

Road Geometry

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TII Standards Training 2017

Athlone	09 th May 2017
Carrick on Shannon	11 th May 2017
Cork	16 th May 2017
Dublin	18 th May 2017

Overview of Changes

Alastair de Beer (TII)

Geometry Standards Published 2017

TII Publications Number	TII Publication Title	Status	Set
DN-GEO-03028	The Location and Layout of Service Areas	Updated	Standards
DN-GEO-03031	Rural Road Link Design	Updated	Standards
DN-GEO-03036	Cross-sections and Headroom	Updated	Standards
DN-GEO-03047	Rural Cycleway Design – Off Road	Updated	Standards
DN-GEO-03060	Geometric Design of Junctions	New	Standards
CC-SCD-00001 - CC-SCD-00007	Standard Construction Details for Road Type and Cross Section	Updated	Standards
CC-SCD-01110	SCD for Raised and Kerbed Channelising Islands	New	Standards

Geometry Standards Withdrawn 2017

TII Publication Number	TII Publication Title	Status	Set	Notes
DN-GEO-03032	Road Link Design for Type 2 and Type 3 Dual Carriageways	Withdrawn	Standards	Superseded by DN-GEO-03031 and DN-GEO-03060
DN-GEO-03033	Geometric Design of Roundabouts	Withdrawn	Standards	Superseded by DN-GEO-03060
DN-GEO-03035	Layout of Grade Separated Junctions	Withdrawn	Standards	Superseded by DN-GEO-03060
DN-GEO-03042	Layout of Compact Grade Separated Junctions	Withdrawn	Standards	Superseded by DN-GEO-03060
DN-GEO-03043	Geometric Design of Major/Minor Priority Junctions and Vehicular Access to National Roads	Withdrawn	Standards	Superseded by DN-GEO-03060
DN-GEO-03045	Segregated Left Turn Lanes and Subsidiary Deflection Islands at Roundabouts	Withdrawn	Standards	Superseded by DN-GEO-03060
DN-GEO-03057	Geometric Design to Improve Surface Drainage	Withdrawn	Technical	Incorporated into DN-GEO-03031

DN-GEO-03031 – Rural Road Link Design

Principal Updates

- References to geometric design of urban roads and streets removed (DMURS).
- Design requirements for Type 2 and Type 3 Dual Carriageways incorporated (TD 10 withdrawn).
- Design requirements for cycle/pedestrian facilities incorporated into the road cross section added to Standard.
- Geometric design to enhance surface water drainage incorporated.
 - ***One all encompassing Rural Road Link Design Standard.***



DN-GEO-03060 - Geometric Design of Junctions

New combined junction standard:

- ✓ Priority junctions
- ✓ Direct accesses
- ✓ Roundabouts
- ✓ Grade separated junctions
- ✓ Compact grade separated junctions

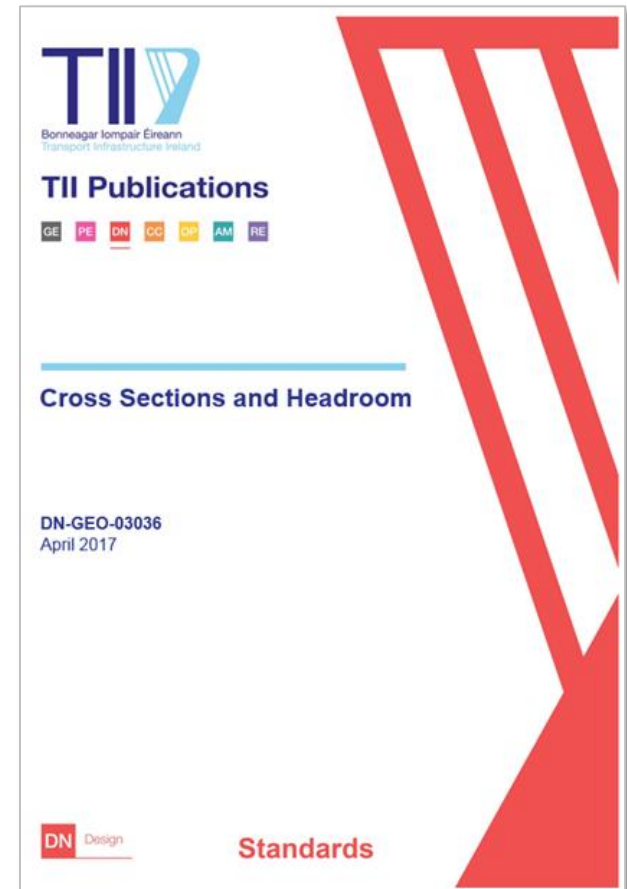


- Junction arrangements for Type 2 and Type 3 Dual Carriageways incorporated.
- References to junction arrangements for urban roads and streets have been removed.
- Details of facilities for non-motorised users (NMUs) at junctions have been added.
- ***One all encompassing Junction Design Standard.
(excluding major interchanges)***

DN-GEO-03036 – Cross Sections and Headroom

Principal Updates:

- Design details for cycle facilities within the road cross section included.
- Options for provision of cycle facilities clarified.
- Rural Cycle Scheme standard renamed to Rural Cycleway Design (Offline).
- Forgiving roadsides concept introduced at early stage design.



DN-GEO-03036 – Cross Sections and Headroom

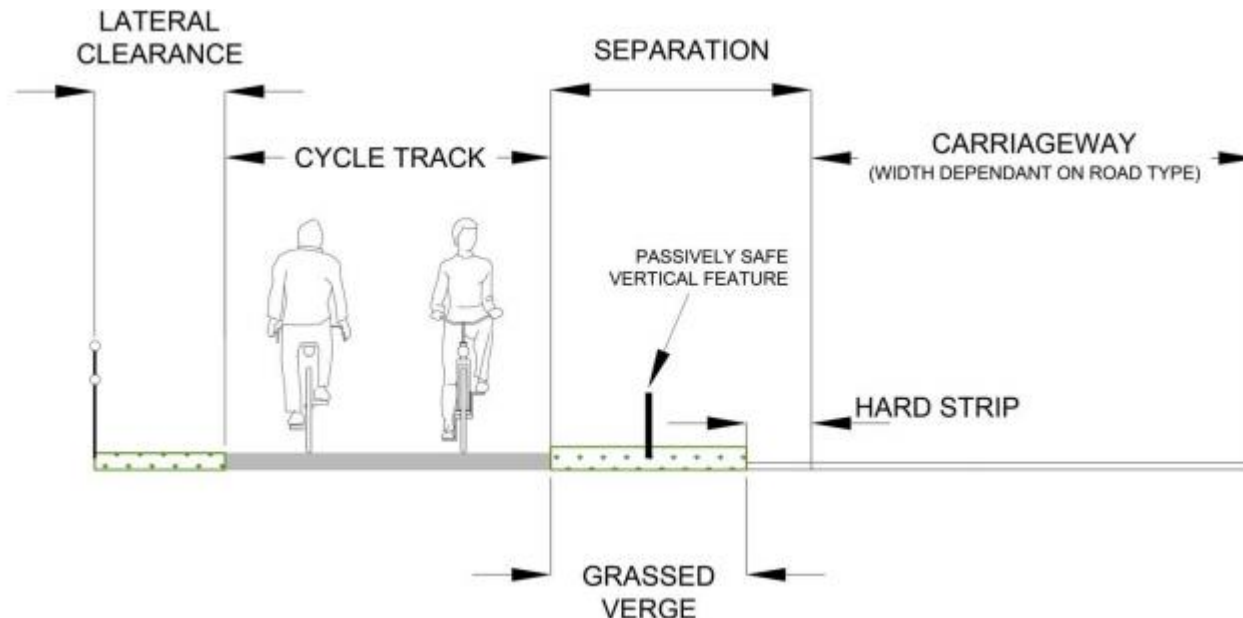
Principal Updates:

- 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.
 - As a Cycleway remote from the road designed in accordance with DN-GEO-03047. This may include the use of suitable disused railways, canal tow paths or forest trails where appropriate.
 - Within the maintenance strip or verge of the national road in accordance with DN-GEO-03036.
 - Using a suitable existing alternative route incorporating appropriate signage (Departure from Standards).

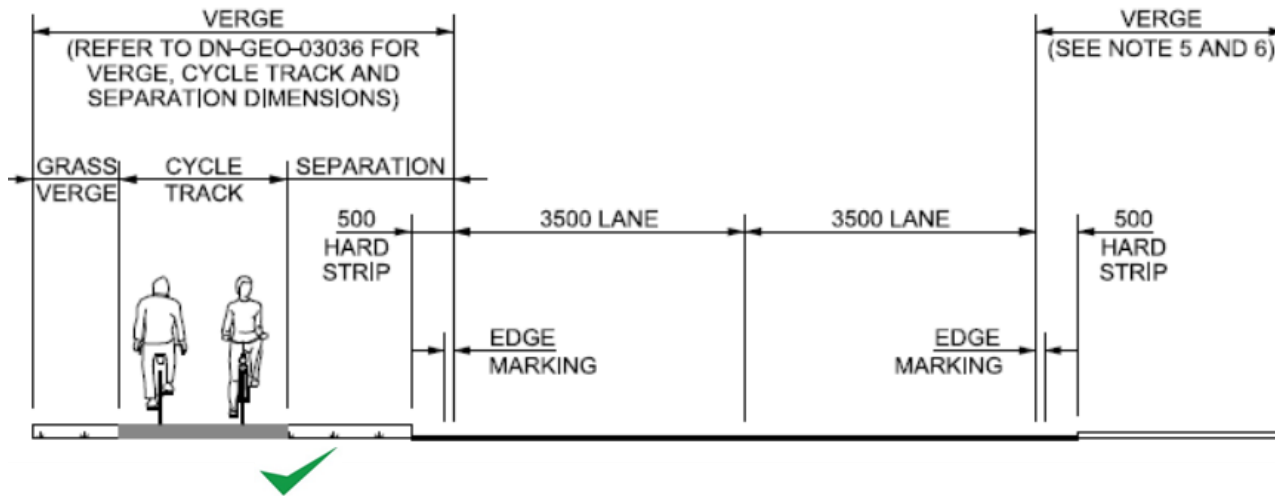
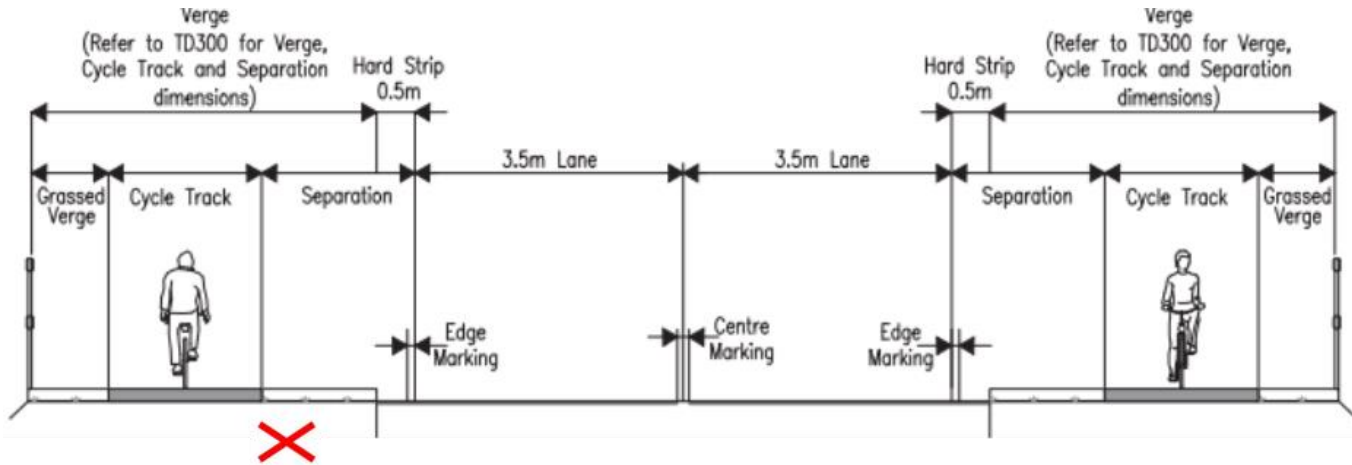
DN-GEO-03036 – Cross Sections and Headroom

Principal Updates:

- Where cycle/pedestrian facilities provided within the verge:
 - Position as far from the edge of the carriageway as possible.
 - Share the maintenance strip where practical, including access to side roads at structures locations (designed as cycleway rural road crossings in accordance with DN-GEO-03047).
 - Separation distances are the minimum requirements.



