VOLUME 8 TRAFFIC SIGNS AND LIGHTING

SECTION 4 TRAFFIC MANAGEMENT AT ROADWORKS

PART 6

TA 92/03

# CROSSOVER AND CHANGEOVER DESIGN

## SUMMARY

This document provides guidance to assist designers of temporary traffic management systems that include changeovers and crossovers. Geometric and non-geometric advice is given.

## INSTRUCTIONS FOR USE

1. Remove existing Contents pages for Volume 8.

2. Insert new Contents pages for Volume 8 dated November 2003.

3. Insert TA 92/03 into Volume 8, Section 4, Part 6.

4. This Advice Note supersedes Chapter 5 of TA 45/85 (DMRB 2.2.8).

5. Please archive this sheet as appropriate.

Note: A quarterly index with a full set of Volume Contents Pages is available separately from The Stationery Office Ltd.

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NORTHERN IRELAND



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## REGISTRATION OF AMENDMENTS

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**SECTION 4 TRAFFIC MANAGEMENT AT ROADWORKS**

**PART 6**

**TA 92/03**

# CROSSOVER AND CHANGEOVER DESIGN

**Contents**

Chapter

# 1. INTRODUCTION



## General

1.1 This Advice Note should be used to determine the location and design of crossovers and changeovers in temporary traffic management systems.

1.2 This Advice Note supersedes **Chapter 5** of **TA 45 [DMRB 2.2.8]**.

1.3 Experience has highlighted the need for advice to provide consistency in the design and layout of crossovers on dual carriageway roads and motorways. Use of this document should ensure appropriate locations, and satisfactory horizontal and vertical design. Crossover location, and more particularly crossover length, must not be dictated by using an existing central reserve gap that is too short for the mandatory temporary speed limit. A well-designed crossover will minimise vehicle braking and queuing, therefore reducing the risk of nose-to-tail accidents upstream.

1.4 The design of a crossover is a balance between available locations, economical construction cost and convenience to road users. As crossovers form part of a temporary and often changing situation, attention should be given not only to the known situation and programme for the Works, but also to the possibility of unplanned changes or events.

1.5 The basis of the design recommendations in this Advice Note allows for a reduction in normal driver comfort within the design while maintaining acceptable limits for sideways acceleration. Temporary traffic management arrangements are prominently signed and consequently driver concentration is heightened. In this situation drivers are able to tolerate a tighter geometric design than can be accepted in a non-roadworks situation on the assumption that the chosen design speed is consistent with the adopted temporary mandatory speed limit.

1.6 New construction within the central reserve should normally be retained for future use, unless there is justification for removal at the completion of the Works e.g. where retention creates a safety hazard or affects the environment.

## Scope

1.7 This Advice Note sets out guidance for the location and geometric layout of crossovers and changeovers on dual carriageway roads and motorways. It supplements the advice given in Chapter 8 (1991) paragraph 4.4.2.1 of the Traffic Signs Manual [TSM]. A software macro is provided (Chapter 6) to assist designers in sizing a crossover.

1.8 This Advice Note also highlights features, such as lighting, drainage, pavement and non-motorised user issues that require consideration in the design and operation of any crossover.

## Re-Use of Existing Crossover Sites

1.9 Prior to re-use of an existing crossover site a design assessment is required, even where it has operated without problems in the past. There is no requirement to assess any existing crossover site until plans arise to re-use it. In the event that a crossover site fails this assessment, guidance is given in paragraph 4.4.

## New Roads and Network Improvement Schemes

1.10 When designing new roads or network improvement schemes it is not usually desirable to provide crossover sites for the purposes of future maintenance works. However, part of the design process for a new road or improvement scheme is to include consideration of future maintenance needs. This Advice Note should be taken into account when identifying lengths of central reserve which could be designed to contain the minimum of equipment to allow for the construction of crossovers, at a later date. In all cases the maintaining organisation should be consulted through the Overseeing Organisation.

