision for any NMU requirements. An effective way of achieving this is through consultation with user groups. The Designer should refer to the requirements of DN-GEO-03047 Rural Cycleway Design (Offline) in this regard.

The Designer's attention is drawn to the requirement to provide proper and sufficient footways for pedestrians, cycle facilities and adequate margins for ridden horses and driven livestock where it is considered necessary, or desirable, for the safety or accommodation of these road users.

In general, this will be the case for online improvements of National roads where no safer alternative route is available.

NMUs should be discouraged from using new offline high-speed roads where the existing route remains available and provides a safer alternative.

3.9 People with Disabilities

People with Disabilities are better able to participate in the community if suitable and accessible facilities are available that make it easier for them to reach their desired destinations, especially for those that do not drive. Suitable provision is therefore an essential component of the cross-section.

Designers are required to take necessary measures to ensure no discrimination on the basis of disability when considering the design of roadside features.

The required standard of provision for persons with disabilities must be considered at the early stages of scheme preparation and the level of facilities must be agreed with the Road Authority.

3.10 Visibility

On curved alignments and approaches to junctions, it may be necessary to widen the cross-section, particularly verges and central reserves, to ensure that drivers and other road users can see the appropriate distances, and that the layout meets the visibility requirements. Refer to DN-GEO-03031 for visibility requirements and verge widening.

3.11 Express Roads

Refer to DN-GEO-03031, Chapter 9 for requirements in respect of roads designated as Express Roads.

4. Cross-Sections on Open Roads

4.1 General

Tables 4.1 to 4.4 give detailed dimensions for cross-sectional elements. The information covers rural motorways and rural all-purpose roads, urban motorways, urban all-purpose dual carriageway roads and single carriageway urban relief roads, together with associated interchange links, loops and on and off slip roads. For graphic representations of these cross-sections, refer to the Road Type and Cross Section set of Standard Construction Details (CC-SCD-00001 to CC-SCD-00016) on the TII Publications website.

Wide Motorway cross-sections will normally be used only where adjacent lengths of road are of equivalent cross-section.

Table 4.4 gives detailed dimensions for each element of the cross-sections for regional and local roads diverted or improved on-line as part of a National Road scheme. The particular type of cross-section to be adopted shall be a Type 1, 2 or 3 depending on the predicted traffic flows and the resulting capacity level to be provided in accordance with DN-GEO-03031 Table 6.1.

4.2 Paved Width

The width of the paved elements of the cross-section, i.e. carriageways, hard shoulders and hard strips, shall be in accordance with the requirements of this Standard. Any reduction or increase in the width of these elements is a Departure from Standard, unless the increase results from the requirements for pavement widening on curves as detailed in DN-GEO-03031.

4.3 Traffic Lane Widths

Traffic lane widths as detailed in Tables 4.1 to 4.4 are measured between the trafficked side of carriageway edge lines and the centre line of lane lines.

Where more than two traffic lanes are required in either direction, the middle traffic lane(s) widths are measured between the centre line of the adjacent lane lines.

Where kerbs are used, they shall be a maximum height of 80mm above the adjacent pavement and shall be splayed over the full height, by at least 45° to the vertical.

Information on the provision, start and finish of climbing lanes incorporated into single and dual carriageway roads can be found in DN-GEO-03031.

Traffic lanes shall be widened on curves of low radius to allow for the swept path of long vehicles. See DN-GEO-03031 for details of curve widening.

4.4 Changes of Carriageway Edge Treatment

Where slip roads, interchange links and loop roads join or leave main carriageways, the edge detail may change from hard shoulder to hard strip or carriageway edge.

Transitions between different edge details should take place over the length of the taper.

See DN-GEO-03060 for the layouts of merges and diverges at junctions.

4.5 Hard Strips

A hard strip provides a surfaced strip that abuts on the traffic lanes. The key reasons for the provision of hard strips include:

- pavement integrity/stability;
- partial, cost-effective provision for stopped vehicles;
- provision of valuable additional width to accommodate temporary traffic management layouts;
- snow and water collection;
- overrun facility for driver error or evasive action; and
- improved level of service and driver comfort.

The hard strip also supports edge lines, reduces the risk of vegetation encroachment over edge lines and allows for the placement of road studs outside vehicle wheel paths, where appropriate.

4.6 Hard Shoulders

The hard shoulder is provided adjacent to the nearside of the traffic lanes to offer a place to stop in emergencies, clear of mainline traffic. It also provides access for emergency vehicles and additional road space during temporary traffic management operations. On all-purpose single carriageways, the hard shoulder also provides room for slow moving vehicles to pull over to allow other traffic to overtake.

Offside hard shoulders are not permitted.

4.7 Central Reserves

Central reserves provide physical separation between carriageways thereby providing freedom from interference from opposing traffic, particularly where a VRS is provided.

Minimum central reserve widths are given in Tables 4.1 to 4.4. A central reserve width less than the minimum is a Departure from Standard.

The standard widths are based on the assumption that the road alignment is straight and level between carriageways and that only a minimal amount of equipment or street furniture needs to be accommodated, either permanently or during temporary maintenance activities. Dimensions in excess of those listed in Tables 4.1 to 4.4 may be used in circumstances where deemed appropriate, subject to the approval of TII. The Designer shall consider whether it is necessary to widen the central reserve in order to:

- provide the requisite stopping sight distances in accordance with DN-GEO-03031;
- accommodate any street furniture, utility or drainage features and equipment;
- meet the requirements of DN-REQ-03034 for Vehicle Restraint Systems;
- accommodate any permanent signs required, with particular attention to the provision of adequate working width and set-back for safety barriers relative to the complete sign assembly;
- accommodate significant difference in levels of adjacent carriageways;
- accommodate temporary traffic management layouts for the envisaged maintenance regime subject to adequate pavement provision;

- accommodate variable message signs and signals;
- accommodate any parts of structures or complete structures;
- provide sufficient space for maintenance operations;
- fulfil landscape and environmental objectives;
- accommodate NMUs when crossing; and
- accommodate snow and water collection.