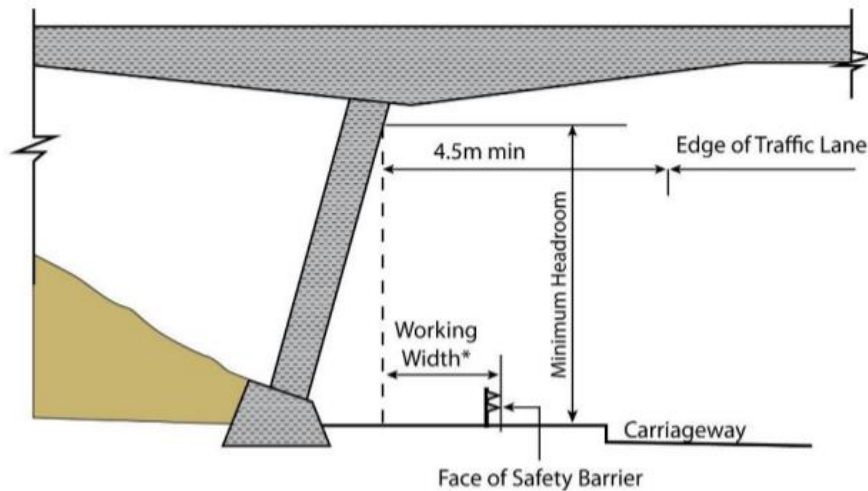
SCDs for Road Type and Cross Section



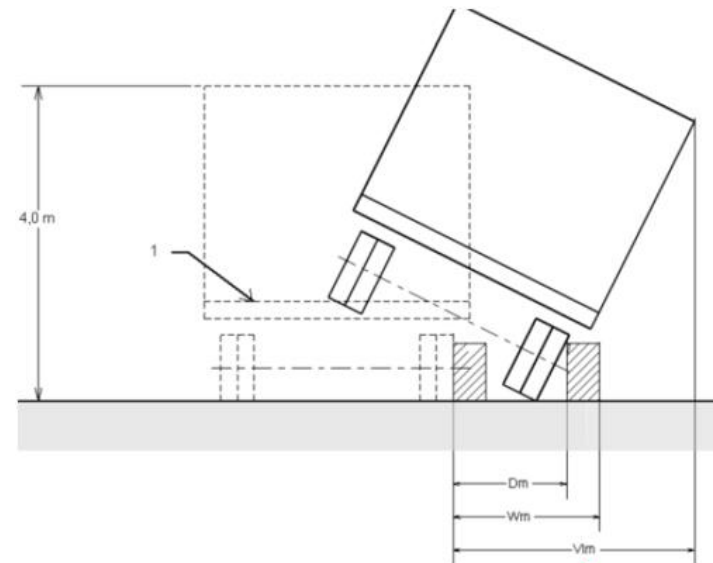
DN-GEO-03036 – Cross Sections and Headroom

Principal Updates:

- Clarification in relation to the minimum headroom clearances at structures:
 - To the back of the working width or vehicle intrusion width, whichever is greater, of any safety barrier.



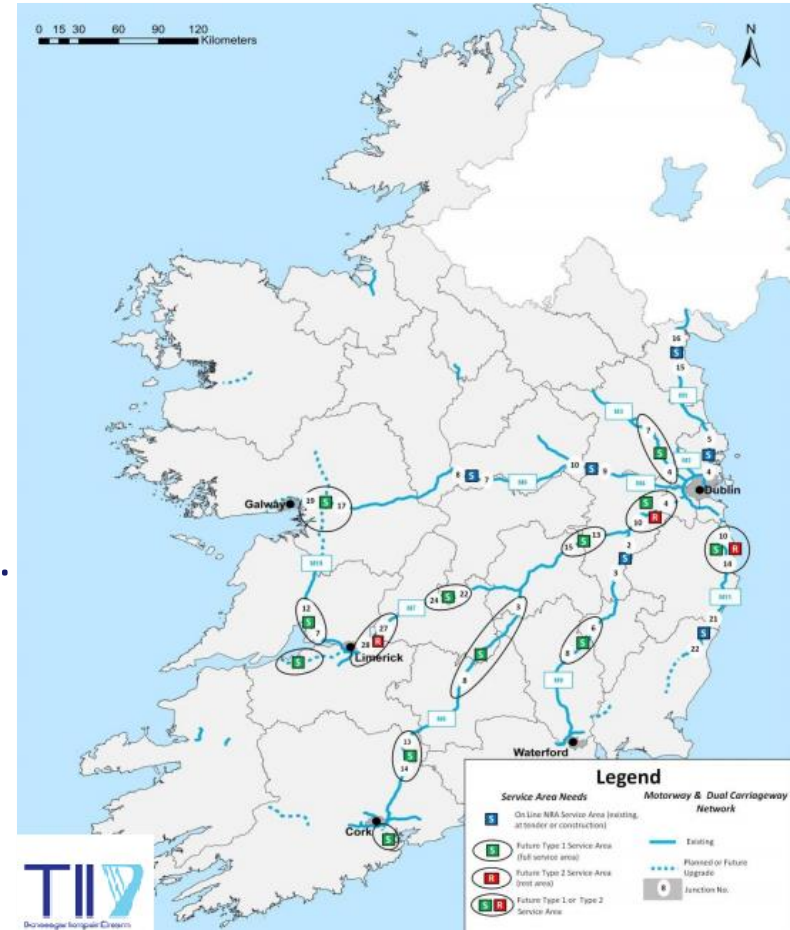
*working width or vehicle intrusion width, whichever is greater



DN-GEO-03028 – Location and Layout of Service Areas

Principal Updates

- New Type 1 (Terminal) Service Area to serve port related traffic added.
- Level of facilities based on assessment of demand and subject to TII approval (parking, toilets, shower, fuel, food).
- Express Roads now a road category where provision of service areas shall be considered.
- TII's policy on service areas referenced for level of provision.
- Reference made to EU Directive on the deployment of alternative fuels infrastructure.



Rural Road Link Design

Peter Adams (Arup)

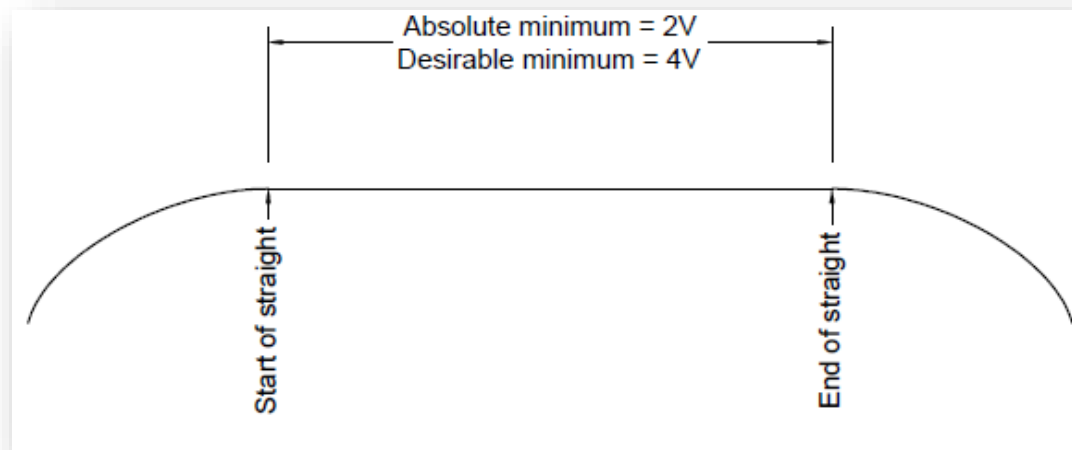
Why update the Standard?

- Keep it up to date – include new chapters where required
- Include latest thinking
- Learn from experience – clarify ambiguity, sharpen requirements
- Remove redundant references
- Retain practical considerations
- Don't strangle the skill of road design

DN-GEO-03031 Rural Road Link Design

Principal Updates:

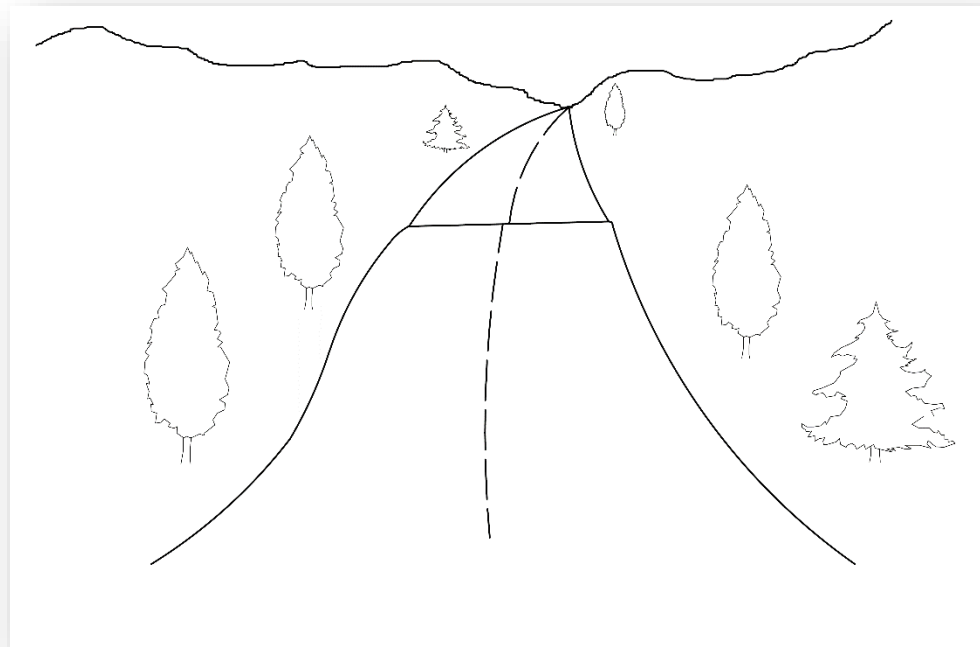
- DN-GEO-03032 (TD 10) has been incorporated, Type 2 & 3 DC added to Rural Road Layouts in Table 6/1
- Distinction between **Bands A and B Design Speed** removed
- Definitions for Urban Street and Urban Relief Road included
- Broken Back Curves have been defined