1.11 **BD 78 [DMRB 2.2.9]** gives mandatory requirements for crossovers at tunnels.

## Construction Records

1.12 As-built drawings for the Works should indicate the assumed design speed used in the design of a crossover. This will assist at a later date when crossover sites are considered for re-use.

## Explanatory Note

1.13 This Advice Note applies to all crossovers, but the terminology used is applicable to the first crossover in a temporary traffic management system.

## Implementation

1.14 This Advice Note should be used forthwith on all schemes for the construction, improvement and maintenance of trunk roads, including motorways, currently being prepared provided that, in the opinion of the Overseeing Organisation, this would not result in significant additional expense or delay progress. Design Organisations should confirm its application to particular schemes with the Overseeing Organisation. Where this is confirmed, the contract documents for the Works should be written to reference this Advice Note.

## Definitions

1.15 **A changeover** is a change of lanes introduced to divert traffic within an existing carriageway, including the hard shoulder. A changeover is normally associated with temporary works where one or more lanes are closed. It may occur after the traffic has been merged into fewer lanes than the permanent situation. No further reference is made to changeovers in this Advice Note as the criteria for crossovers apply equally to changeovers.

1.16 **A crossover** is where one or more lanes on a dual carriageway or motorway are diverted onto the opposing carriageway. This is normally where a contraflow situation is required to carry out Works on the primary carriageway. **Crossover length** is shown in Figure 1. Note that a second crossover is needed to return to the primary carriageway. **Crossover site** is the paved area within the central reserve used as part of the crossover.

1.17 To differentiate between existing horizontal alignment and the new horizontal curves introduced to form the crossover:

- **bend** is used to describe a horizontal radius in the existing road alignment;
- **curve** is used to describe the crossover "S" shape;
- **entry curve** is used to describe the first curve of the "S" shape;
- **exit curve** is used to describe the second curve of the "S" shape;
- **non-assisting** refers to superelevation that assists traffic in the non-works situation but adversely affects traffic through a crossover curve.

1.18 **Longitudinal alignment** is measured on the centreline of the temporary alignment.