The Designer shall consider other features that may have to be accommodated in the central reserve as well as the safety of maintenance operations and the safety of all who may be required to work on or near the road in the course of their duties, e.g. emergency service personnel. During project appraisal, the Designer shall also ensure that future network plans for traffic control (e.g. gantries) are taken into account.

Piers for overbridges are not permitted within the central reserve of Type 2 or 3 Dual Carriageways.

Variations of central reserve widths in close succession should be avoided. The Designer shall consider how the scheme will integrate with adjacent highway sections and the route as a whole.

Where the central reserve width varies, raised profile markings should be used to define the edge of the running lane clearly. Particular care should be taken to avoid creating the illusion of a lane gain, for example, by the use of hatching as per the Traffic Signs Manual Chapter 7 in the widened area. Furthermore, variations in safety barrier set back should be carefully considered in this regard to provide a flowing appearance.

Reference should be made to DN-GEO-03060 for guidance on widening the central reserve at priority junctions on Type 3 Dual-Carriageway all-purpose roads. Remote from junctions, crossing places for NMUs should be avoided on dual carriageway all-purpose roads. Where there is sufficient demand for a crossing point, the Designer should consider the provision of an underpass or overbridge. A flow of about 10 users in any hour may warrant such a provision, and this will need to consider step-free access options with limited grades to accommodate all NMUs.

4.8 Emergency Crossing Points

DN-GEO-03031 provides advice on the design of Emergency Crossing Points.

4.9 Hardening of Central Reserves

Techniques for reducing maintenance liabilities within central reserves should be considered during the preparation of new roads, road improvement schemes and also for major maintenance operations on existing roads, to reduce risks to both operatives and other highway users.

For new construction schemes, central reserves shall be paved.

When deciding whether to harden existing central reserves as part of a road improvement / maintenance scheme, the Designer shall:

- check the adequacy of the surface water drainage system;
- make an assessment of environmental factors, such as the landscape character of the setting and location of the road, the environmental consequences of weed control and the function of the central reserve as a potential habitat. The environmental database for the route should therefore be consulted;

- determine the area to be hardened, based on what areas of vegetation may be left uncut without affecting visibility or sign conspicuity;
- take account of whole-life costs and safety considerations;
- determine if the central reserve is to be used to accommodate temporary traffic management layouts for the envisaged maintenance regime.

As a minimum, any general hardening of the central reserve should be designed to be capable of withstanding light vehicle over-run and prevent weed growth. The design shall be in accordance with DN-PAV-03074 Design of Bituminous Mixtures, Surface Treatments, and Miscellaneous Products and Processes

4.10 Verges

The verge is important from a number of perspectives, including safety, the environment, when considering the initial cost and ongoing maintenance and operating costs. It can provide a separate route for NMUs on all-purpose roads and also offers an area to accommodate footways, cycle facilities and other dedicated facilities to improve safety and convenience for these groups. On motorways, stranded motorists may use the verge on foot to reach the emergency telephones or await the arrival of a rescue vehicle. The design of the verge, as well as the location of the emergency telephone, should consider the access requirements that may be required for some NMUs.

Minimum verge widths are given in Tables 4.1 to 4.4. A verge width less than the minimum requires a Departure from Standard. Where the Tables denote 'Varies', the decision rests with Designers, taking into account the advice in this Standard, however where communications ducting and chambers are to be accommodated in the verge, a minimum verge width of 2.0m shall be provided.

Verge widths shown do not include the additional width required to facilitate mandatory pedestrian/cycle facilities. The additional verge width for these facilities shall be calculated in accordance with this Standard to account for required separation distances, minimum facility width and lateral clearance requirements discussed later in this document.

Advice concerning choice of verge width corresponds with that provided for central reserves. Additional advice solely for verges is given below.

The verge offers an important component in road drainage systems, including the storage of snow displaced from the carriageway. It offers an area to support ancillary roadside equipment such as VRS, ITS equipment, traffic counters, lighting and other highway features such as laybys and landscaping. Environmental fencing is a regular feature of the cross-section and the Designer shall establish the requirements as early as practicable to make appropriate provision of road width. Congested verges with insufficient room for necessary roadside components present both safety and engineering difficulties.

As noted previously, new roads shall be designed to provide a more forgiving environment for errant vehicles. This can be achieved through the provision of a Clear Zone to the side of the carriageway as per Section 3.4. The concept of providing wide verges to slow and contain errant vehicles, and accommodating shallower side slopes for example, may have significant land take implications and needs to be considered early in the design process. If properly incorporated during the early stages of planning and design, the Forgiving Roadsides principles, as outlined in Chapter 2, can be used to avoid such issues. Examples of this could include incorporating the maintenance strip into shallow embankments or combining swale drains and the maintenance strip.

DN-REQ-03034 provides requirements to ensure the safety of road users if a VRS is struck and deflected near the road edge or central reserve.

Designers shall comply with DN-REQ-03034 when designing VRS in situations where hazards cannot be mitigated or modified. Where necessary, additional verge width may need to be provided, for example on the approach to underbridges to allow sufficient embankment width behind the VRS to ensure the VRS and associated foundation can perform adequately.

Verges should be sufficiently firm, level and free from hazards to permit their occasional use by NMUs in the absence of dedicated facilities.

Where footways are provided, the widths shall be in accordance with DN-PAV-03026 Footway Design.

Variations of verge widths in close succession should be avoided. The Designer shall consider how the scheme will integrate with adjacent highway sections and the route as a whole.

4.11 Maintenance Strip and Side Slope Widths

Maintenance strip and side slope widths should be chosen to suit the local situation. The width of maintenance strip will depend upon:

- terrain;
- environmental design features;
- engineering and geotechnical measures used to accommodate changes in ground levels;
- the need to accommodate various types and widths of drainage features and other services in any maintenance strip;
- maintenance requirements;
- the need to accommodate cycle/pedestrian facilities;
- Clear Zone requirements.

The width of maintenance strip shall be determined by the Designer. A typical minimum width of 3.0m is recommended. Where practical, cycle/pedestrian facilities should be provided within the maintenance strip.

To provide a more forgiving environment for errant vehicles, the provision of a Clear Zone in accordance with DN-REQ-03034 shall also be considered when choosing the appropriate maintenance strip and side slope widths, refer Figure 3.1 and Figure 3.2.