DN-GEO-03031 Rural Road Link Design

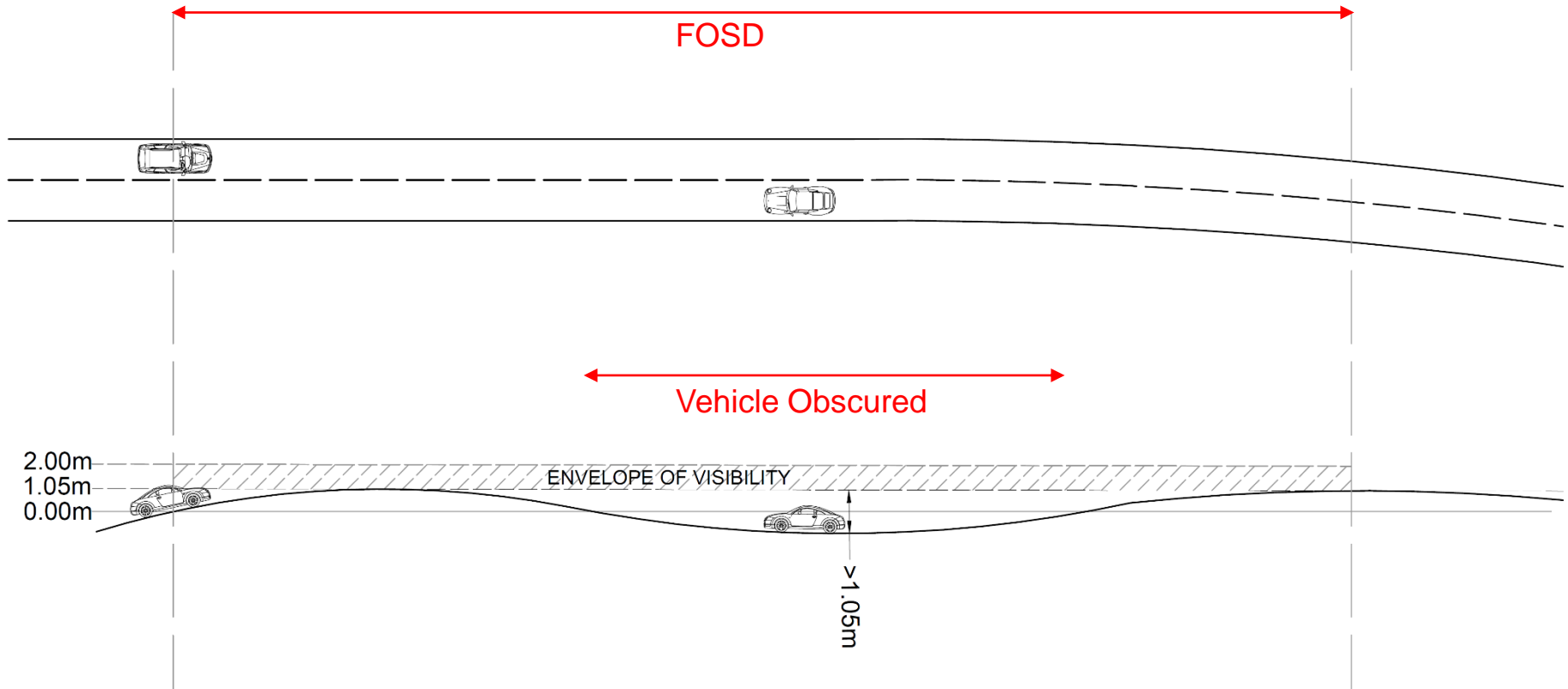
Hidden Dips

- An amended definition for a hidden dip / FOSD along with diagrams to illustrate is now included (Section 7.9).



DN-GEO-03031 Rural Road Link Design

Hidden Dips



Problem: Vertical height between the underside of 1.05m sight line and the road surface too great to provide FOSD in the vertical plane.

DN-GEO-03031 Rural Road Link Design

	Associated Relaxation	Motorways		Type 1, 2 and 3 Dual Carriageways		Type 1, 2 and 3 Single Carriageways	
		High Object	Low Object ¹	High Object	Low Object ¹	High Object	Low Object ¹
1	No Relaxation in horizontal curvature, vertical curvature, gradient or superelevation.	1 Step ^{2,3}	2 Steps ³	2 Steps ³	2 Steps ³	2 Steps ⁵	2 Steps ⁵
2	1 Step Relaxation in horizontal curvature.	1 Step ^{2,3}	2 Steps ³	1 Step ^{2,3}	2 Steps ³	1 Step ^{2,4,5}	2 Steps ⁵
3	2 Step Relaxation in horizontal curvature.	None ²	1 Step	None ²	1 Step	None ^{2,4}	1 Step ^{4,5}
4	3 Step Relaxation in horizontal curvature.	None ²	None ²	None ²	None	None ^{2,4}	None ^{2,4}
5	4 Step Relaxation in horizontal curvature.	None ²	None ²	None ²	None	None ^{2,4}	None ^{2,4}
6	Relaxation in vertical curvature.	None ²	1 Step	None ²	1 Step	None ^{4,5,6}	1 Step ^{4,5}
7	Uphill Gradient Relaxation	1 Step ²	2 Steps	1 Step ²	2 Steps	None ^{2,4}	1 Step ^{4,5}
8	Downhill Gradient Relaxation	None ²	1 Step	None ²	1 Step	None ^{2,4}	1 Step ^{4,5}
9	Superelevation Relaxation.	None ²	1 Step	None ²	1 Step	None ^{2,4}	1 Step ^{4,5}

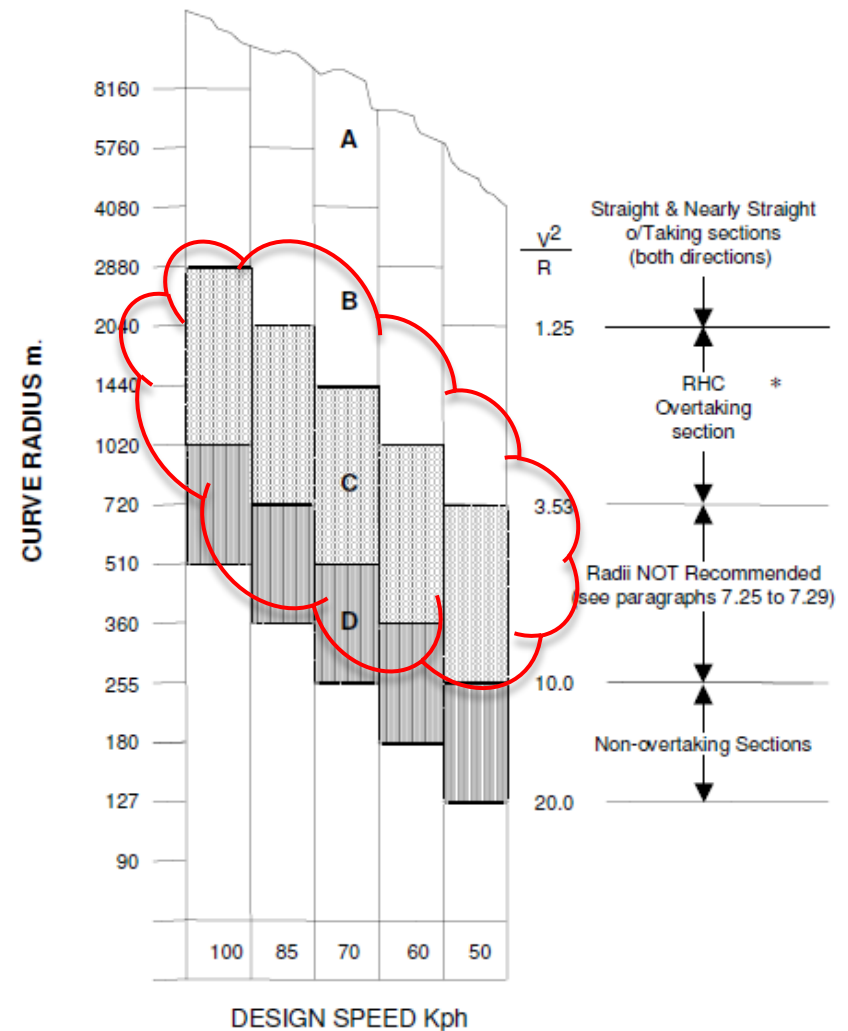
Sight Distance Updates

- Tables 2/1 and 2/2 showing the permitted relaxation in Stopping sight distance remote from and in the vicinity of a junction are included. (Previously included in Annex B).
- Motorways and Dual Carriageways a **one step** Relaxation below the Desirable Minimum Stopping SSD to the **high object** in combination with an uphill gradient relaxation is now permitted (remote from junction only).

DN-GEO-03031 Rural Road Link Design

Band C Curvature

- Previous version of standard recommended that use of horizontal curvature within Band C is avoided but did not require a departure.



DN-GEO-03031 Rural Road Link Design

Band C Curvature

New Road Design and Online Improvement:

- The use of radii in Band C is now regarded as a Departure from Standards for new and online improvement road schemes due to potentially unsafe overtaking conditions (Section 7.7)

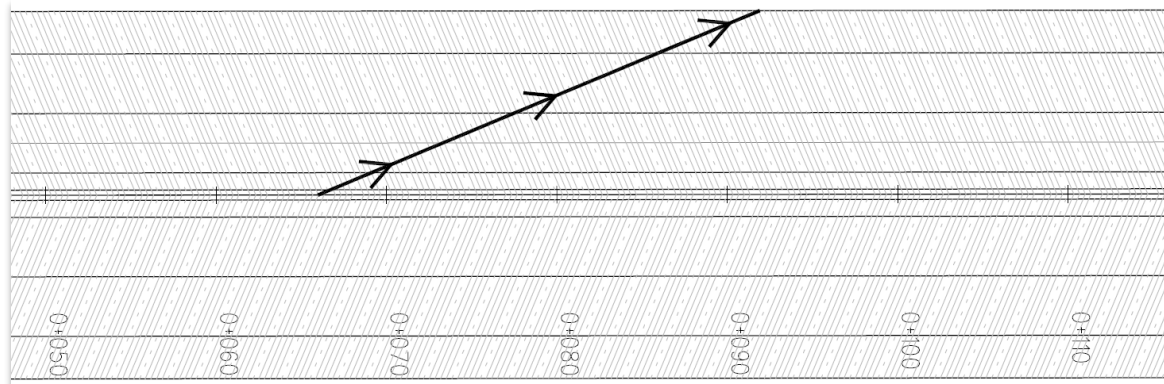
Regional and Local Roads:

- Use of Band C curves permitted as a relaxation from standard for regional and local roads upgraded as part of a national road scheme (Section 10.11)

DN-GEO-03031 Rural Road Link Design

Road Camber

- Section 11.5. – As a relaxation, a camber of 3% may be used for sections of carriageway with shallow or flat longitudinal gradients and greater than 2 lanes in width, to reduce drainage path lengths.
- The designer must consider the increased length of transitions required at rollover sections when using a camber of 3%.



- For narrow local roads, a continuous crossfall between the edges of the road is a permitted relaxation.