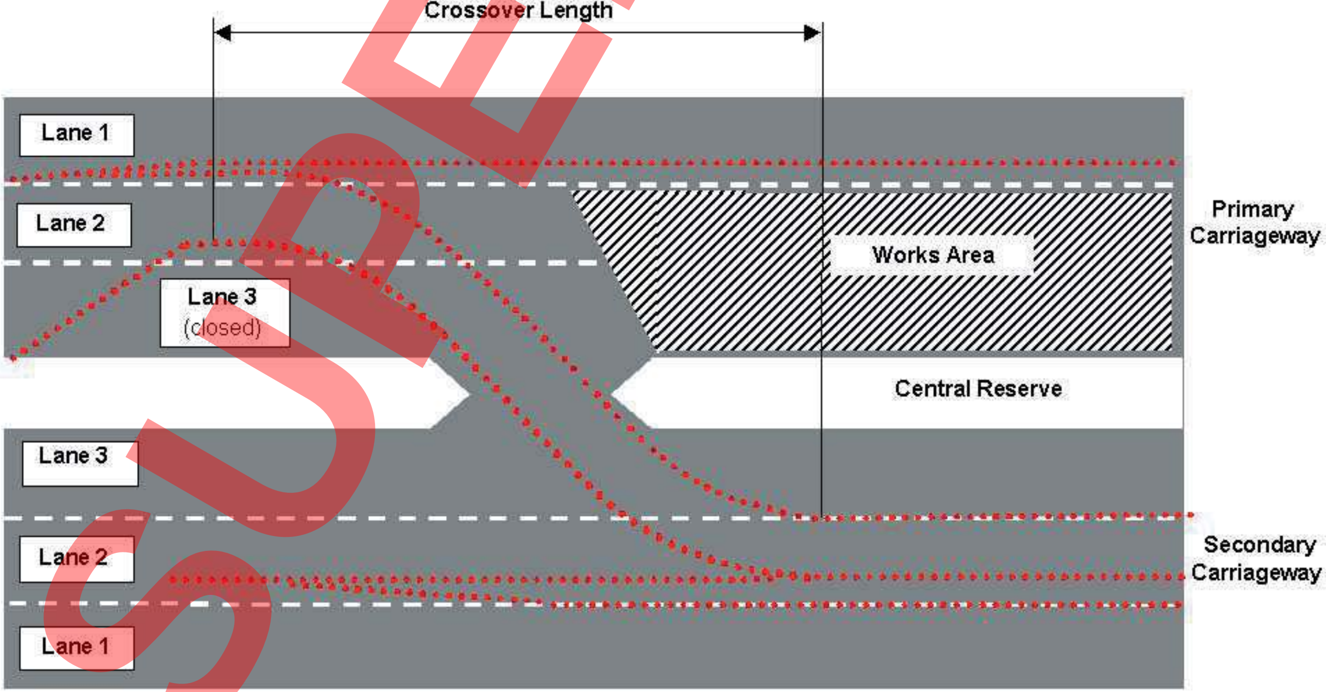


**Figure 1: Typical layout of a crossover**

1.19 **Lateral shift** is used to describe the sideways change in position of a vehicle from one carriageway to the opposite carriageway.

1.20 The term **Large Goods Vehicles (LGV)** is used in this document to identify those vehicles (defined as over 3.5 tones gross weight) classified as LGVs for licensing purposes in accordance with European harmonisation of terminology.

1.21 **Rollover factor** is used to describe the possibility of overturning, particularly in relation to large vehicles. Overturning depends on the height of the centre of gravity relative to the width of the vehicle's track. The motions which might cause a large vehicle to roll over depend very greatly on the characteristics (dimensions, loading and suspension) of the individual vehicle and the manoeuvres being carried out, but allowances have been made within the guidance given in this Advice Note.

1.22 **Temporary crossover site:** paved area within the central reserve that is to be built, or already exists, but will not be used again after the completion of the Works.

1.23 **Permanent crossover site:** paved area within the central reserve that is to be built, or already exists, and will be closed but not removed at the completion of the Works, allowing future use.

1.24 **Two-way crossover:** A crossover that carries traffic in only one direction at a time, but which may be reversed during the Works to carry traffic in the opposite direction.

1.25 **One-way crossover:** A crossover that carries traffic in only one direction at a time, and which must not be reversed during the Works.

1.26 **Primary carriageway:** The carriageway on which the Works are being carried out, and therefore that from which the crossover commences.

1.27 **Secondary carriageway:** The carriageway opposite to the primary carriageway.

1.28 **Works:** The maintenance or improvement project that requires the use of a crossover/changeover.

# 2. TRAFFIC MANAGEMENT

2.1 The requirements for traffic management contractors working on high speed roads are given in the Specification for Highway Works (SHW).

2.2 Traffic management system designs shall be in accordance with the TSM Chapter 8 and the Design Manual for Roads and Bridges (DMRB). Particular reference to **TA 64 [DMRB 8.4.3]** is required.

2.3 Speed cameras are an effective way of reducing speeds within temporary traffic management systems. Where the police are willing to operate the cameras, then their provision should be considered for inclusion in the contract requirements. The Overseeing Organisation should be consulted to determine current policy before a decision to use cameras is taken.

# 3. PLANNING

3.1 The responsibility for the design of the traffic management system shall be as stated in the contract documents for the Works.

3.2 Regardless of the status of the designer of the traffic management system, the Overseeing Organisation and their Agents should ensure that due consideration is given in the preparation of the Works to the practicality of achieving crossover designs that conform to this Advice Note, prior to entering into a contract for the Works. The overriding principle is that crossovers should be constructed to comply with the proposed temporary mandatory speed limit for the Works.

3.3 The choice of location for a crossover is the most critical factor affecting both the safety in use and construction costs for the crossover site. It will also have a significant bearing on the safety, capacity and delays for the whole traffic management system.

