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– Grade Separated Junctions

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Course Content

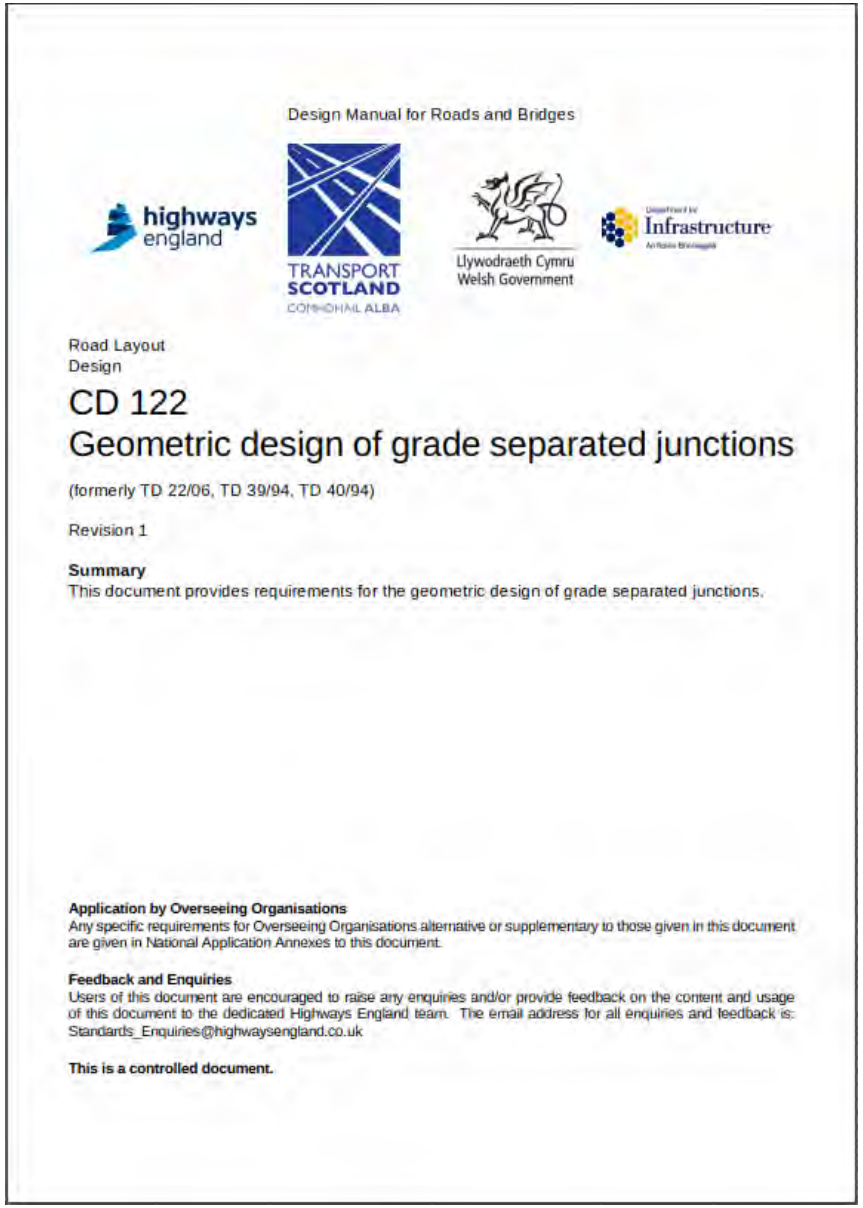
- Outlining hierarchy of junction types
- Standards used in the design
- Different types of Grade Separated Junctions
- Key considerations in the design of each

What is a Grade Separated Junction?

– A Grade Separated Junction is a junction where the conflicting traffic flows are kept apart, usually by means of a bridge or tunnel. They are one of the most effective ways of solving traffic congestion, as they do not directly require any traffic to slow down and stop at any time.

Standards

- DMRB CD122
- Previously DMRB TD22/06
- Notable changes from the previous documents:
  - **Merge layout referencing has been updated**
  - 3 lane merge and diverge layouts have been reviewed and amended
  - Merge and diverge datum points have been included



Design Manual for Roads and Bridges

highways england

TRANSPORT SCOTLAND

Llywodraeth Cymru
Welsh Government

Infrastructure

Road Layout
Design

CD 122
Geometric design of grade separated junctions

(formerly TD 22/06, TD 39/94, TD 40/94)

Revision 1

Summary
This document provides requirements for the geometric design of grade separated junctions.

Application by Overseeing Organisations
Any specific requirements for Overseeing Organisations alternative or supplementary to those given in this document are given in National Application Annexes to this document.