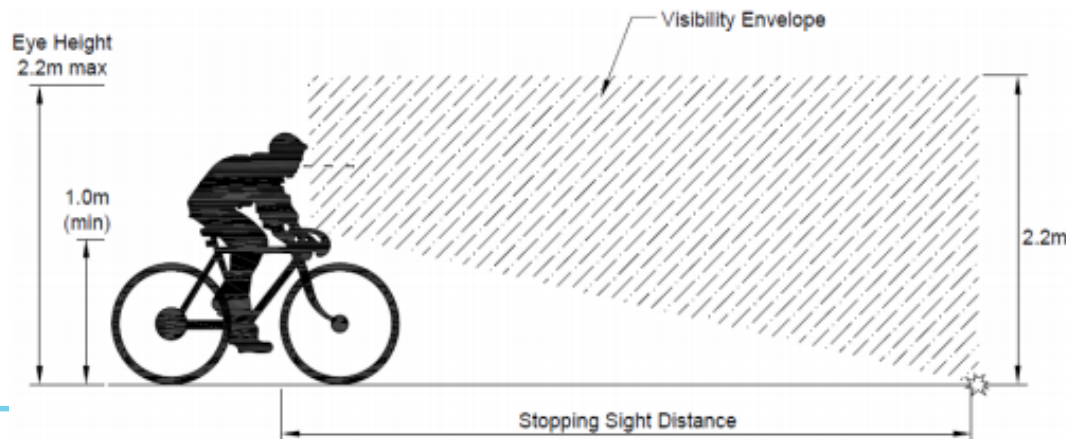
DN-GEO-03031 Rural Road Link Design

Two-way Single Carriageways (Vertical Curve Design)

- Requirement for one step below desirable minimum curves on straight or near straight sections removed
- Unless FOSD is provided, the crest K value should not be greater than **Desirable Minimum**
- Definition of Overtaking Section
- Approach to Line-Marking
- Overtaking Value increased to 50% for new build schemes

DN-GEO-03031 – Rural Road Link Design

- The design requirements for non-motorised users have been incorporated:
 - i) Design speeds for cyclists
 - ii) Dynamic and Stopping Sight Distances for Cyclists
 - iii) Horizontal Alignment for Cycle Facilities
 - iv) Gradients for Cycle Facilities



DN-GEO-03031 Rural Road Link Design

New Chapter 9 – Express Roads

Regulation (EU) No. 1315/2013 (TEN-T Core Network)

- **Article 39 (2)**

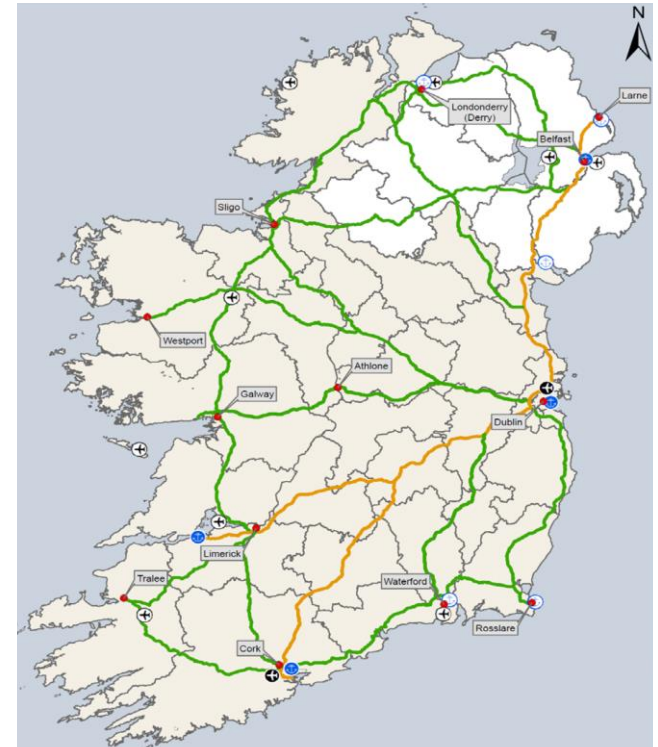
*'...the following requirements shall be met by the infrastructure of the **core network**:*

(c) for road transport infrastructure

- the requirements under points (a) or (b) of Article 17 (3)'

*Article 17 (3) (a) and (b) are the motorway and **express road** definitions.*

The core network can only be motorway or express road.



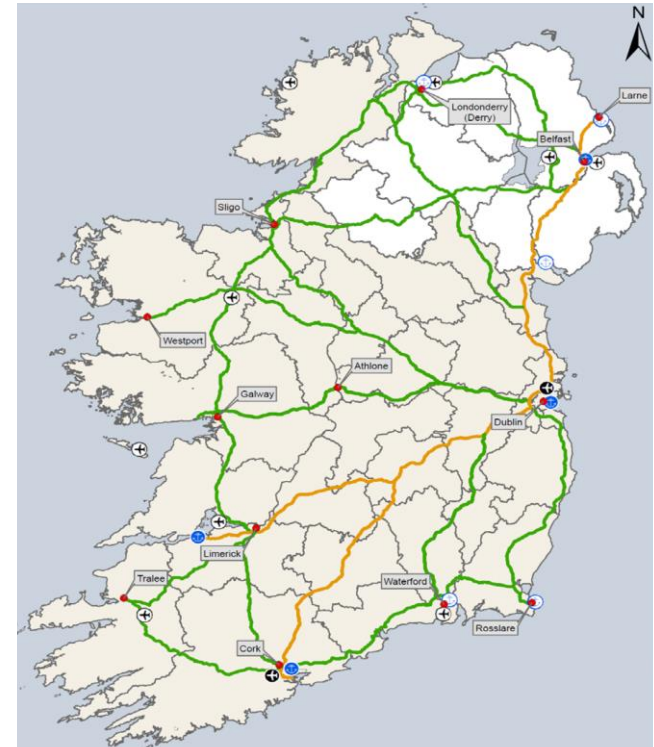
DN-GEO-03031 Rural Road Link Design

Express Road Definition added:

*“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.”*

- An Express Road shall be a Type 1 Single or Type 1 or 2 Dual Carriageway road type.
- Junction types permitted:
 1. Grade separated and compact grade separated
 2. Roundabouts
 3. Left-in/Left-out

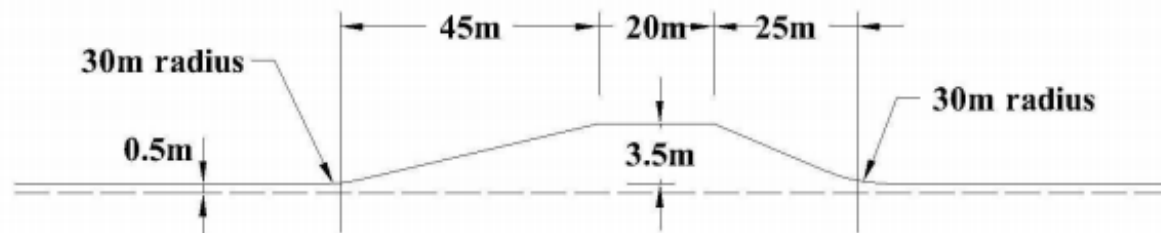


DN-GEO-03031 – Rural Road Link Design

Type 2 and 3 Dual Carriageway Parking Bays

- To allow for breakdowns and to facilitate maintenance
- Provided both sides every 1km to 1.5km dependant on site constraints
- Sited so that opposing parking bays either side of the road are staggered
- Wherever practicable, parking bays should not be sighted on the inside of bends or near junctions

Figure 8.4: Parking Bay



DN-GEO-03031 Rural Road Link Design

New Chapter 11

‘Geometric Design to Enhance Surface Drainage of Carriageways’

- Incorporates DN-GEO-03057 (IAN 09/13) into standard:
 - Issue of Aquaplaning not given sufficient prominence in existing geometric standards
 - Road surface geometry has the most direct influence on the surface flow and the build-up of storm water runoff
 - Places avoidance of aquaplaning as a geometric design issue



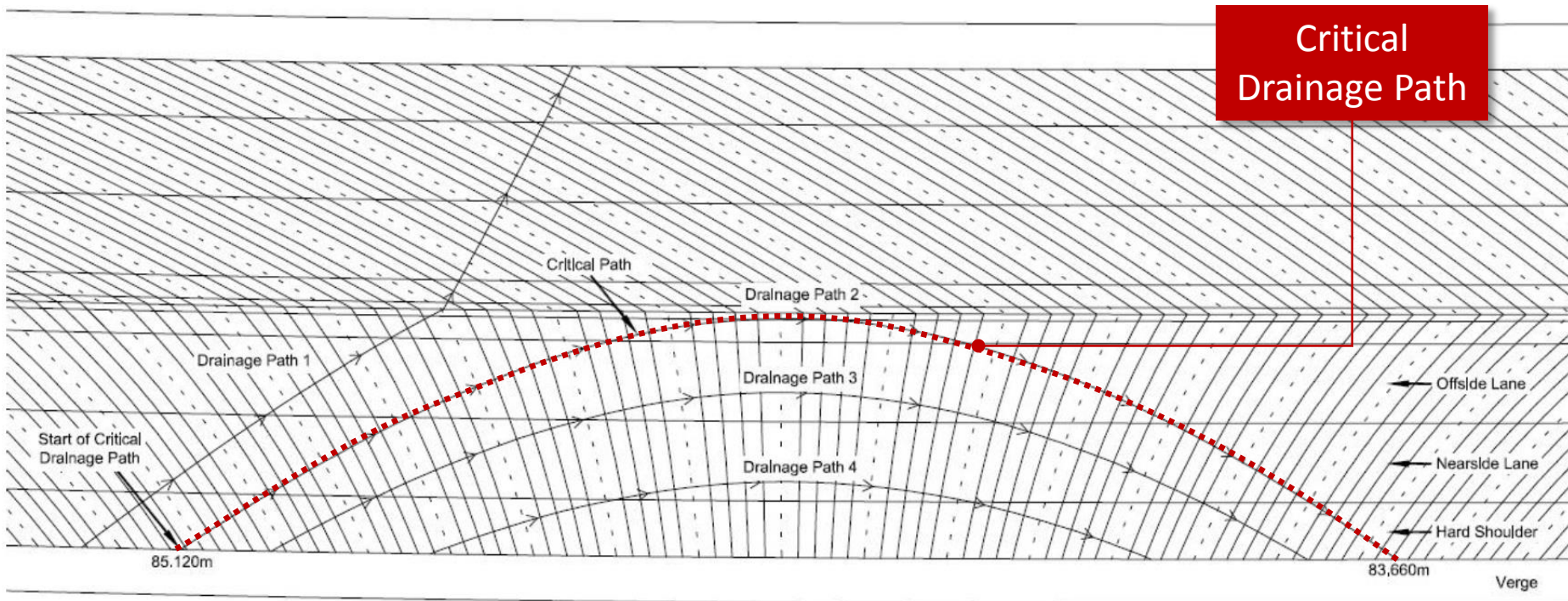
DN-GEO-03031 Rural Road Link Design

New Chapter 11

- Introduces mandatory design requirements to limit water film depths and minimise aquaplaning risk
- Increases the minimum resultant gradient from 0.5% to 1%
- Requires the designer to compile an **Aquaplaning Assessment Report** for submission to TII at **Preliminary Design Stage**

Drainage Flow Path - Length

- WFD analysis to be carried out on Critical Drainage Path
 - Contour plot at typical Rollover Location:



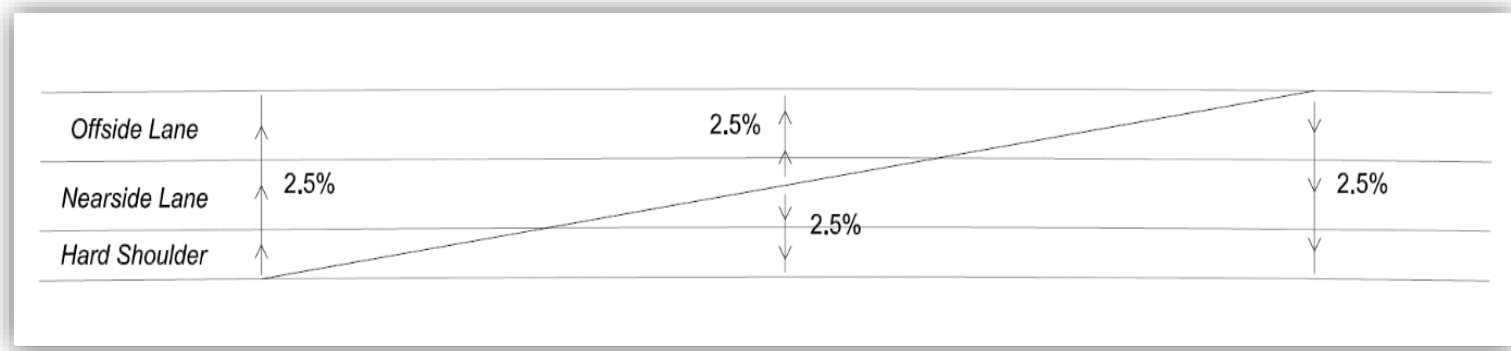
$$D = \frac{0.103 \times T^{0.11} \times L^{0.43} \times I^{0.59}}{S^{0.42}} - T$$

Assessment Criteria

- To minimise aquaplaning potential, geometric design must ensure:
 - Water film depths must not exceed ~~2.5mm~~ 3.3mm on new single carriageways (**review of Departures**)
 - On Motorways & Dual Carriageways, a maximum value of 3.3mm will apply
 - Road surface geometry shall be such that flow paths are limited to approximately 60m in length

Rolling Crowns

- Superelevation applied along diagonal crown line across carriageway



- Instantaneous change in crossfall (must not exceed 5%)
- Crown lines must be sufficiently long to achieve satisfactory ride quality
- A Departure from Standards on high speed roads

Geometric Design of Junctions

Peter Adams (Arup)

DN-GEO-03060 Geometric Design of Junctions

- New TII Standard **combining existing junction standards** into a single consolidated document

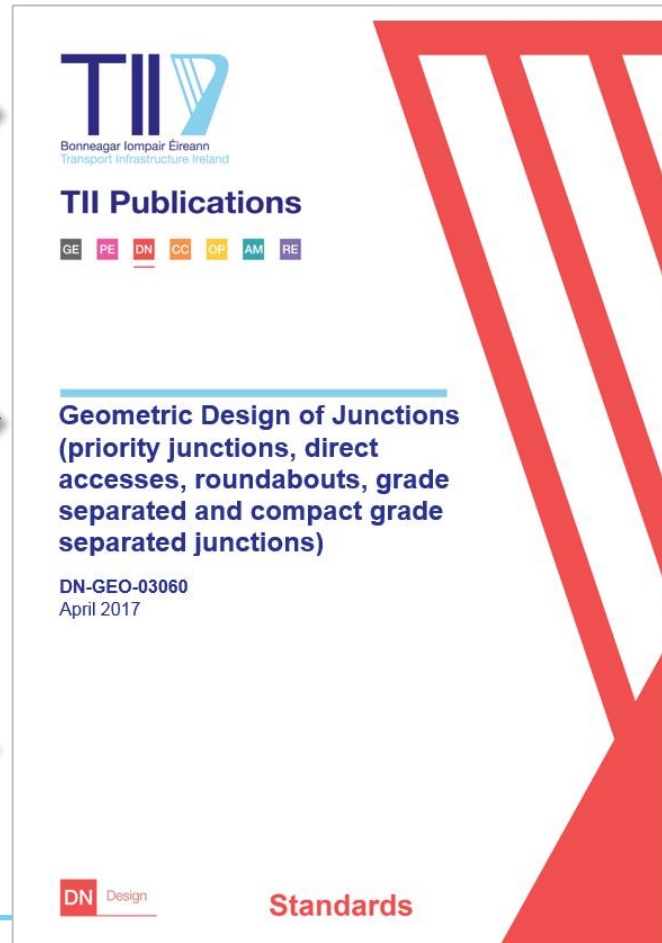
DN-GEO-03043
TD 41-42



DN-GEO-03033
TD 16/07



DN-GEO-03042
TD 40/94



DN-GEO-03035
TD 22/06



DN-GEO-03045
TD 51/03



DN-GEO-03032
TD 10/07



DN-GEO-03060 Geometric Design of Junctions

CONTENTS

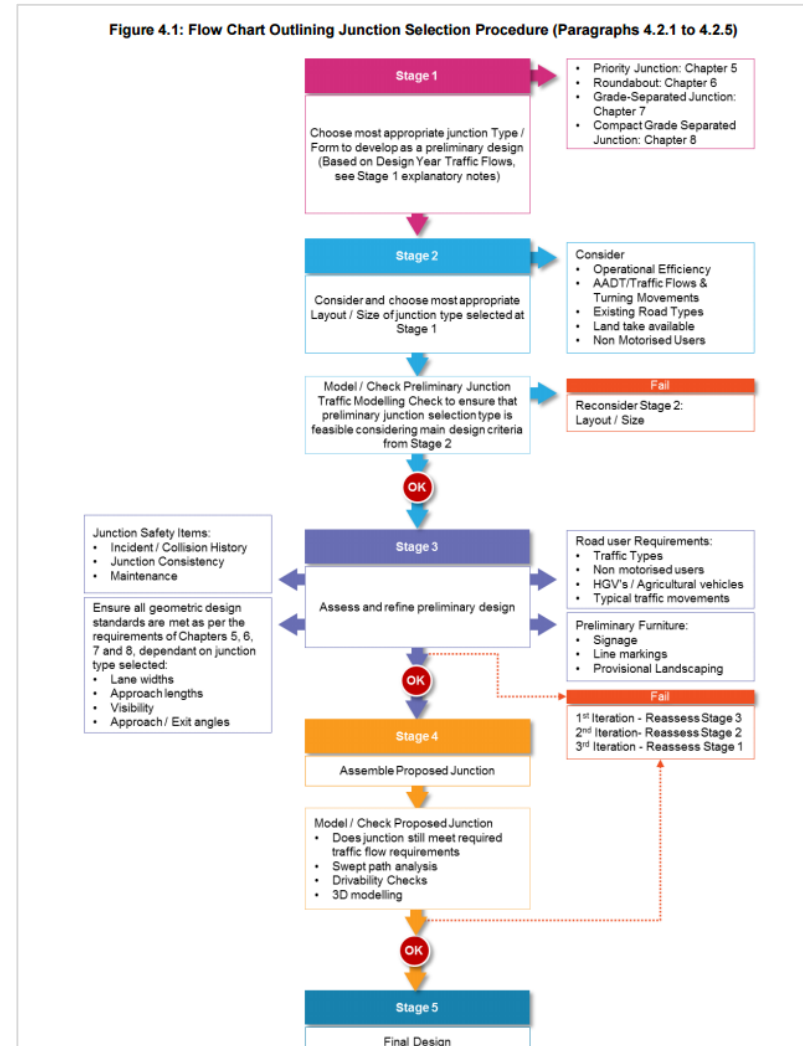
- General Introduction and Definitions
- Junction Types chapter
 - Junction descriptions and *indicative* photos and figures of layouts
 - Road markings to be designed in accordance with the TSM!
 - Advantages and disadvantages per junction type
- Road Safety chapter
 - General safety requirements at junctions
 - Specific safety requirements for a particular junction type are included within the appropriate chapter for that junction type



DN-GEO-03060 Geometric Design of Junctions

CONTENTS

- Selection of Junction Type Chapter
 - Guidance in relation to the process for choosing the most appropriate junction type
 - AADT values provided to assist with an ***initial assessment of the most appropriate junction type***
 - Final junction arrangement shall be informed by a detailed analysis of turning movements and peak hour flows
- Individual chapters for the design and layout of each junction type



DN-GEO-03060 Geometric Design of Junctions

Junction Analysis Procedure

- To record the decision making process in selecting the most appropriate junction form
- Should form part of the junction strategy or preliminary design report
- Junction layout and turning movement diagram to be included
- Worked example included in Appendix D of the document

Data Collection		Classification and Name	AADT		Design Speed (Km/h)	Posted Speed (Km/h)
			Current Year ()	Design Year ()		
Major road						
Intersecting Road						
Junction Type		New <input type="checkbox"/>		Existing <input type="checkbox"/>		
Site Visit		Yes: <input type="checkbox"/>	No: <input type="checkbox"/>	Date of Site Visit (if applicable): _____		
Functional Characteristics		Part 1 (General Information for all Intersections)				
Collision Analysis						
Access Requirements (Including NMU Requirements and Level of Usage)						
Access Control						
Future Development						
Vehicle Design Type (Include any Special Design Vehicle Details)						
% HGV's						
		Part 2 (Specific Information for More Detailed Analysis)				
Junction Layout & Turning Movement Diagram		<i>Include Layout with all approaches clearly labelled. Direction of flow and flow ratios to be clearly identified. Worked example included in Appendix D to this document.</i>				
Notable Constraints due to Upstream/Downstream Junction		Yes: <input type="checkbox"/>	No: <input type="checkbox"/>	Notes: _____		
Proposed Improvements to Other Roads (that would impact the traffic movement at this location)						
Geometric Characteristics						
Road Geometry on all approaches		To be attached in an appendix to this document.				
Is design compliant with the standards		Yes: <input type="checkbox"/>				
Desirable Stopping Sight Distances				Achievable Stopping Sight Distances		
Mainline Horizontal Curvature						
Profile gradient on mainline		_____ %		Intersecting Roadway		_____ %
Other Characteristics						
Traffic Management Measures						
Impact on Utilities						
Impact on Right of Way						
Recommendation of Type of Junction Treatment based on Functional, Geometric and Other Characteristics						
Scope of Modelling Required		Local Junction Modelling <input type="checkbox"/>		Micro-simulation Modelling <input type="checkbox"/>		
Designer: _____		Date: _____				
Approved: _____		Date: _____				

DN-GEO-03060 Geometric Design of Junctions

Chapter 5 - Geometric Design of Priority Junctions and Vehicular Accesses to National Roads (Principal Changes from TD 41/42)

- **Junction Siting:**

- Junctions located on the inside of sharp curves (below Desirable Minimum R as per DN-GEO-03031) now regarded as a Departure from Standards.

- **Vertical Alignment:**

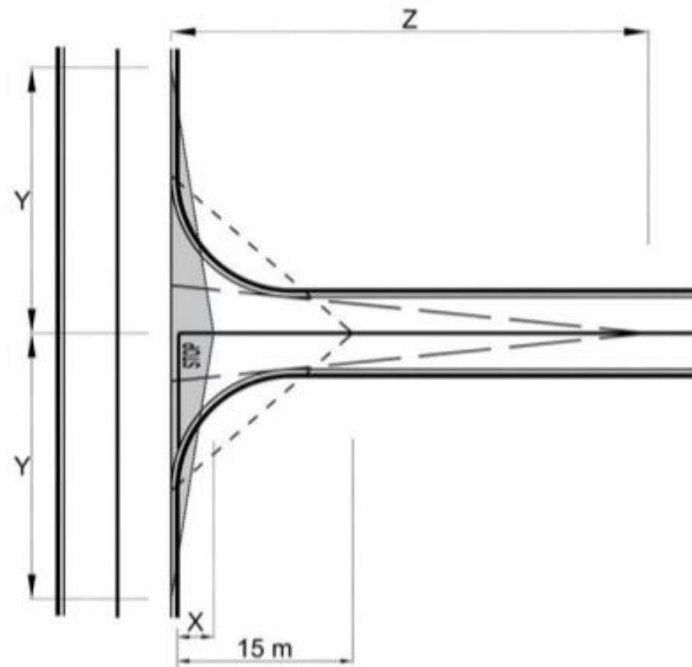
- Maximum gradients on **major road** approaches to junctions as per the road type design speed (no Relaxations on immediate approach to junctions)

DN-GEO-03060 Geometric Design of Junctions

Chapter 5 - Geometric Design of Priority Junctions and Vehicular Accesses to National Roads (Principal Changes from TD 41/42)

- **Visibility Requirements:**

- The visibility requirement for drivers emerging from a minor road or direct access is now to the **high object (1.05m)** on the major road as defined in DN-GEO-03031.