Whenever practicable, side slopes adjacent to emergency roadside telephones should be kept to a minimum angle to assist motorists in waiting at the road boundary in the event of an emergency or breakdown.

4.12 Auxiliary Lane Provision

Where auxiliary lanes are provided in accordance with general arrangement layouts given in DN-GEO-03060, the width of the auxiliary lane(s) shall be equal to the width of the adjacent nearside mainline lane.

Changes in lane width between connector roads and auxiliary lanes shall be carried out over the full length of the nose.

Table 4.1 Rural Motorways - Dimensions of Cross-Section Elements Including: Slip Roads, Interchange Links and Loops

	Nearside				Offside		
	Verge [1,4]	**Hard Strip[2]**	**Hard Shoulder**	**Carriage -way [2, 9]**	**Hard Strip[2]**	**Verge[1,4]**	**Central Reserve[1,4]**
Mainlines							
Motorway[9]	2.00		2.50	7.00 (2 Lane)	1.00	-	2.60 [5]
Wide Motorway	3.00	-	3.00	7.50	1.00	-[3]	9.00
Wide Motorway with provision for extra lane	3.00	-	3.00	7.50	1.00	-[3]	16.00
Slip Roads, Interchange Links and Loops: Merges and Diverges							
1 Lane	4.50	1.50	-	4.00	0.50	3.50	-
2 Lane	4.00	1.00	-	7.30	0.50	3.50	-
Slip Roads: Diverge Only							
2 Lane	4.00	1.00	-	6.00	0.50	3.50	-

Notes:

1. *Verge and central reserve dimensions are minimum values: any reduction shall require a Departure from Standard.*
2. *Carriageway, hard shoulder and hard strip dimensions are fixed values: Any reduction or increase in the width of these elements is a Departure from Standard, unless the increase results from the requirements or pavement widening on curves as detailed in DN-GEO-03031.*
3. *For details of offside verges at divided structures, see Table 5.1.*
4. *Where a hard strip is present, the corresponding verge or central reserve dimension includes the hard strip. However, where a hard shoulder is present, the corresponding verge dimension does not include the hard shoulder.*
5. *Width of central reserve on a Motorway is determined by the type of vehicle restraint system. See DN-REQ-03034.*
6. *For guidance on selection of slip roads and interchange link and loop roads, see DN-GEO-03060 for the design of Grade Separated Junctions.*
7. *All dimensions are in metres.*
8. *For graphic representation of these cross-sections, refer to the appropriate Standard Construction Detail for road type and cross section on the TII Publications website.*
9. *Where the traffic assessment indicates more than 2 lanes are required in each direction, any additional lanes shall be 3.5m in width for Motorways. Details of verges, hard shoulders and the central reserve shall be the same as for a Motorway with 2 lanes in each direction.*

Table 4.2 Rural All-Purpose Roads - Dimensions of Cross-Section Elements Including: Slip Roads, Interchange Links and Loops

	Nearside				Offside		
	Verge [1,4,11,12]	**Hard Strip** [2]	**Hard Shoulder** [2]	**Carriage-way** [2, 13]	**Hard Strip** [2]	**Verge** [1,4]	**Central Reserve** [1,4]
Mainlines							
Type 3 Single	3.00	0.50	-	6.00	-	-	-
Type 2 Single	3.00	0.50	-	7.00	-	-	-
Type 1 Single	3.00	-	2.50	7.30	-	-	-
Type 3 Dual Carriageway	3.00	0.50 min	-	7.00 (2 Lane) 3.50 (1 Lane)	0.50	- [3]	1.50
Type 2 Dual Carriageway	3.00	0.50	-	7.00	0.50	- [3]	1.50
Type 1 Dual Carriageway [13]	2.00	-	2.50	7.00 (2 Lane)	1.00	- [3]	2.60 [5]
Slip Roads, Interchange Links and Loops: Merges and Diverges							
1 Lane	4.50	1.50	-	4.00	0.50	3.50	-
2 Lane	4.00	1.00 (Type 2/3) [6] 1.50 (Type 1) [6]	-	7.30	0.50	3.50	-
Slip Roads: Diverge Only							
2 Lane	4.00	1.00 (Type 2/3) [6] 1.50 (Type 1) [6]	-	6.00	0.50	3.50	-

Notes:

1. *Verge and central reserve dimensions are minimum values: any reduction is a Departure from Standard.*
2. *Carriageway, hard shoulder and hard strip dimensions are fixed values: any reduction or increase in the width of these elements is a Departure from Standard, unless the increase results from the requirements for pavement widening on curves as detailed in DN-GEO-03031.*
3. *For details of offside verges at divided structures, see Table 5.1.*
4. *Where a hard strip is present, the corresponding verge or central reserve dimension includes the hard strip. However, where a hard shoulder is present, the corresponding verge dimension does not include the hard shoulder.*
5. *Width of central reserve on Type 1 Dual Carriageway is determined by the type of VRS. See DN-REQ-03034.*
6. *The Nearside hard strip on a Type 1 Single and Type 1 Dual Carriageway shall have a width of 1.50m and on a Type 2 or 3 Single and Dual Carriageway shall have a width of 1.00m.*
7. *For guidance on selection of slip roads and interchange link and loop roads, see DN-GEO-03060 for the design of Grade Separated Junctions.*
8. *All dimensions are in metres.*
9. *For graphic representation of these cross-sections, refer to the appropriate Standard Construction Detail for road type and cross section on the TII Publications website.*
10. *The type of cross-section to be adopted shall depend on the capacity level to be provided with reference to DN-GEO-03031 Table 6.1.*
11. *Verge width shall be determined to take into account the uses and clearances required.*
12. *Verge widths shown do not include the additional width required to facilitate pedestrian/cycle facilities. The additional verge width for pedestrian/cycle facilities shall be calculated in accordance with this Standard to account for required separation distances, minimum facility width and lateral clearance requirements.*
13. *Where the traffic assessment indicates more than 2 lanes are required in each direction, any additional lanes shall be 3.5m in width for Type 1 Dual Carriageways. Details of verges, hard shoulders and the central reserve shall be the same as for a Type 1 Dual Carriageways with 2 lanes in each direction.*