Feedback and Enquiries
Users of this document are encouraged to raise any enquiries and/or provide feedback on the content and usage of this document to the dedicated Highways England team. The email address for all enquiries and feedback is: Standards_Enquiries@highwaysengland.co.uk

This is a controlled document.

Why do we use them?

- **Safety –** Junctions are a potential source of danger and congestion unless they are designed to have a similar capacity to the approach highways and allow smooth uninterrupted flow.

- **Capacity -** The cost of vehicle delay at the single level intersection is usually the major criterion that is then used to justify the provision of grade separation.

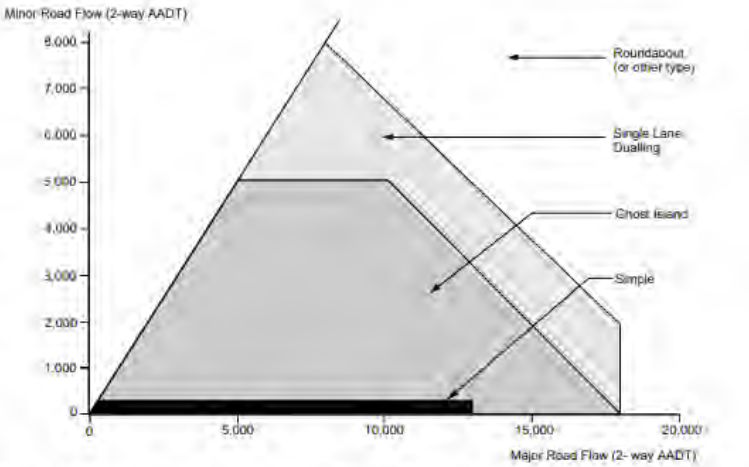


Figure 2/2 : Approximate Level of Provision of T-junctions on New Single Carriageway Roads for Various Major and Minor Road Design Year Traffic Flows (paras 2.2, 2.14)

Diamond

- The advantages of this layout are minimised land from certain quadrants of the junction, conventional slip roads and the requirement for only one bridge.
- The disadvantage is that there are a number of conflict points on the minor road. Diamond layouts are unsuitable to cater for high mainline merging and diverging flows and can also be unsuitable where there are high ahead flows on the minor road.

Figure A.1 Typical layouts of grade separated junctions - diamond

Half-cloverleaf

- An advantage of a half-cloverleaf layout is that they include less conflict points compared to a diamond layout; however, a higher concentration of the turning movements occurring at the same point.
- A disadvantage of half-cloverleaf layouts is that they necessitate greater slip road curvature and loops compared to diamond layouts.

Figure A.3 Typical layout of grade separated junction - half-cloverleaf quadrants 1 and 3

Dumbbell roundabout

- The dumb-bell roundabout has the advantage of requiring less land than both the diamond and the two bridge roundabout layouts. It also requires only one bridge.
- In relation to traffic flow capacity, a dumbbell roundabout layout can be considered an intermediate between the diamond/half-cloverleaf and the two bridge roundabout layouts.

Figure A.5 Roundabout - dumbbell configuration (one bridge & two roundabouts)

Two bridge roundabout

- The most common grade separated junction layout is the two bridge roundabout. They provide greater traffic flow capacity than the dumbbell roundabout layout and are less complex.
- They do however require two bridges and have a greater footprint.

Figure A.6 Roundabout - 2 bridge configuration

4 way, 3 level interchange

- Its advantages are that both the overall land take and the carriageway area are reduced when compared to a full interchange with entirely free flow link roads.

- The disadvantages are this layout requires a relatively high number of structures and if the turning movements exceed capacity, operational problems such as queuing on the roundabout entries can occur.

Figure A.7 3 level roundabout

4 way, 2 level 'cyclic' interchange

- A 2 level 'cyclic' interchange utilises reverse curves. The land take is extensive however and it requires a relatively high number of structures.

- One particular disadvantage is that it requires separate diverge points for left and right movements from both mainlines, which can be complex to sign.

Figure A.8 4 way, 2 level cyclic interchange

4 way, 4 level interchange

- A 4 level interchange layout has the advantages of reduced land take, absence of loops and low number of structures; however, it can be visually intrusive due to its overall height.