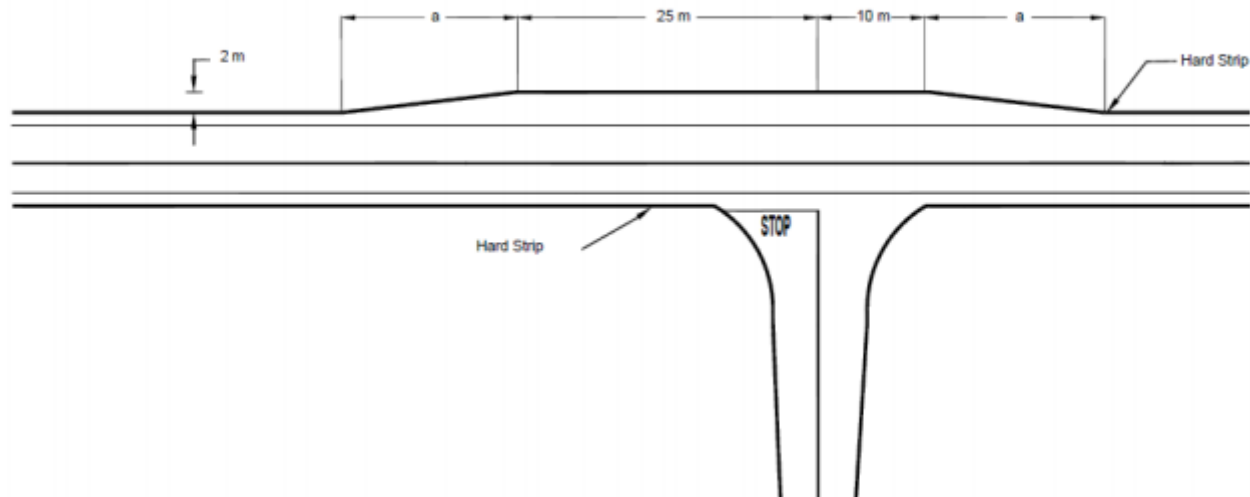


DN-GEO-03060 Geometric Design of Junctions

Chapter 5 - Geometric Design of Priority Junctions and Vehicular Accesses to National Roads (Principal Changes from TD 41/42)

- Nearside passing bays to be incorporated at all simple priority junctions on new Type 2 and Type 3 Single carriageways (no hard shoulder)
- Retrofit options at junctions to be addressed in future update to DN-GEO-03030 – Guidance for Minor Improvements to National Roads

Figure 5.4: Priority Junction with Nearside Passing Bay for Roads without Hard Shoulders

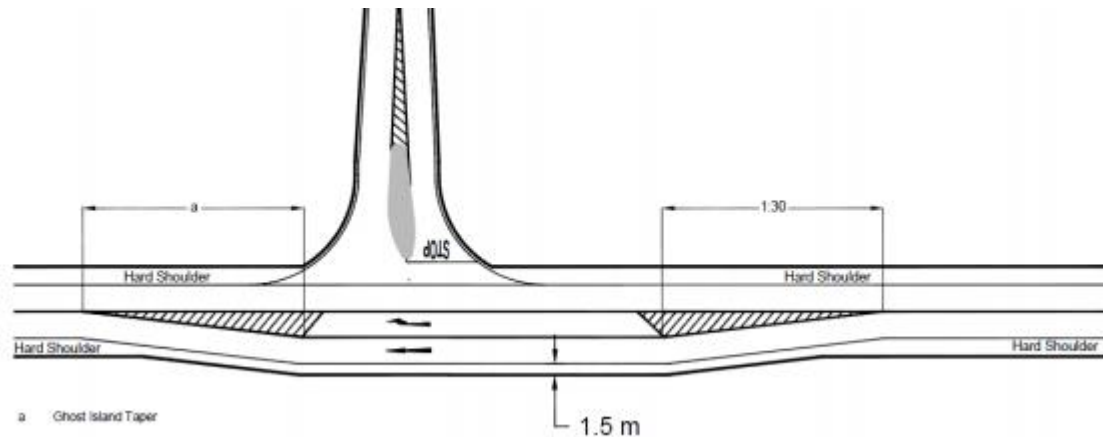


DN-GEO-03060 Geometric Design of Junctions

Chapter 5 - Geometric Design of Priority Junctions and Vehicular Accesses to National Roads (Principal Changes from TD 41/42)

- Hard shoulders on the major road opposite a ghost island junction shall be tapered to form a **1.5m hard strip**
- Upgrading an existing simple priority junction to provide a ghost island right turn lane - **0.5m hard strip permitted** if existing pavement is to be used to facilitate required widening

Figure 5.26: Treatment of Hard Shoulders at a Ghost Island Junction



DN-GEO-03060 Geometric Design of Junctions

Chapter 5 - Geometric Design of Priority Junctions and Vehicular Accesses to National Roads (Principal Changes from TD 41/42)

- **Dwell Area / Gradient**

- A combined Relaxation in dwell area and approach gradient at a dwelling access is not regarded as a Departure from Standards

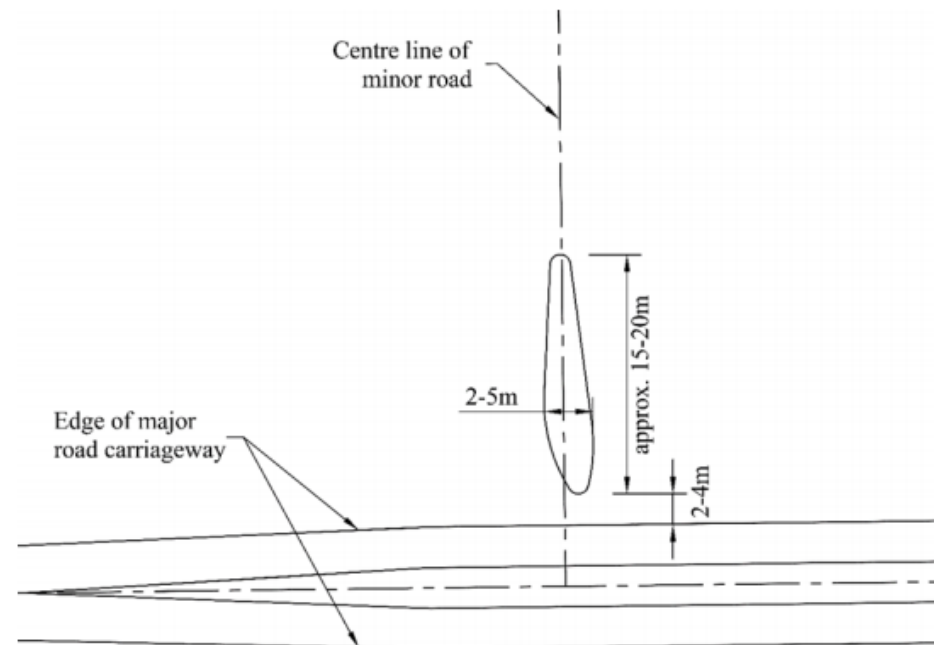
- **Channelising Islands**

- Rural channelising islands shall be raised and kerbed in accordance with CC-SCD-01110 (new SCD)
- Appendix B added for the design of channelising islands

- **Junction Corner Radii**

- 13m at Rural Simple Junctions (verify by swept path analysis)

Figure B.2f: Finalised design



DN-GEO-03060 Geometric Design of Junctions

- **Merge / Diverge Tapers**

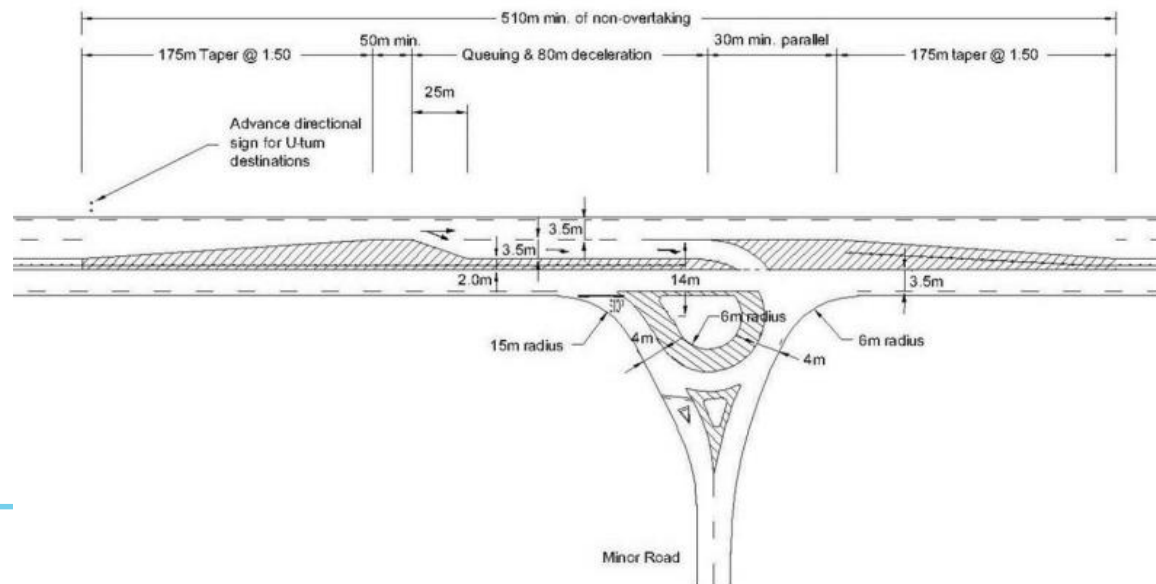
- Merge / Diverge **auxiliary lanes & tapers** not permitted on Single Carriageways
- Merge and diverge auxiliary lanes and tapers are not permitted on Type 3 dual Carriageways
- Merge auxiliary lanes and tapers are not permitted on Type 2 Dual Carriageways, however diverge auxiliary lanes and tapers are permitted
- Merge / Diverge direct **tapers** not permitted on Type 1 Dual Carriageways or Motorways

DN-GEO-03060 Geometric Design of Junctions

Chapter 5 - Geometric Design of Priority Junctions and Vehicular Accesses to National Roads (Principal Changes from TD 41/42)

- Priority Junctions – Type 3 Dual Carriageway
 - Restricted to left-in and left-out turning movements only
 - A U-turn loop can be provided at a minor road as a **Departure from Standards** where a roundabout is not justified
 - Permits right turns into the side road or access but not right turns onto the major road

Figure 5.28: Mainline turning loop at minor road (requires a Departure from Standards)



DN-GEO-03060 Geometric Design of Junctions

Chapter 6 - Geometric Design of Roundabouts (Principal Changes from TD 16)

- Roundabout type terminology amended to:
Single Lane and *Multi-Lane* only
- Minimum standard defined for all rural roundabouts, i.e. references to Mini, Compact, Double, Grade Separated, Signalised roundabouts removed