3.4 Ideally a crossover should be located away from junctions, on a straight and relatively flat section of the carriageway, with street lighting and minimal central reserve equipment.

3.5 The aim is to build a safe crossover while still allowing the Works to be constructed in a cost-effective manner. Every effort should be made to find the best possible practical location that is appropriate to a particular crossover.

3.6 Many factors have to be considered when choosing the location of any crossover. In some cases finding a fully suitable location will not be possible and it will be necessary to use a location which does not have an ideal combination of all relevant factors. As with the design of a road, a crossover may have to be a compromise, taking into account the limitations of the available locations.

3.7 The main considerations and limits on the design of the crossover in terms of the effect on the vehicle and driver are:

- The maximum acceptable sideways acceleration.
- The maximum overturning force (affecting rollover of large vehicles).
- Stopping Sight Distances.

**Layout Design Influences**

3.8 The layout of any crossover, in terms of entry and exit lane position, will often be determined exclusively by the requirements of the Works being carried out. However, when there is a degree of flexibility in the layout this may be used to the advantage of the design and cost of the crossover.

3.9 Crossover sites at narrow central reserves generally result in minimal areas of pavement construction.

3.10 Layouts with large lateral shifts (e.g. where the crossover runs from the normal nearside lane or hardshoulder of the primary carriageway to the normal nearside lane on the secondary carriageway) minimise the cost of new pavement and other works on the central reserve.

3.11 The longest length of construction on the central reserve occurs when the crossover runs from the lane adjacent to the central reserve on one carriageway to the equivalent lane on the opposing carriageway e.g. Lane 3 to Lane 3 on a D3 road. Lane 3 may be an offset temporary Lane 3 for certain standard traffic management layouts.

3.12 Most layouts will fall between the extremes in paragraphs 3.10 and 3.11. Fully symmetrical crossover curves provide the opportunity for designing curves completely within the existing carriageway by allowing a short straight alignment across the central reserve. This obviates the problems of changes of camber, crossfall and gradient at a point of curvature, which for most arrangements will need to be catered for as described in paragraph 4.12.

3.13 Any existing Departures From Standard may compound problems with the crossover design, and therefore locations that contain such Departures should be avoided, unless it can be demonstrated that they do not adversely affect the crossover design for the proposed temporary mandatory speed limit.

3.14 The detailed layout constraint effects are considered in Chapters 4 and 5 of this document. Further guidance on pre-contract planning is given in **TA 64 [DMRB 8.4.3]**. However, there are some general constraints as follows:

a) Where a two-way crossover is to be designed the suitability of the location and potential problems must be looked at for traffic in both directions.

b) Any structure at or near a proposed crossover may cause difficulties or preclude the use of that location completely. Even where the structure does not interfere directly with the layout or visibility, all safety aspects should be considered and appropriate measures employed, e.g. protection against impact, siting of signs etc.

c) A sharp horizontal bend immediately before the crossover is undesirable and could rule out the use of the location by reducing visibility through the traffic management system. It will also affect the layout of the crossover.

d) High gradients, steep crossfalls and large level differences between carriageways should be avoided.

e) Crossovers with their associated traffic management signs, plant and operatives are points where drivers have a heavy information load to assimilate. Care should be exercised if existing roadside features cause driver distraction and close attention should be paid to any likely effect on safety.

f) Noise: Crossing a central reserve may create additional noise, particularly if designed for use by LGVs. If practicable, crossover sites should be located away from residential property.

g) Statutory Undertakers' plant, lighting and communication cables, drains: where the central reserve is to be excavated, records of buried plant and equipment should be checked and such locations should be avoided where possible to reduce costs and minimise risks.

h) Overhead power lines can present a hazard, particularly if temporary lighting is to be provided at the crossover.

i) Soft central reserves may be valuable habitats for flora and fauna and specialist advice should be sought before removing areas of the soft estate. There may also be reasons why the soft estate needs to be re-established at the conclusion of the Works.