Table 4.3 Urban Motorways - Dimensions of Cross-Section Elements Including: Slip Roads, Interchange Links and Loops

	Nearside				Offside		
	Verge[10]	**Hard Strip[2]**	**Hard Shoulder[2]**	**Carriageway[2]**	**Hard Strip[2]**	**Verge**	**Central Reserve[1,4]**
Mainlines							
Standard Motorway[9]	2.0	-	2.50	7.00	1.00	- [5]	2.60 [4]
Slip Roads, Interchange Links and Loops: Merges and Diverges							
1 Lane	Varies	1.50	-	4.00	0.50	Varies	-
2 Lane	Varies	1.00	-	7.30	0.50	Varies	-
Slip Roads: Diverge only							
1 Lane	Varies	1.00	-	6.00	0.50	Varies	-

Notes:

1. *Central reserve dimensions are minimum values: any reduction is a Departure from Standard.*
2. *Carriageway and hard strip dimensions are fixed values: any reduction or increase in the width of these elements is a Departure from Standard, unless the increase results from the requirements for pavement widening on curves as detailed in DN-GEO-03031.*
3. *The central reserve dimension includes the offside hard strip.*
4. *Width of central reserve is determined by the type of VRS. See DN-REQ-03034.*
5. *For details of offside verges at divided structures, see Table 5.1.*
6. *For guidance on selection of slip roads and interchange link and loop roads, see DN-GEO-03060 for the design of Grade Separated Junctions.*
7. *All dimensions are in metres.*
8. *For graphic representation of these cross-sections, refer to the appropriate Standard Construction Detail for road type and cross section on the TII Publications website.*
9. *Where the traffic assessment indicates more than 2 lanes are required in each direction, any additional lanes shall be 3.5m in width for Urban Motorways. Details of verges, hard shoulders and the central reserve shall be the same as for an Urban Motorway with 2 lanes in each direction.*
10. *Where it is necessary to accommodate communications ducting and chambers, a minimum verge width of 2.0m shall be provided.*

Table 4.4 Urban All-Purpose Roads - Dimensions of Cross-Section Elements Including: Slip Roads, Interchange Links and Loops

	Nearside			Offside		
	Verge[3]	**Hard Strip[2]**	**Carriageway[2]**	**Hard Strip[2]**	**Verge[1,4]**	**Central Reserve[1,4]**
Mainlines						
Single Carriageway Relief Road	Varies	-	6.00 to 7.00	-	-	-
Dual Carriageway Relief Road	Varies	-	7.00	-	-	1.80
Dual 2 Lane	Varies	-	7.30	-	- [4]	1.80
Dual 3 Lane	Varies	-	11.00	-	- [4]	1.80
Slip Roads, Interchange Links and Loops: Merges and Diverges						
1 Lane	Varies	1.50	4.00	0.50	Varies	-
2 Lane	Varies	1.00 (Type 2/3) [5] 1.50 (Type 1) [5]	7.30	-	Varies	-
Slip Roads: Diverge Only						
2 Lane	Varies	1.00 (Type 2/3) [5] 1.50 (Type 1) [5]	6.00	-	Varies	-

Notes:

1. *Central reserve dimensions are minimum values: any reduction is a Departure from Standard.*
2. *Carriageway and hard strip dimensions are fixed values: any reduction or increase in the width of these elements is a Departure from Standard, unless the increase results from the requirements for pavement widening on curves as detailed in DN-GEO-03031.*
3. *Verge width shall be determined to take account of the uses and clearances required.*
4. *For details of offside verges at divided structures, see Table 5.1.*
5. *The Nearside hard strip on a Type 1 Single and Dual Carriageway shall have a width of 1.50m and on a Type 2 or 3 Single and Dual Carriageway shall have a width of 1.00m.*
6. *For guidance on selection of slip roads and interchange link and loop roads, see DN-GEO-03060 for the design of Grade Separated Junctions.*
7. *All dimensions are in metres.*
8. *For graphic representation of these cross-sections, refer to the appropriate Standard Construction Detail for road type and cross section on the TII Publications website.*
9. *Table 6.1 of DN-GEO-03031 does not apply to Urban Roads. Refer to UK DMRB TA 79 for guidance on assessing the Traffic Capacity of Urban Roads.*

4.13 Connector Road Lane Provision

For guidance on determining the required number of lanes, hard shoulder and hard strip provision on connector roads, see DN-GEO-03060.

Where connector roads approach junctions, those dimensions given in the relevant sections of DN-GEO-03060 that prescribe safe and efficient junction designs may take precedence over the cross-section dimensions given in this Standard. Traffic movements at the junction may demand the development of additional lanes to provide capacity for separate traffic streams.

4.14 Separator Zones

The widths of separator zones should generally follow the decision-making process used to determine central reserve widths discussed previously. Designers should be aware that minimal width separator zones could lead to problems due to a lack of refuge area for occupants of broken down vehicles and also for maintenance.

Where traffic on any lane of a parallel road runs counter to the mainline traffic flow, the risks associated with headlight glare shall be assessed and the need for and the type of mitigation measures shall be considered when determining the required width of separator zones.

Methods of avoiding headlight glare include:

- designing the alignments of the roads so as to provide significant level differences;
- providing anti-dazzle screening fences or earth bunds;
- providing appropriately designed soft planting that provides foliage all year round at the correct heights;
- where the use of a VRS is required, it may be practicable to provide a system that is designed to cut off glare.

Designers should take into consideration which mitigation method provides the most sustainable solution. Sightline requirements must not be compromised by the above measures.

4.15 Provision of Lay-bys

For guidance on determining the requirements for the provision of lay-bys, see DN-GEO-03031 and DN-GEO-03046.

4.16 Road Markings

For details of the road markings required to define lanes, hard shoulders, etc. on the various types of road cross-section, see the Traffic Signs Manual.

4.17 Rural Areas Cycle and Pedestrian Facility Layouts

4.17.1 General Principles

Cycle/Pedestrian Facilities shall be provided as part of all Type 2 and Type 3 Single Carriageway and Type 2 and Type 3 Dual Carriageway national road schemes and shall be provided as follows:

- as a Cycleway remote from the road designed in accordance with DN-GEO-03047. This may include the use of suitable disused railways, declassified national roads, canal tow paths or forest trails where appropriate.
- within the maintenance strip or verge of the national road in accordance with the design details outlined in this document.
- using a suitable existing alternative route incorporating appropriate signage. This option shall require a Departure from Standard which shall outline the justification for the use of this option.