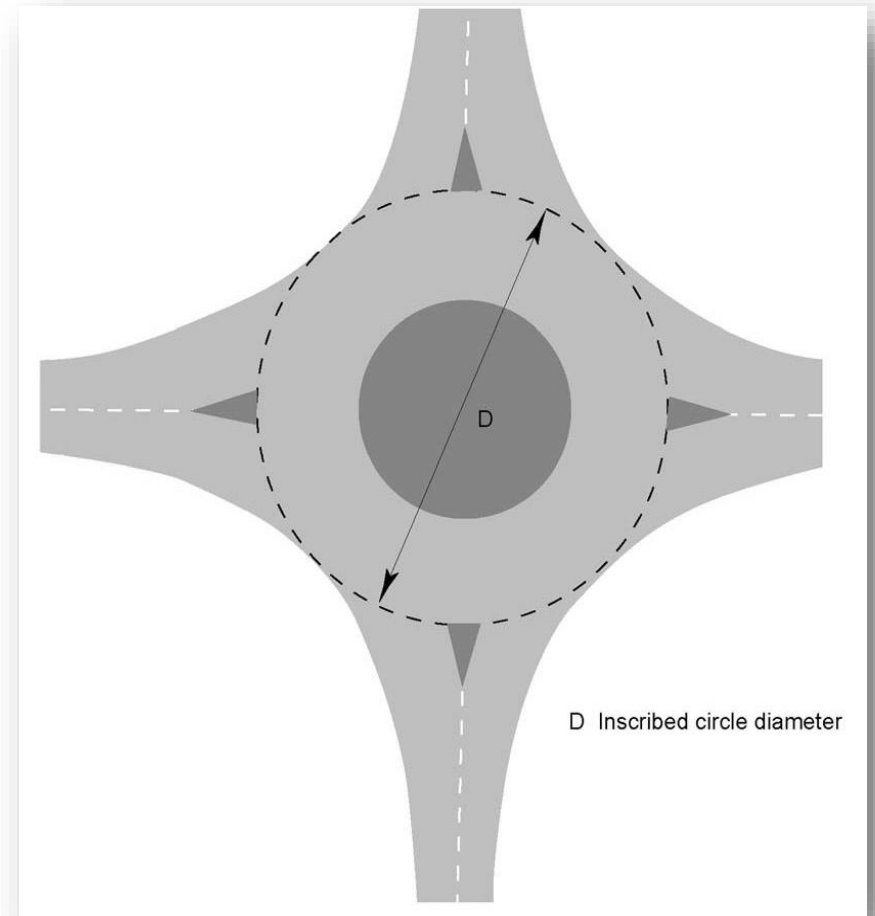
DN-GEO-03060 Geometric Design of Junctions

Chapter 6 - Geometric Design of Roundabouts (Principal Changes from TD 16)

Minimum/Maximum ICD introduced for various roundabout types:

- Single Lane
- Multi-Lane
- Five arm roundabout

Other factors such as NMU crossing requirements to be considered

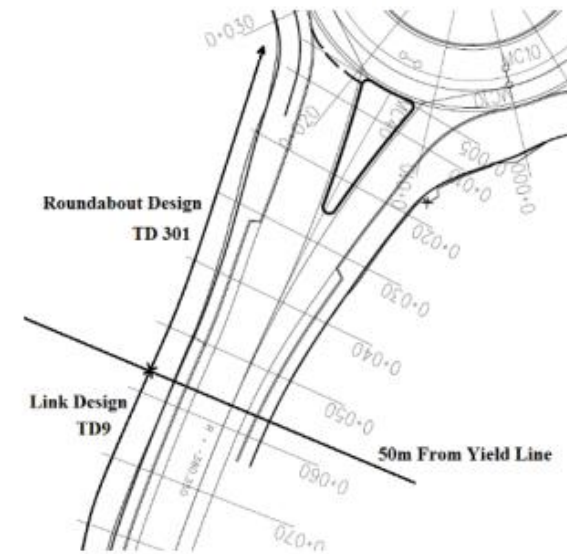


DN-GEO-03060 Geometric Design of Junctions

Chapter 6 - Geometric Design of Roundabouts (Principal Changes from TD 16)

- Introduction of cut-off point between roundabout and link design 50m from yield line.
- Five arm roundabout now a departure from standards
- Maximum longitudinal gradient of the circulatory carriageway of 2.5%
- Minimum resultant gradient of 1% within 50m of roundabout (may be reduced locally to 0.5% at interface)
- Design of Segregated Left Turn Lanes now included (previously DN-GEO-03045 (TD 51/03))

Figure 6.1: Cut-Off Point between Link Design and Roundabout Design



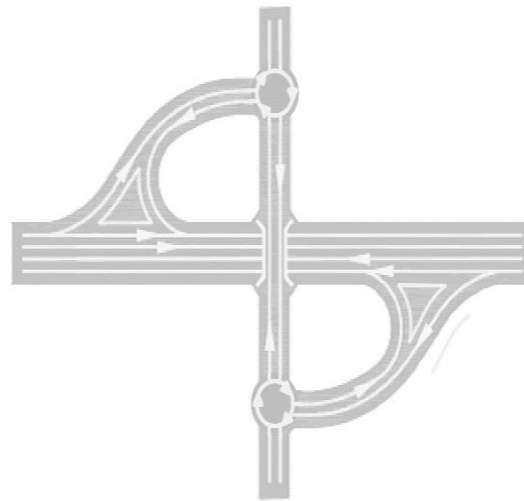
DN-GEO-03060 Geometric Design of Junctions

Chapter 7 - Layout of Grade Separated Junctions (Principal Changes from TD 22)

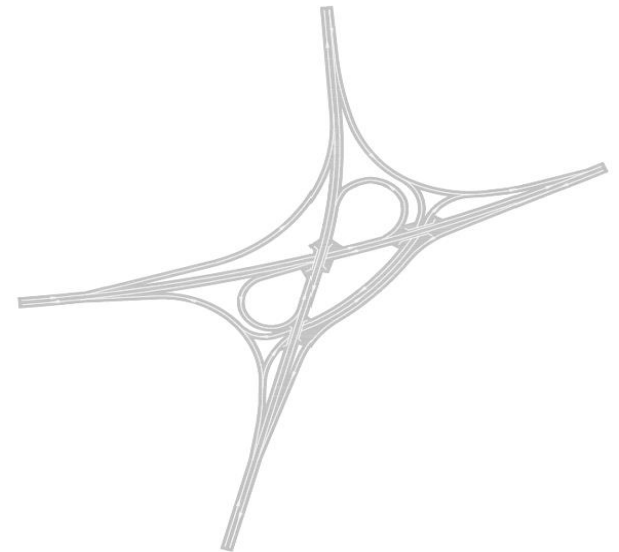
- Layout Options revised for Grade Separation on Motorway / Type 1 DC



Dumb-bell



Half Cloverleaf

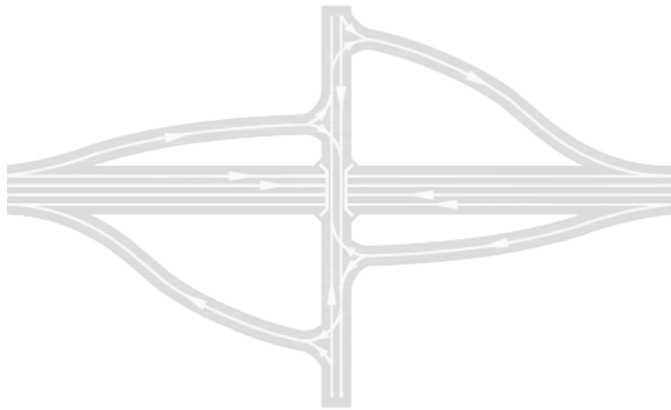


Interchange

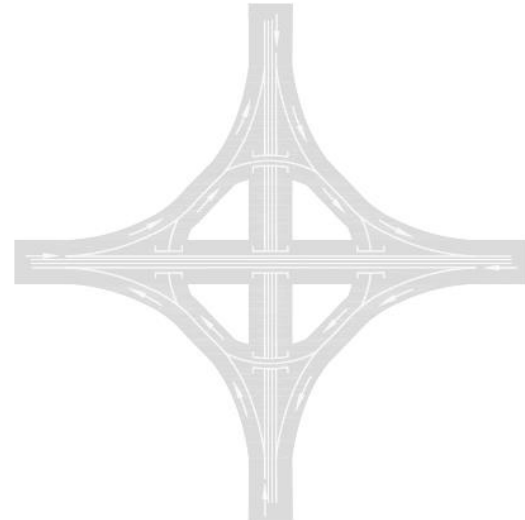
DN-GEO-03060 Geometric Design of Junctions

Chapter 7 - Layout of Grade Separated Junctions (Principal Changes from TD 22)

- Examples of Layout Options **removed** from standard:



Diamond

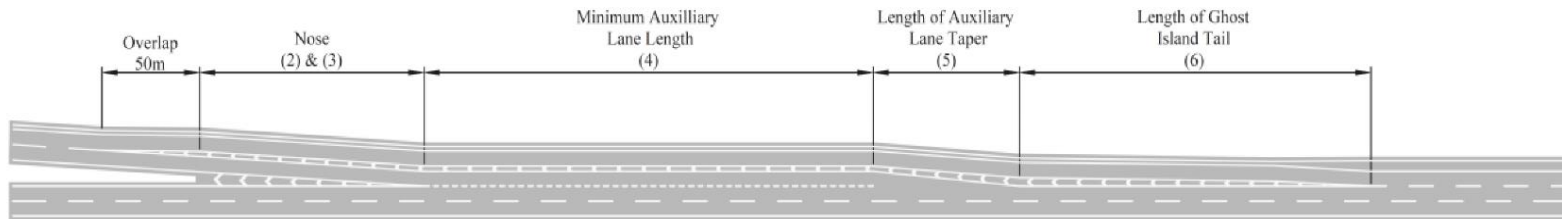


3 Level Roundabout

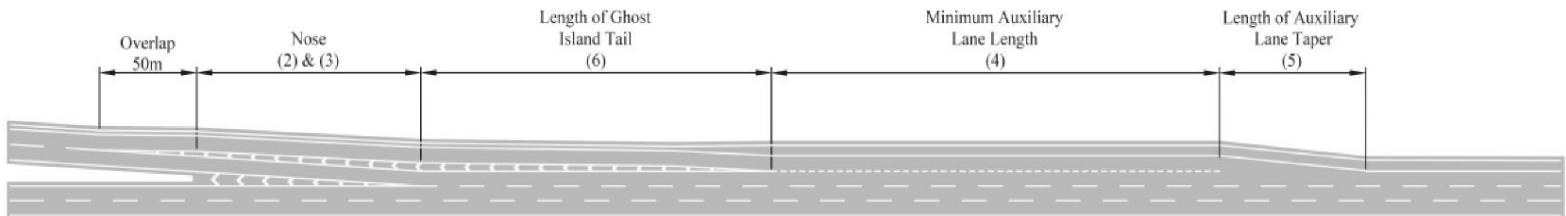
DN-GEO-03060 Geometric Design of Junctions

Chapter 7 - Layout of Grade Separated Junctions (Principal Changes from TD 22)

- Merge layout options amended to remove direct tapers



C – Lane Gain With Ghost Island Merge (Option 1 Preferred)