Figure A.9 4 way 4 level interchange layout

4 way, 2 level interchange

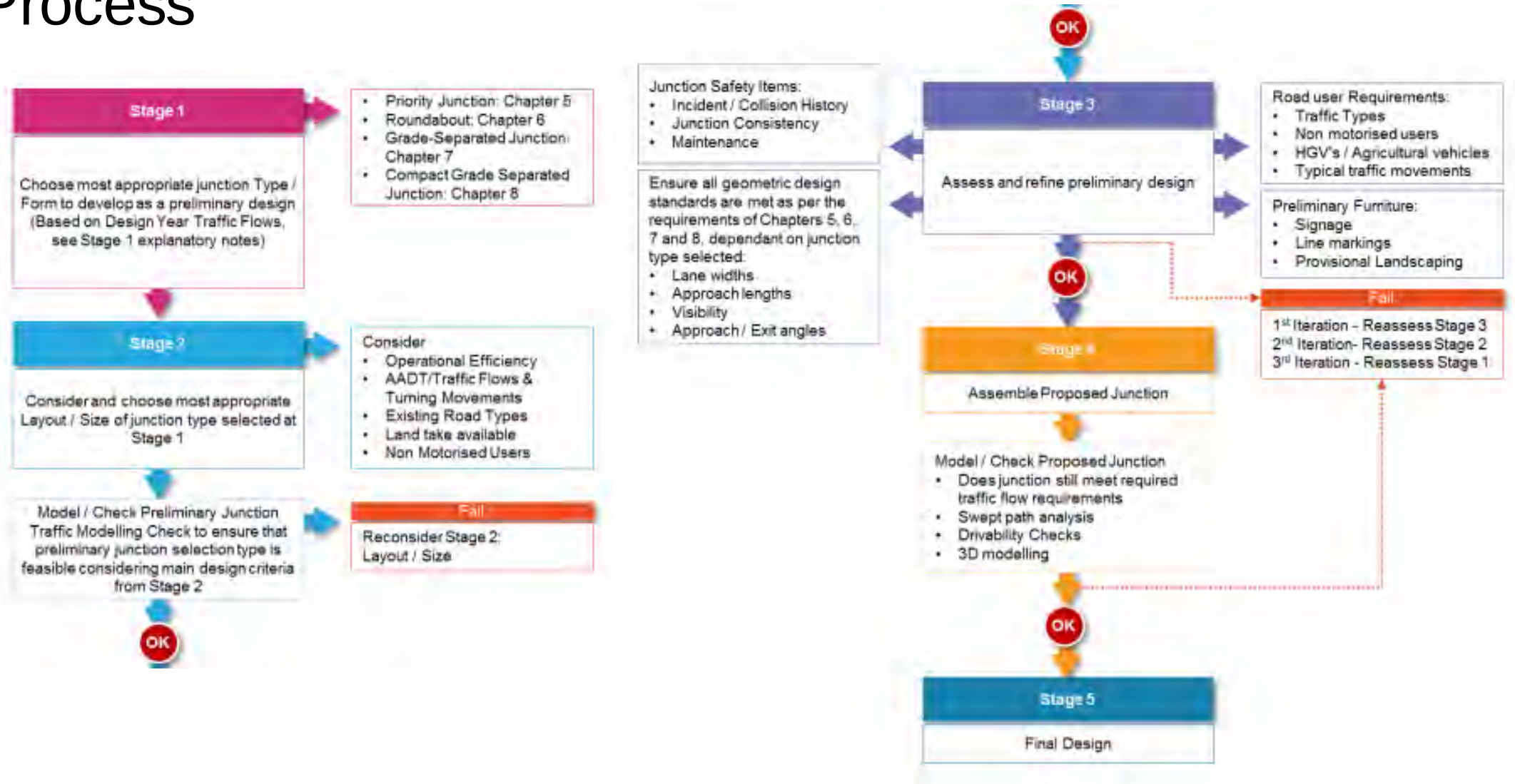
- A 4 way, 2 level interchange layout, is an alternative to the 4 level option.
- It is less visually intrusive, but has a larger land take and larger carriageway area. Another disadvantage is that it includes loops.

Figure A.10 4 way restricted height interchange

Design Considerations

- Traffic Volume
- Space
- Network continuity

Design Process



Design Elements

CD122 covers:

– Merges and diverges
– Weaving and Spacing
– Connector Roads

All other elements are covered by other standards:

– Approaches – CD109
– Roundabout – CD116
– Major / Minor Junction – CD123

Merges and Diverges

- Traffic Flows
- Design Class
  - Rural Motorway / Rural All-Purpose / Urban Road