Where cycle/pedestrian facilities are provided within the verge, the Designer should position the cycle/pedestrian facility as far from the edge of the carriageway as possible to increase the safety/comfort of users, provided the clearances to objects as specified later in this section can be achieved. The separation distances from the carriageway detailed later in this section are the minimum requirements. The cycle/pedestrian facility should share the maintenance strip where practical, including access to side roads at structure locations. Such accesses shall be designed as cycleway rural road crossings in accordance with DN-GEO-03047.

Where incorporated within the verge, the preferred cycle/pedestrian facility is a two-way facility located on one side of the road. The Designer must however take into consideration the availability of land, the number of junctions, private entrances and the need for cyclists to cross the road along with other issues presented in this Standard when choosing between a one-way or two-way facility.

4.17.2 Cross-section

Generally, rural cycle facilities will also provide for pedestrians, unless a separate pedestrian footway or footpath is provided. When determining the cross-section widths, the level of pedestrian and cyclist usage shall be considered. The anticipated speed of the cyclist given the vertical profile, and the space that each user will occupy when using the cycle facility should also be assessed.

The space needed for a cyclist to feel safe and comfortable depends on:

- the space needed for a cyclist in motion known as the cyclist's dynamic envelope, particularly at low speeds;
- the clearance when passing fixed objects;
- the distance from, and speed of other traffic;

Other considerations in determining cycle facility width are:

- Cycling in a rural environment is a social activity and therefore sufficient width is required to allow cyclists to pair up or travel in groups;
- Not all cyclists travel at the same speed therefore room to overtake needs to be provided;
- When families travel together sufficient width for an adult to cycle parallel with young children for safety and reassurance reasons;
- The volume of cyclists;
- Cyclists with trailers/panniers;
- Trikes and recumbents;
- Whether the cross-section is shared with other users (pedestrians, motorised vehicles);
- Whether the facilities are one-way or two-way operation;

- Lateral clearance when positioning obstacles such as kerbstones, lamp posts, bollards, trees and walls.

Table 4.5 and Table 4.6 present the mandatory requirements for cycle facilities. The Desirable Minimum values outlined will provide a reasonable quality of service and will satisfy all of the core design principles. The Designer shall consider the location, the function and the probable use of the facility if considering values below the Desirable Minimum.

The One Step Below Desirable Minimum values outlined in Table 4.5 and Table 4.6 may be applied in difficult circumstances. This may be due to a number of factors such as land constraints, historical sites infringing on the proposed facility and other obstacles that could be encountered.

The use of values less than One Step Below Desirable Minimum values outlined in Table 4.5 and Table 4.6 where these values cannot be physically achieved shall require a Departure from Standard.

Table 4.5 demonstrates the required widths based on whether the cycle facility is one-way, two-way or a shared facility with pedestrians.

Table 4.5 Mandatory Widths for Cycle Facilities

		Desirable Min (m)	One Step Below Desirable Min (m)
One Way Cycle Facility	Low Volume	2.0	1.75
	High Volume	3.0	1.75
Two Way Cycle Facility	Low Volume	2.5	2.0
	High Volume	3.0	2.5
Shared Use One Way Cycle Facility with Pedestrians	Low Volume	3.0	2.0
	High Volume	4.0	3.0
Shared Use Two Way Cycle Facility with Pedestrians	Low Volume	3.0	2.0
	High Volume	5.0	3.0

As part of the design process it is important to define whether the facility will attract low or high volumes of cyclist/pedestrian traffic to give the Designer the choice to make an informed decision on cross section dimensions and whether or not segregation of cyclists and pedestrians is necessary. Low volume facilities are those considered to attract less than 1500 users a day and high-volume facilities are those expected to attract 1500 or greater users a day.

4.17.3 Carriageway Separation Distances

When cycle/pedestrian facilities follow the route of a road, a separation distance is to be provided between the road and the cycle track through the provision of a grassed verge. The carriageway separation distance includes any hard strips. Table 4.6 presents the minimum separation distances between the road carriageway and the cycle track. The minimum grassed verge width to be provided shall be 1m. The cycle facility should however be located as far from the edge of the carriageway as possible and share the maintenance strip if practical, as described earlier in this section.

Passively safe reflective vertical features shall be positioned within the grassed verge width where the cycle track runs adjacent to the road.

Any values below those outlined in Table 4.6 require a Departure from Standard.

Table 4.6 Carriageway Separation Distances

Road Type	Desirable Min (m)	One Step Below Desirable Min (m)
Type 2 and Type 3 Single Carriageway	2.0	1.5
Type 2 and Type 3 Dual Carriageway	6.0	3.0

Details in relation to cycle facilities at junctions and accesses are provided in DN-GEO-03060.

4.17.4 Lateral Clearance

If vertical objects such as a wall, a fence or a VRS are located immediately adjacent to a cycle facility, the effective width of the cycle facility will be reduced. A minimum lateral clearance of 0.5m shall be provided to vertical objects where they are located adjacent to cycle facilities.

4.17.5 Typical Details

Figure 4.1 and Figure 4.2 illustrate the cross-section requirements of the different cycle facility options which may or may not be shared with pedestrians. See Table 4.5 and Table 4.6 above for the required dimensions.

4.17.6 Safety Barriers

The provision of safety barriers shall be made in accordance with DN-REQ-03034. Any safety barrier required shall be positioned between the carriageway and the cycle track. The minimum distance between the cycle track and the safety barrier shall be equal to the working width of the safety barrier and comply with the minimum lateral clearance requirements outlined earlier. In addition, safety barrier adjacent to the cycle track should be of an enclosed double-sided beam type or similar, as described in DN-REQ-03034.

4.17.7 Construction Details

Construction details for cycle facilities developed as part of a National Road scheme shall as per Chapter 8 of DN-GEO-03047.