j) An assessment of the strength and suitability of the adjacent carriageway and central reserve pavement (if paved) will be required.

k) Where a Private Means of Access (PMA) is affected by the crossover location or length of contraflow, the landowner should be approached in advance to determine if alternative arrangements for the PMA can be made. Similarly, laybys may need to be closed off for the duration of the works and such a factor may influence the position of the crossover.

l) Wide Loads: Crossovers may present difficulties with the movement of wide loads, particularly on dual two-lane roads. Guidance is available in "The Movement of Abnormal Indivisible Loads through Planned Roadworks" available from the Overseeing Organisation.

m) The movements of non-motorised users should be considered at the outset of the planning and any necessary diversion routes arranged with other highway authorities and private landowners. Ideally adverse effects, including diversions, should be avoided when planning the location of crossovers.

n) Traffic volumes and composition: the successful operation of the crossover will depend on maintaining a sufficient number of lanes to cater for expected traffic demand. An assessment of LGV flow will also be required to ensure that sufficient lanes are available.

o) Crossovers should be located so as to avoid or minimise traffic diversions and be as far away from junctions as possible. This is particularly important where restrictions for LGVs are in place for one or more lanes, or where certain lanes are dedicated to a particular destination at the next exit downstream.

p) The location and number of crossovers has a direct effect on the physical length of the temporary traffic management system. The length will have a bearing on driver stress and will also affect the arrangements for recovery of broken-down vehicles. The Overseeing Organisation should be consulted to determine current policy on the length and spacing of roadworks.

# 4. GEOMETRIC DESIGN

### Design Speed and Speed Limits

4.1 The temporary mandatory speed limit to be used for a particular project is a matter to be determined by reference to TSM Chapter 8. The design speed to be adopted for a crossover is directly related to the temporary mandatory speed limit imposed by the Traffic Regulation Order for the overall Works, in accordance with Table 1 (see Annex A for tables).

4.2 The selection of design speed is not affected by the status of the crossover site as permanent or temporary and hence geometric design features are unaffected by the designation.

4.3 It is not acceptable to attempt to reduce costs by selecting a crossover design speed and corresponding temporary speed limit lower than TSM Chapter 8 would normally recommend.

4.4 Where, exceptionally, a crossover cannot be designed for the prevailing “blanket” temporary mandatory speed limit in place for the whole length of the Works, it should be designed for an appropriate lower design speed and the temporary mandatory speed limit may be further reduced locally at the crossover. In the case of existing crossover sites, shown by assessment to be sub-standard, the designer will need to consider the cost implications of enhancement. Where such costs are likely to be disproportionate, consideration should be given to providing a lower temporary mandatory speed limit and adopting a corresponding design speed. Reducing the design speed by one step (Table 1) is preferable to two steps, and a two-step reduction should only be considered in extreme cases where the costs of adopting a one-step reduction remain disproportionately high. In no circumstances should reductions of more than two steps be allowed as it is unlikely that traffic will obey such extreme speed limits.

4.5 The advice of TSM Chapter 8 (1991 para 2.3.4.2) normally recommends that a mandatory speed limit is undesirable where the length of restriction is less than 800m. However, in the case of a crossover, the length of any locally lower mandatory speed limit (see paragraph 4.4) will normally be less than 800m. This is acceptable and enforceable because the crossover is evident to drivers as being a good reason to slow down further and because the overall length of speed controlled zone (i.e. the “blanket” temporary mandatory speed limit) is greater than 800m.

### Design Philosophy

4.6 The design philosophy adopted for crossovers is based on providing acceptable horizontal radii for an “ideal” crossover and where various adverse factors exist, reducing the risk by increasing the radii in steps to continue to provide an acceptable layout. Annex A gives design tables to determine the curve radii to be used for a particular situation.