Figure 3.14a Layout A option 1 - taper merge

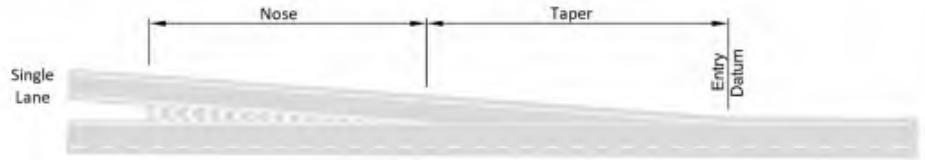


Figure 3.14f Layout E Option 1 - lane gain with ghost island offside merge

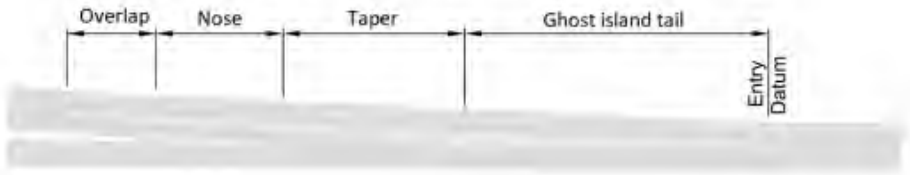
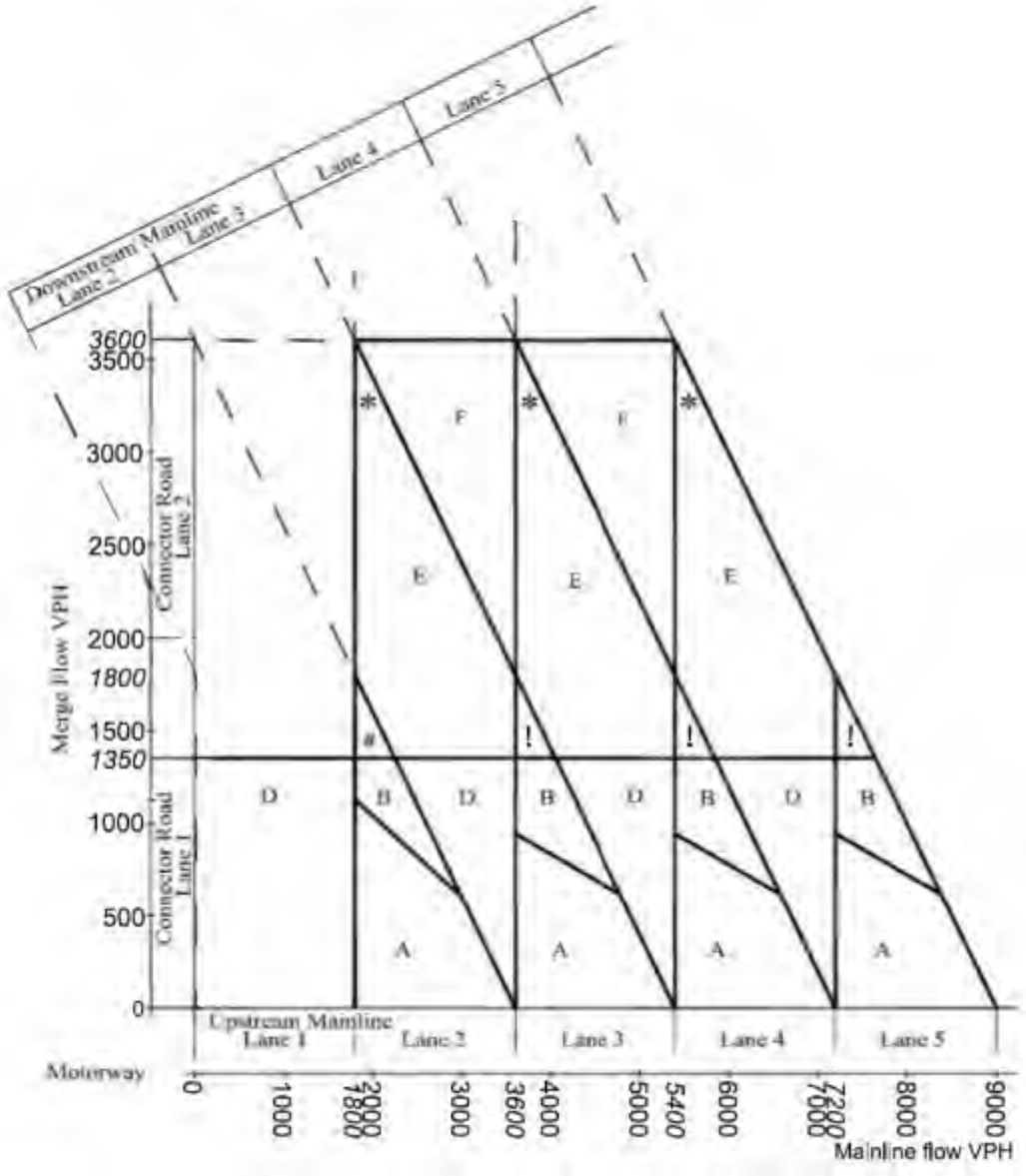