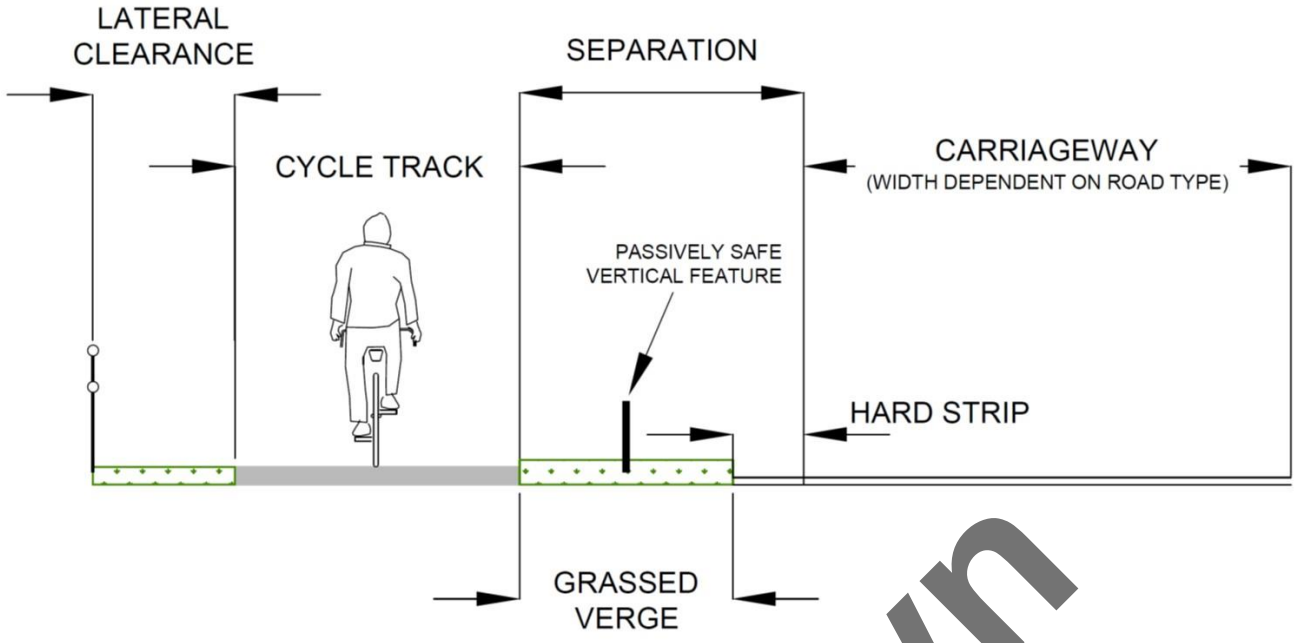


Figure 4.1 Off-Road One-Way Cycle Track

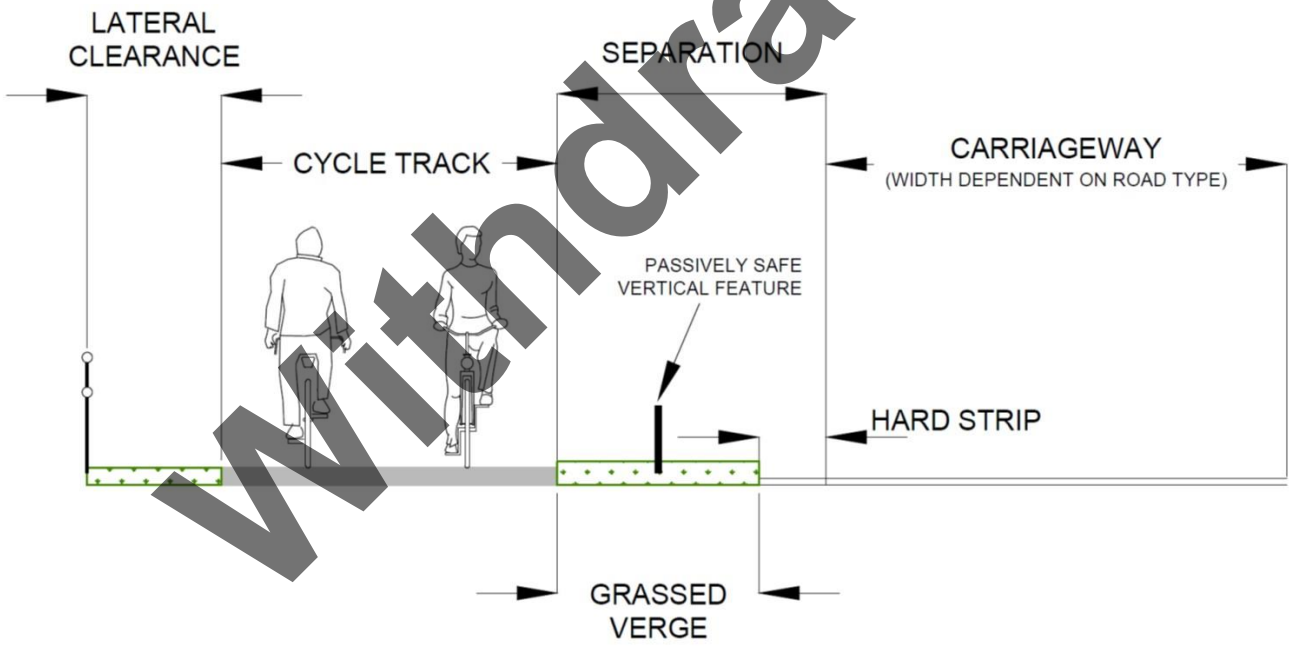


Figure 4.2 Off-Road Two-Way Cycle Track

5. Cross-Sections at Structures

5.1 General

The cross-section requirements detailed below for structures assume a straight horizontal alignment of the carriageway. If this is not the case the verges and central reserve may require widening to give the stopping sight distances required in accordance with DN-GEO-03031. For graphic representations of these cross-sections, refer to the Road Type and Cross Section set of Standard Construction Details (CC-SCD-00001 to CC-SCD-00016) on the TII Publications website

Variations of cross-section provision at bridges in close succession shall be avoided except where sight distance requirements dictate otherwise. The verge and central reserve widths appropriate for the longest structure shall be used. Individual cases shall be treated on their merits.