### Horizontal Alignment

#### *Existing Bends*

4.7 Horizontal curvature on the existing carriageway, i.e. a bend at the proposed crossover location, may cause difficulties in the design. It is preferable that the radius of curvature of the entry curve into the crossover is the same as that of the exit curve. The effect of any existing bends on the ability to provide this has to be taken into account.

4.8 The provision of equal entry and exit curve radii poses no difficulty if the carriageway is straight.

4.9 Any existing horizontal bend has an adverse effect on the curves forming the crossover. An existing right hand bend results in a tighter entry radius than would be the case with a straight road. Similarly an existing left hand bend causes tightening on the exit curve.

4.10 An existing bend may also effectively form a third curve either before entry to the crossover or on the exit. Although this occurs entirely on the existing carriageway, it will cause a ‘triple’ bend to be created. Introducing a third change of direction for drivers to negotiate is undesirable.

4.11 Where a bend on the approach to a crossover has superelevation in any direction, the radius of the crossover entry curve should be increased in accordance with Table 3 to allow a greater margin of safety when drivers are already experiencing different sideways forces before entering the crossover.

4.12 Where the entry and/or exit curves are located partly on the existing carriageway and partly on the central reserve there may be a change of vehicle sideways acceleration. Crossover radii should be





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increased in accordance with Tables 3 and 4 when acceleration changes occur on any curve. The extreme case is a change from assisting superelevation to adverse camber.

4.13 An extreme case is where the existing bend is of the same hand and its radius is approaching the design limit for the radius of the entry curve. In this case the entry curve approximates so closely to the radius of the existing bend that, effectively, no 'lateral shift' can take place. In these circumstances the crossover should be sited elsewhere.

4.14 The use of unequal curve radii through the crossover is undesirable and it should be avoided, but with one exception: where a right-hand bend exists, the radius of the exit curve can be greater than that of the entry curve, provided that the crossover will only be used in this direction. If the crossover is to be used later in the other direction then undesirable "tightening" through the crossover would occur. In this situation the crossover must be designed and constructed with equal radii curves. Alternatively the crossover must be reconstructed for the reverse direction.

4.15 The use of crossovers with equal entry and exit curve radii will result in long crossover lengths if they are situated on a significant bend in the road and such crossovers will be asymmetric. However, this is preferred as this will not be particularly noticeable to a driver whereas any change of radii would.

### *Transition Curves*

4.16 Generally transition curves are not required in the design of a crossover and the 'tightening radius' effect created is undesirable.

4.17 The use of a transition curve will cause the overall length of the crossover to increase. This will normally increase the length of the central reserve gap in most designs with a resulting increase in construction costs.

4.18 Where the crossover cannot be better located or designed in accordance with the recommendations of this document, the use of a transition curve may be required to reduce sideways acceleration or overturning problems.

## Vertical Alignment

### *General*

4.19 The vertical alignment to be considered in the design of the crossover is that lying on the vehicle path for the temporary layout, rather than that of the centreline of the normal carriageway.