Figure 3.12b Motorway merging diagram



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Merges and Diverges

Figure 3.30a Layout A option 1 - taper diverge

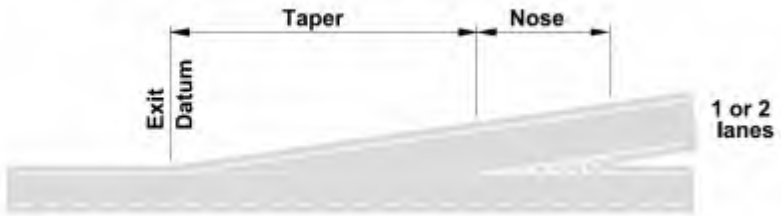
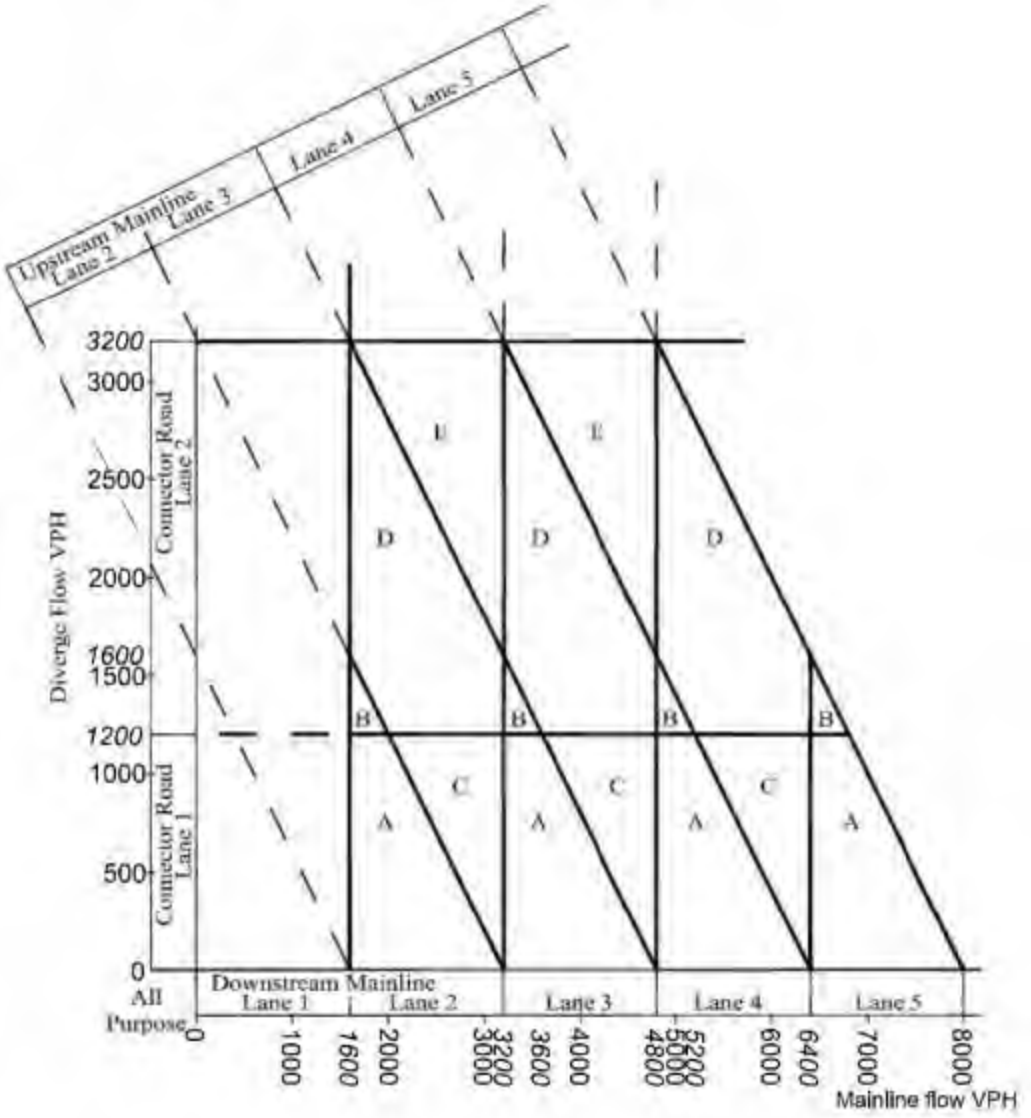