The requirements of this Standard are not applicable to road tunnels.

5.2 Roads diverted or improved on-line as part of a National Road scheme

The cross-section at a structure of a road diverted or improved on-line as part of a National Road scheme shall have a minimum width of 5.5m.

5.3 Traffic Lane Widths

Lane widths shall be maintained through or over a structure.

5.4 Hard Shoulders and Hard Strips

Where hard shoulders or hard strips are provided adjacent to the edges of the carriageway they shall be continued at the same width through or over the structure.

5.5 Central Reserves

The width of central reserve applicable to the adjacent open road section should be continued through or over the structure. Reference is brought to the restrictions on piers within the central reserve within Section 4.7 of this document.

5.6 Verges at Underbridges and Overbridges

In planning the overall width required, consideration should be given to the space necessary for structural elements of the bridge, including: foundations, items such as bridge joints, drainage runs, electrical equipment and services, and VRS. Consideration should also be given to maintenance operation needs.

On all-purpose road overbridges, underbridges, elevated roads and viaducts, the nearside verge shall provide a clear width for pedestrian access and cycle facilities. The width can be varied depending upon the overall length of the structure and the likely pedestrian and cyclist flows as indicated below and in Table 5.1. Where it is anticipated that mobility impaired users will be regular users of the structure, consideration shall be given to providing a width of 1.80m as this allows for two wheelchair users to pass one another in opposite directions. Where regular use is not envisaged, a minimum width of 1.5m is permissible, although passing places will be required at regular intervals.

Regular pedestrian usage on an all-purpose road occurs where there is a clearly defined local need with a predicted maximum flow of more than 25 pedestrians per hour and/or footways are provided, or are to be provided, on contiguous sections of road. **Occasional** pedestrian usage occurs at other locations.

Verge widths may need to be increased to allow adequate visibility, particularly where a bridge is located on a horizontal curve.

Table 5.1 Verge Widths on Underbridges

Road Type	Location	Pedestrian/Cyclist Usage	Bridge Length (m)	Raised Verge Width (m)
Motorway	Nearside	-	All	0.60
	Offside			
All-Purpose Road	Nearside	Regular	≤ 100	2.00
			> 100	1.50
		Occasional	All	1.50
		Mobility Impaired Users	All	1.80
		Rural Cycle Facilities	All	2.75 min
	Offside*	All	All	0.60

Note:

** For bridges carrying Regional and Local Roads it may be appropriate to treat one side as the offside despite the road carrying two-way traffic.*

5.6.1 Verges on Underbridges

On underbridges, the verge adjacent to the bridge parapet shall be raised with a maximum kerb height of 80mm above the adjacent pavement. Kerbs shall be splayed for their full height, by at least 45° to the vertical. Any reduction in verge width below the values in Table 5.1 shall be regarded as a Departure from Standard.

5.6.2 Verges beneath Overbridges

Beneath overbridges the verge width shall be not less than 2.0m and shall also comply with the following arrangements where applicable.

At overbridges where an abutment is adjacent to the carriageway:

a) The distance from the edge of road pavement to the face of the abutment shall be not less than 4.5m.

b) Where there is regular pedestrian usage, a paved footway of 1.65m minimum clear width shall be provided on the nearside verge and behind any VRS where one is provided. Consideration shall be given to increasing this width to 1.80m where it is anticipated that there will be regular use by mobility impaired users.

c) Where a cycle facility is required, a minimum raised verge width of 2.75m shall be provided which includes the lateral clearance and separation distance.

At overbridges where a pier is adjacent to the carriageway:

a) The distance from the edge of the traffic lane to the face of the pier shall be not less than 4.5m.

b) The minimum distance from the edge of road pavement to the face of the pier shall be determined to suit the safety barrier set-back and working width as defined in DN-REQ-03034.

c) Where there is regular pedestrian usage, a paved footway of 1.65m minimum clear width shall be provided on the nearside through the span separate from the main carriageway. Consideration shall be given to increase this width to 1.80m where it is anticipated that there will be regular use by mobility impaired users.

d) Where a cycle facility is required, a minimum raised verge width of 2.75m shall be provided which includes the lateral clearance and separation distance.

5.7 Safety Barriers and Bridge Parapets

Safety barriers and bridge parapets shall be positioned in accordance with the requirements of DN-REQ-03034.

6. Headroom at Structures

6.1 General

Dimensional standards are given in Table 6.1 for New Construction Headroom and Maintained Headroom at overbridges and at other structures over a road.

Table 6.1 Standard Headroom at Structures

Type of Structure	New Construction Headroom (m)	Maintained Headroom (m)
Overbridges	5.30	5.03
Footbridges and Sign/Signal Gantries	5.70	5.41
Free Standing Temporary Structures	N/A	5.41

The headroom provision at underbridges shall be in accordance with Table 6.1 unless otherwise agreed with the relevant Road, Railway or Water Authority.

The headroom values given are the minimum; where it is economical and/or environmentally acceptable, greater headroom should be provided.

The requirements of this Standard are not applicable to road tunnels.

6.2 Dimensional Requirements

Headroom shall be measured at right-angles to the surfaces of the carriageway, hard shoulder, hard strip, verge or central reserve, at the point where it is a minimum.

The relevant standard headroom in Table 6.1 shall be provided:

a) Over the paved carriageway, hard shoulder or hard strip plus any provision for future widening;

b) Over the full verge width, except where (e) applies, and even then, for a minimum of 4.5m from the edge of the traffic lane;

c) Over the central reserve of a dual carriageway, except where (e) applies;

d) Between the carriageway and the pier or abutment face where such a support is located within 4.5m of the edge of the road pavement, except where (e) applies;

e) To the back of the working width or vehicle intrusion width, whichever is greater, of any VRS as defined in DN-REQ-03034, where installed (see Figure 6.1).

The headroom standards for pedestrian subways and combined pedestrian/cycle subways are contained in DN-GEO-03040. Headroom standards for rural cycle facilities are included in this document.