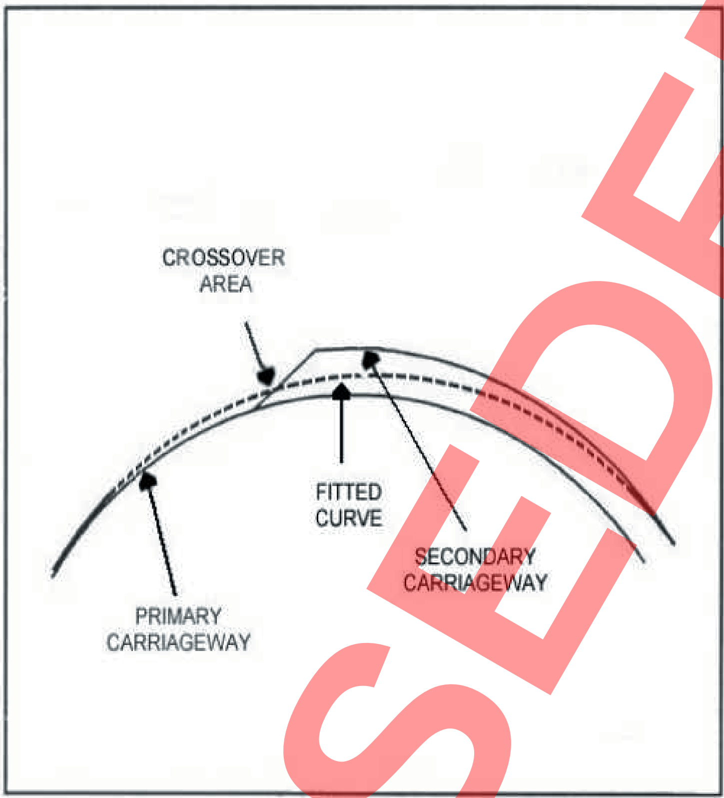
4.20 The longitudinal vertical curve to be considered is the approximate curve that can be fitted between the two existing vertical curves, one for each carriageway, allowing for any temporary construction. Figure 2 gives an example of Fitted Curve diagrams for a particular case where the secondary carriageway is higher than the primary carriageway.

4.21 Consideration must be given, where there are adverse factors through the crossover, to the effects of the crest curve on the limits of adhesion or the overturning of large vehicles. See Tables 3 and 5.

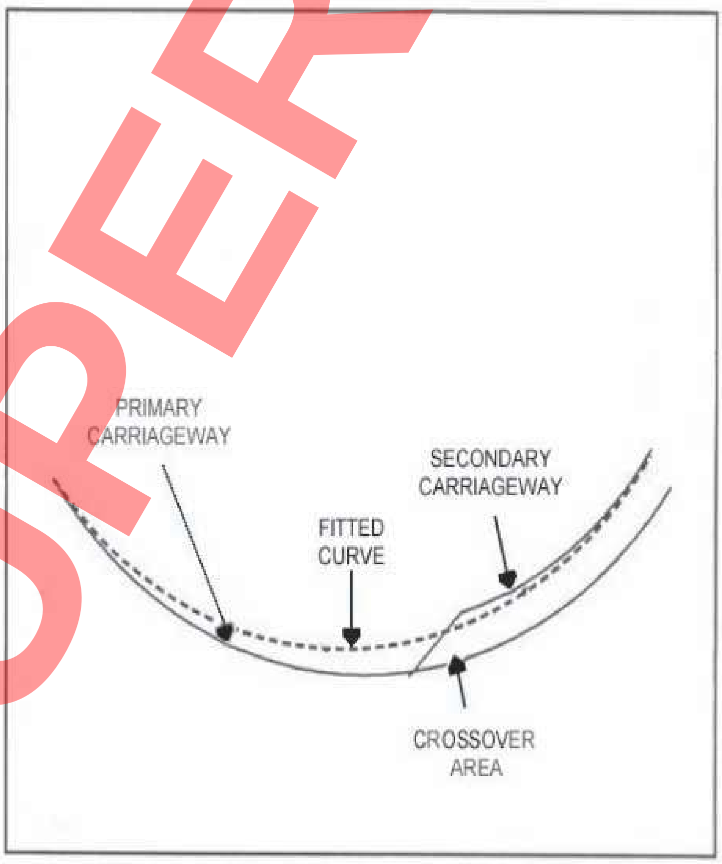
4.22 Consideration must be given to the effects of a sag curve causing an unacceptable reduction in comfort level or distances illuminated by headlights. See Tables 3 and 5.

4.23 Taking the fitted curve as shown in Figure 2, the vertical alignment through the crossover should be designed to comply with Table 5.