Table 3.31 Diverge layouts geometric parameters

Road class	Length of exit taper (metres)		Nose ratio	Nose length (metres)	Minimum auxiliary lane length (metres)	Length of auxiliary lane taper (metres)	Length of ghost island head (metres)
	1 lane	2 lane					
Rural motorway							
Mainline	170	185	1:15	80	200	75	180
Within interchange	120	130	1:15	70	150	55	n/a
Rural all-purpose design speed							
120 kph	150	150	1:15	70	170	55	160
100 kph or less	130	130	1:15	70	150	55	140
Urban road speed limit							
60 mph	95	110	1:15	50	125	40	100
50 mph or less	75	90	1:12	40	100	40	80

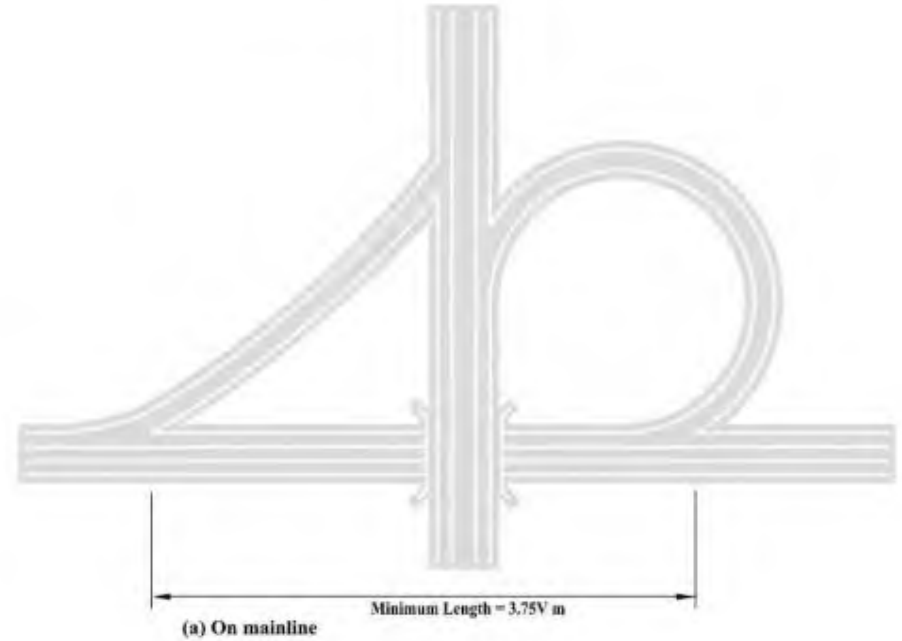
Figure 3.26a All-purpose road diverging diagram



Watch out for..

The minimum spacing between the tips of the noses of successive merges, successive diverges or a diverge followed by a merge shall be 3.75V metres, where V is the design speed of the mainline or connector road.

Figure 3.35 Example of successive merges/diverges



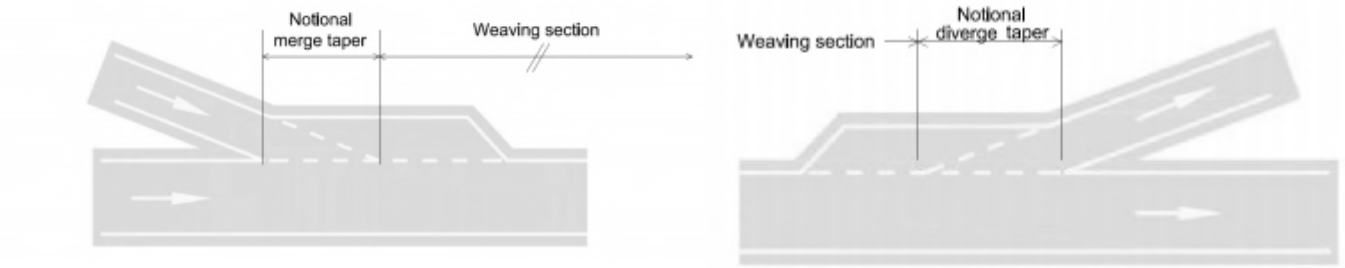
Weaving and Spacing

For rural roads, the minimum weaving section length shall be:

1) 2 km for motorways; and
2) 1 km for all-purpose roads

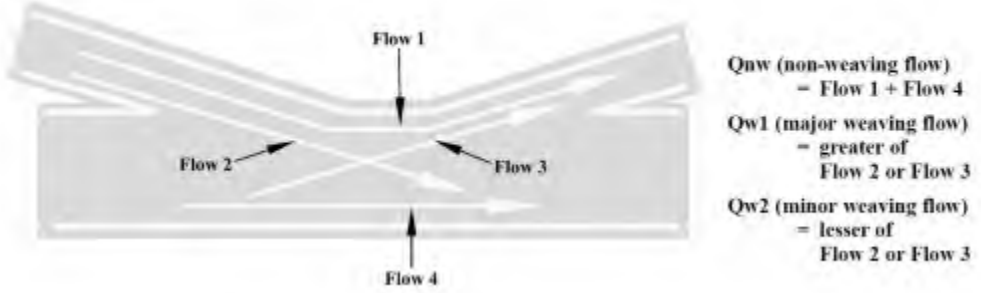
A weaving section shall be assessed using the weaving section lanes calculation where successive full grade separated junctions are spaced less than:

1) 3 km for rural motorways; and
2) 2 km for rural all-purpose roads.



$$N = \frac{1}{D}\left(Q_{nw} + Q_{w1} + Q_{w2}\left(2\frac{L_{\min}}{L} + 1\right)\right)$$

Figure 4.7N5 Flow terms used in weaving



Connector Roads

CD 109 provides the base geometric parameters for the design speeds.

Cross sectional layouts are given in CD 127 for each connector road type.

Table 5.4 Connector road design speed

		Mainline design speed			
		Urban 100 kph	Urban 85 kph	Rural 120 kph	Rural 100A kph
Connector road design speed (kph)	Interchange link	70	70	85	85
	Slip road	60	60	70	70
	Link road	100 or 85 see 5.4.1	85 or 70 see 5.4.1	120 or 100A see 5.4.1	100A or 85 see 5.4.1
	Dumb-bell link road	70	70	70	70

Table 5.17b Cross-sections for connector roads to/from mainline motorways

	Adjusted connector road flow (vph)			
	0-900	901-1350	1351-2700	2701-3600
Merge (rural)	MG1A		MG2C	
Merge (urban)	MG1B		MG2D	
Diverge (rural)	DG1A	DG2A		DG2C
Diverge (urban)	DG1B	DG2B		DG2D
Interchange link/loop (rural)	IL1A or IL2A (see clause 5.3)		IL2A	
Interchange link/loop (urban)	IL1B or IL2B (see clause 5.3)		IL2B	

Watch out for..

Figure 3.33a Application of mainline SSD where the length of connector road is greater than the mainline SSD

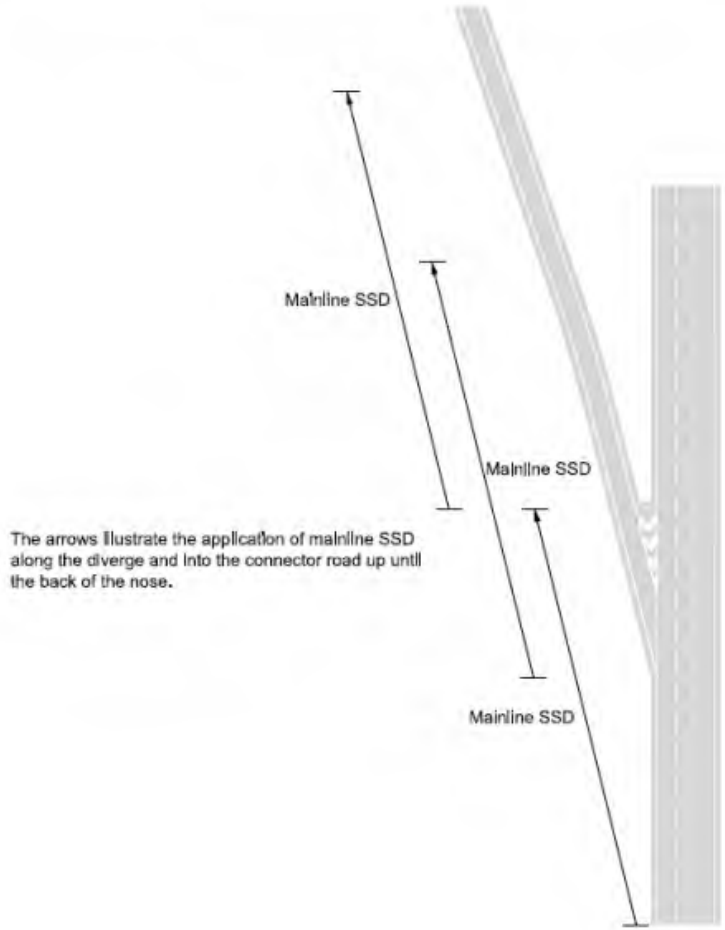


Figure 3.33b Application of mainline SSD where the length of connector road is less or equal to the mainline SSD