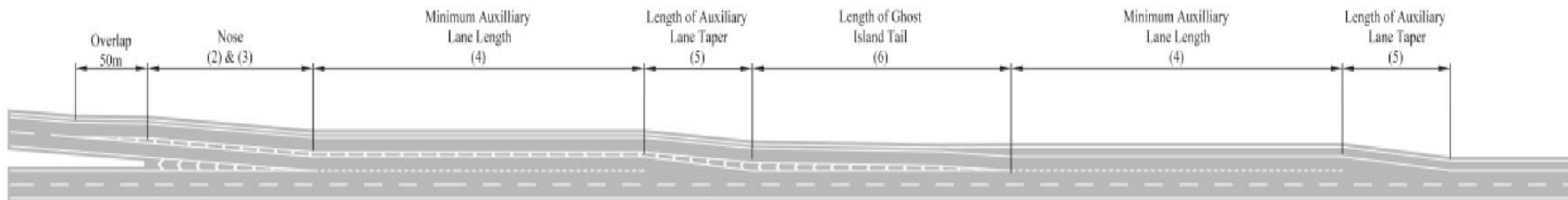


C – Lane Gain With Ghost Island Merge (Option 2 Alternative)

DN-GEO-03060 Geometric Design of Junctions

Chapter 7 - Layout of Grade Separated Junctions (Principal Changes from TD 22)

- Merge layout options amended to remove direct tapers

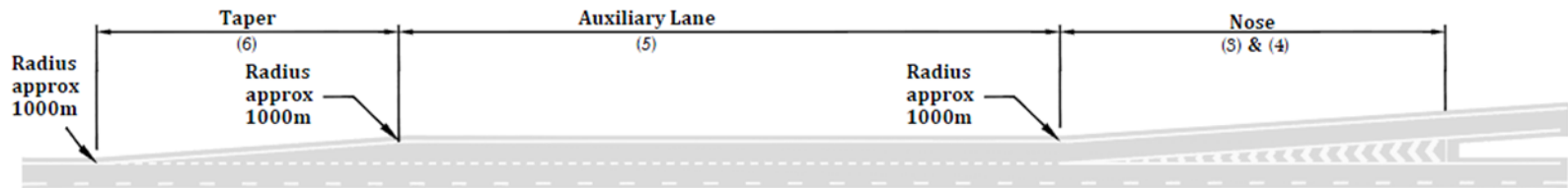


E – Alternative Ghost Island Merge With Auxiliary Lane (Departure Required)

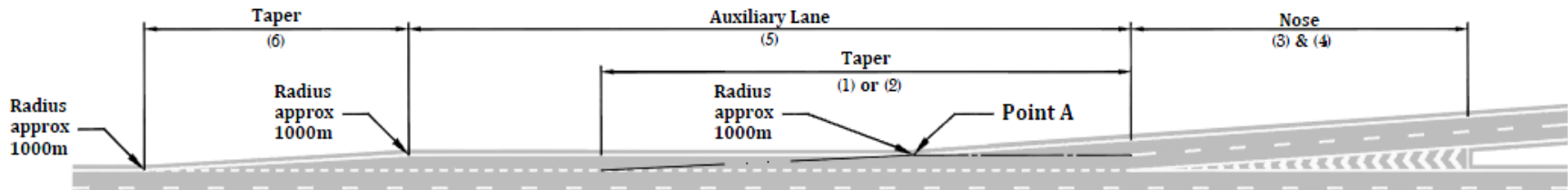
DN-GEO-03060 Geometric Design of Junctions

Chapter 7 - Layout of Grade Separated Junctions (Principal Changes from TD 22)

- Diverge Options reduced to remove direct taper diverges



A - Single Lane Parallel Diverge



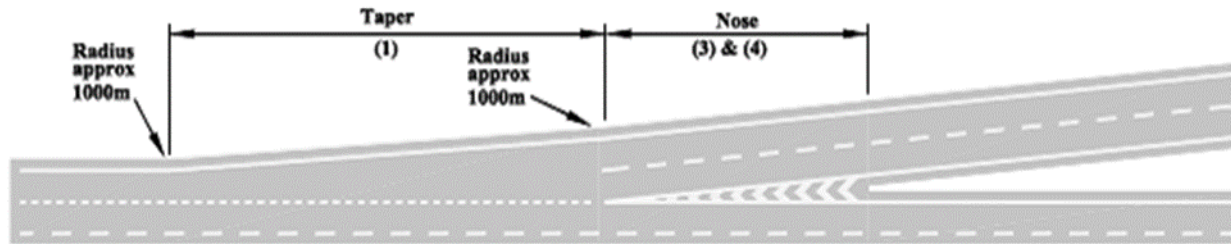
B - Single Lane Parallel Diverge showing
2 x 3.0m Diverging Lane Connector Road

Construction Lines for Taper Diverge and Parallel Diverge
(Single Auxiliary Lane) to determine Point A

DN-GEO-03060 Geometric Design of Junctions

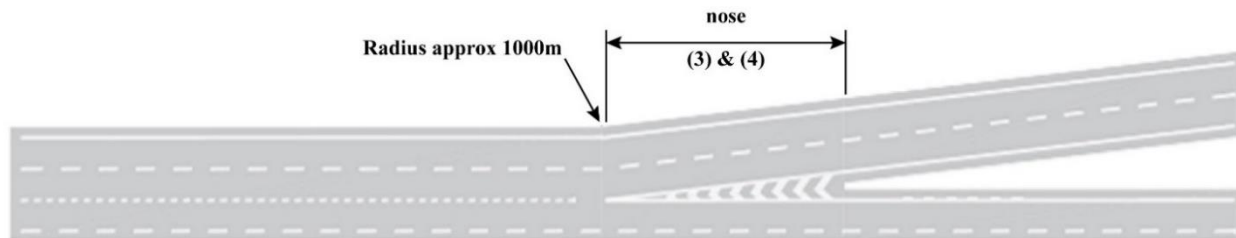
Chapter 7 - Layout of Grade Separated Junctions (Principal Changes from TD 22)

- Diverge Options reduced to remove direct taper diverges



The edge line must be laid to the radii indicated

C - Lane Drop at Taper Diverge



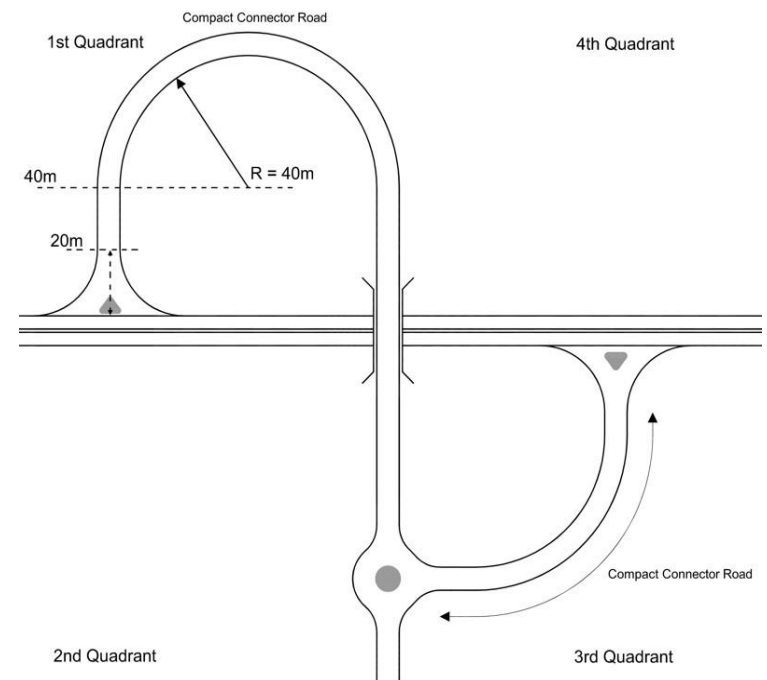
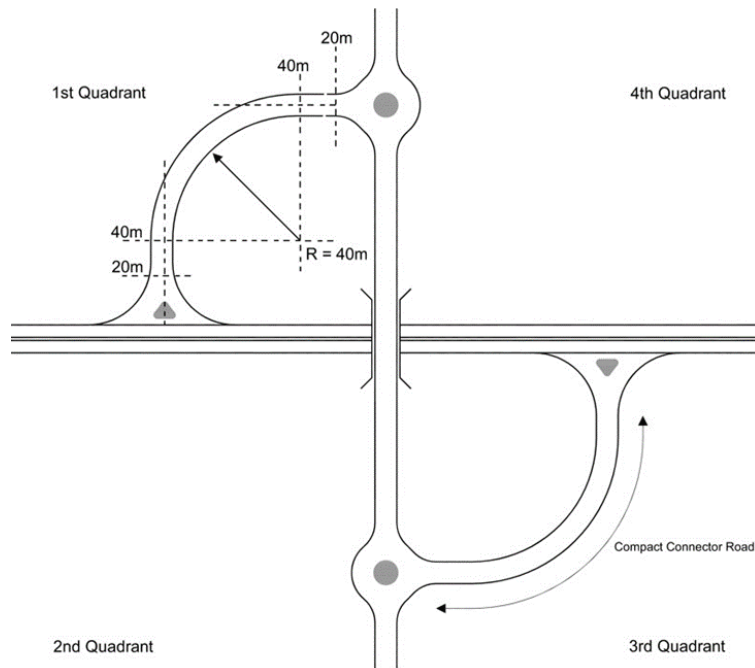
The edge line must be laid to the radii indicated

D - 2 Lane Drop

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Chapter 8 - Layout of Compact Grade Separated Junctions (Principal Changes from TD 40)

- Permissible relaxation to low object (0.26m) visibility restricted by safety barrier
- Layout options reduced

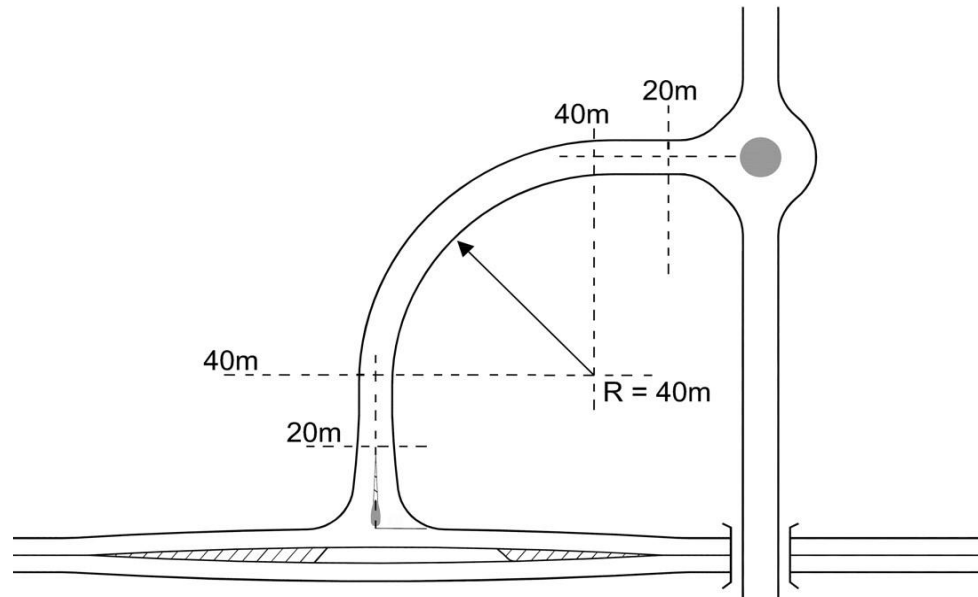


DN-GEO-03060 Geometric Design of Junctions

Chapter 8 - Layout of Compact Grade Separated Junctions (Principal Changes from TD 40)

Layout options

- Single quadrant link with ghost island on major road (single carriageway)



Questions & Answers

Panel of Presenters