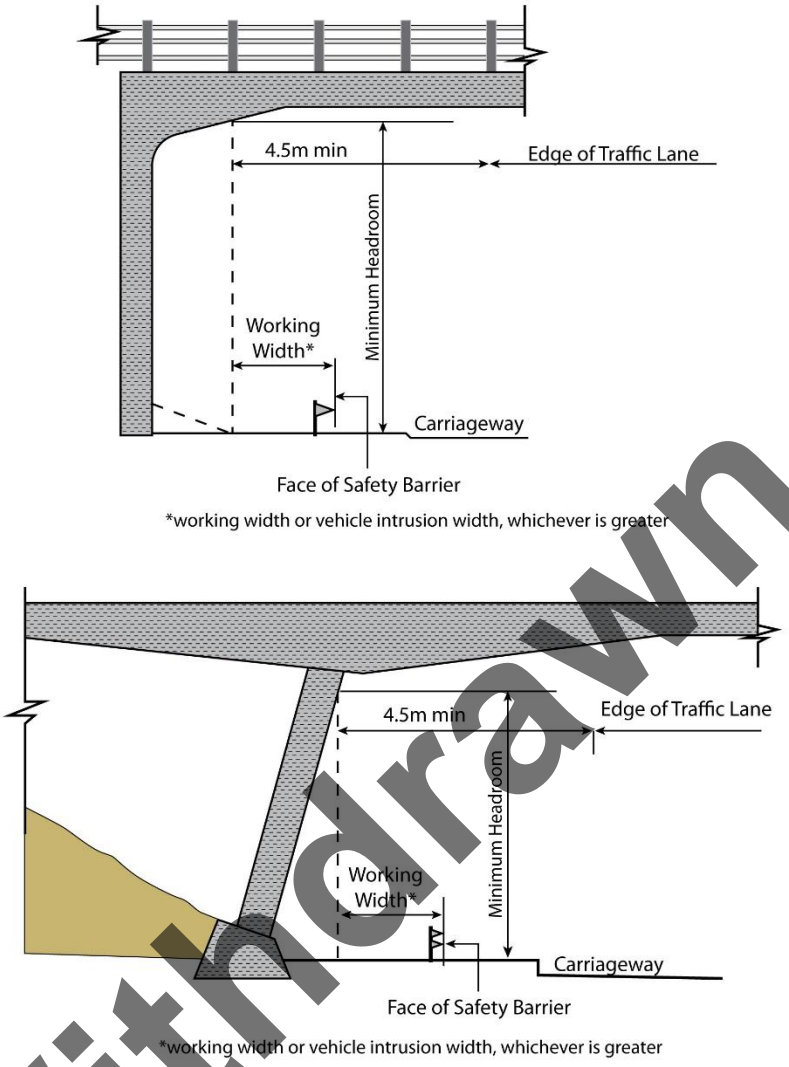


Figure 6.1 Headroom at Structures

6.3 Compensation for Vertical Sag Curvature and Deflection

Where the road passing underneath a structure is on a sag curve, the headroom values in Table 6.1 shall be increased in accordance with Table 6.2. For sag radii between the values listed in Table 6.2, the additional clearance shall be linearly interpolated. The sag radius is measured along the carriageway over a 25m chord.

Allowances shall be made for the deflection of structures. The minimum headroom shall be provided for the total deflection of the structure under the appropriate serviceability limit state design combinations in accordance with I.S. EN 1990 and the Irish National Annex.

Table 6.2 Sag Radius Compensation

Sag Radius (m)	Additional Clearance (mm)
< 650	160
650	130
900	100
1000	80
1200	70
1500	55
2000	45
3000	25
6000	15
> 6000	Nil

6.4 Utility Companies' and Other Authorities' Apparatus

Greater headroom than that determined from this Standard may be required by a Utility Company or other authority. The Designer shall consider the impact of this requirement in the development of the designs.

6.5 Headroom at structures for cyclists

It is important that clear headroom is available throughout the cycle facility, as headroom restrictions may result in head injuries to cyclists therefore impacting on safety and comfort along the cycle facility. The Designer needs to take into account headroom issues associated with gateway entrances, sign heights, overhanging trees, lighting and car/van/truck restriction devices and underpasses. The desirable minimum headroom along cycle facilities is 2.7 metres, however over short distances a reduced head height of 2.4 metres is acceptable. Where the minimum headroom is not available (e.g. existing bridges/tunnels), the Designer shall consider re-directing cyclists to an alternative but suitable route; and in last resort, cyclists should be advised to dismount in advance of the height restriction.

The Designer should refer to DN-GEO-03040 Subways for Pedestrians and Pedal Cyclists Layout and Dimensions with respect to headroom requirements along cycle facilities.

7. References

7.1 TII Publications (Standards)

- DN-STR-03001 – Technical Approval of Structures on Motorways and Other National Roads.
- DN-STR-03005 – Design Criteria for Footbridges.
- DN-REQ-03034 – The Design of Road Restraint Systems (Vehicle and Pedestrian) for Roads and Bridges.
- DN-REQ-03079 – The Design of Road Restraint Systems for Constrained Locations (Online Improvements, Retrofitting and Urban Settings).
- DN-GEO-03031 – Road Link Design.
- DN-GEO-03035 – Layout of Grade Separated Junctions.
- DN-GEO-03042 – Layout of Compact Grade Separated Junctions.
- DN-GEO-03043 – Geometric Design of Major/Minor Priority Junctions and Vehicular Access to National Roads.
- DN-GEO-03040 – Subways for Pedestrians and Pedal Cyclists. Layout and Dimensions.
- DN-GEO-03046 – The Location and Layout of Lay-bys.
- DN-GEO-03047 – Rural Cycleway Design (Offline).
- DN-PAV-03026 – Footway Design.
- PE-PMG-02004 – Project Management Guidelines.

7.2 Other References

- TII Publications (Standards) Specification for Works. Transport Infrastructure Ireland.
- TII Publications (Standards) Standard Construction Details. Transport Infrastructure Ireland.
- Transport in the Urban Environment, Part V. The Institution of Highways and Transportation.
- Traffic Signs Manual. Department of Transport, Tourism and Sport.
- National Cycle Manual. National Transport Authority.
- A Guidance Document for the Implementation of the CEDR Forgiving Roadsides Report, Transport Infrastructure Ireland.

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