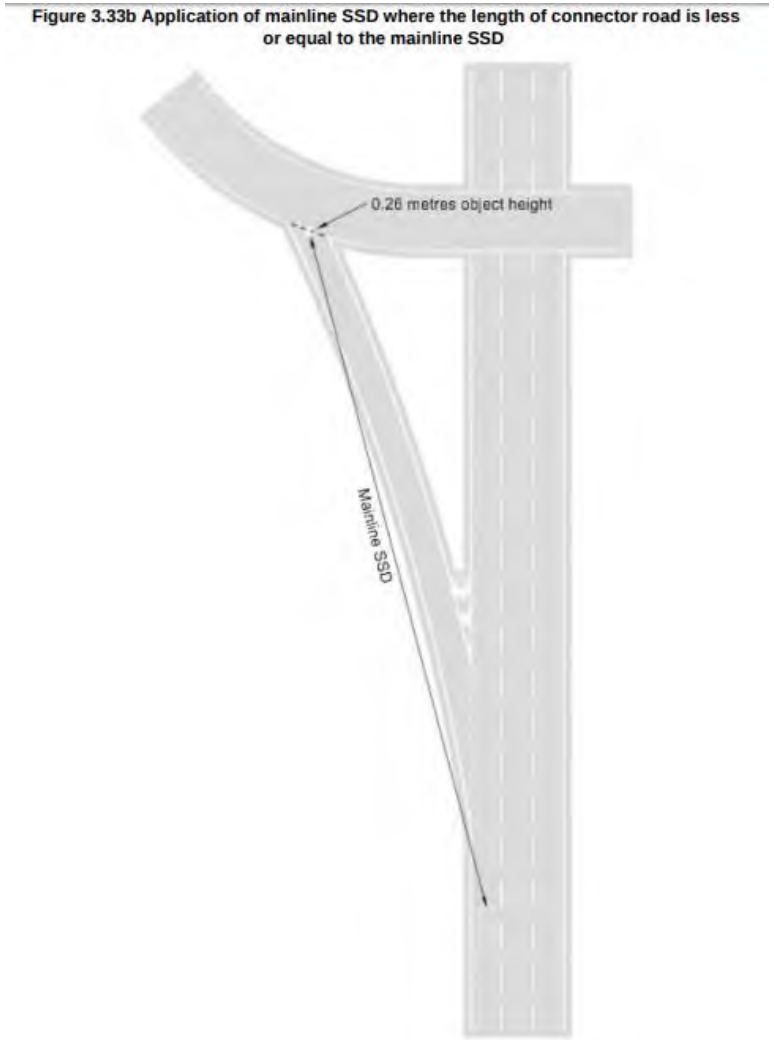
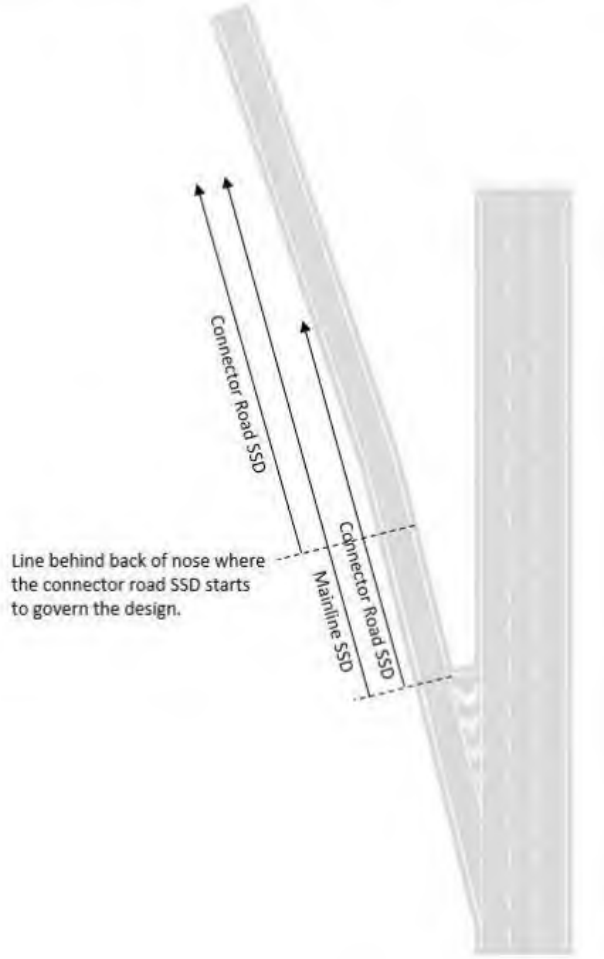


Figure 3.34N2 Example of transition between mainline and connector road SSD governing design



Any Questions

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