**Figure 2: Fitted Vertical Curve Diagrams (Example)**




**a. Crest curve**




**b. Sag curve**

## Gradient

4.24 Designers are reminded to check effects for two-way crossovers when assessing gradient.

4.25 Crossovers should not be located where the downhill gradient exceeds the desirable maximum as given in **TD 9 [DMRB 6.1.1]**. The maxima are reproduced below:

3% Motorways

4% AP Dual Carriageways

4.26 Where downhill gradients steeper than those in **TD 9 [DMRB 6.1.1]** are unavoidable, additional consideration must be given to the measures to be employed for reducing speed e.g. speed enforcement cameras. Downhill gradients may cause undesirable adverse camber effects (Table 2) and horizontal radii may need to be increased (Table 3).

4.27 The effect of an uphill gradient on approach to the crossover is generally beneficial when the gradient complies with paragraph 4.25. However, if the uphill gradient or height risen is near to the advice limits for the start of provision of climbing lanes in **TD 9 [DMRB 6.1.1]** then traffic throughput may be reduced to unacceptable levels.

## Crossfall And Height Differences Between Carriageways

4.28 The longitudinal alignment should be checked along the centreline of the temporary lanes through the crossover, including entry and exit curves. The effective alignment along this path will involve both the existing fitted vertical curve (Figure 2) and the effects of carriageway crossfall and level differences between the carriageways. Situations may arise where the gradient of the fitted curve and the crossfall combine to give an unacceptable resultant value of adverse camber. The resultant value of adverse camber and downhill fitted gradient is calculated using Table 2. Along the full S-curve there may be various different values of resultant adverse camber. The worst value should be determined and inserted into Table 3. As gradient will usually vary along the fitted curve, the worst case instantaneous downhill gradient that occurs along the length of route at which adverse camber is being considered should be used. Relieving effects of uphill gradients are not taken into account.

4.29 The section of road being considered should have minimum crossfalls to both carriageways wherever possible. In circumstances where the road falls to the nearside verge of each carriageway, the crossfalls will form an adverse camber on the curves through the crossover. It will only be in the circumstances where the road falls towards the central reserve that it will assist with one or both curves through the crossover.

4.30 Whenever possible, the crossover location should have no significant difference in the levels between the edges of each carriageway across the central reserve.

4.31 Where the level of the secondary carriageway is lower than that of the primary carriageway, assuming a superelevation not greater than 7% is formed, this will normally assist with the entry into the contraflow section, but will normally create an adverse camber at the exit curve, and the latter case should be used to determine the horizontal design.

4.32 Where the level of the secondary carriageway is greater than that of the primary carriageway, an adverse camber is formed which must not exceed the resultant values given in Table 2. This will generally be the limiting factor when deciding what level difference between the two lanes can be accepted.

4.33 Where a significant difference of level between the two carriageways exists and there is no alternative location for the crossover, additional design and construction may be necessary, possibly in the form of an overlay to raise the level of one of the carriageways. The fitted curve can then be adjusted.

4.34 The side profiles of drainage channels can cause adverse camber to increase while travelling through the crossover entry or exit curve. Where such drainage items are present then the crossover should be located and designed so that any profile does not adversely affect the design and performance of the crossover. Where this is not possible, the termination of channels and use of alternative drainage methods is advised. The elimination of adverse conditions by filling with wearing course material is not recommended, unless a suitable bond can be guaranteed, because a loss of wearing course filler may create a hazard.

4.35 Linear drainage channels systems affect both the lateral and longitudinal alignment levels and need to be considered under both categories when using Table 2.

### Rollover

4.36 The worst case for rollover is when changing from a 7% adverse camber in one direction to a 7% adverse camber in the other. This does not supply enough energy for a large goods vehicle to roll-over although it is close to the limit. Camber changes of greater than 10% (e.g. –5 to +5%) are not recommended so as to allow a margin of safety.

4.37 The main factors to be taken into consideration when checking the design are:

a) Crossovers from one 7% adverse camber to another must be avoided.

b) Crossovers should cross the central reserve at a shallow angle of no more than 20 degrees, where possible, to the existing road. This factor is important whatever the width of the central reserve.

c) Changes in level or camber should be gradual and preferably on a straight section.

### Stopping Sight Distance

4.38 Stopping Sight Distances (SSD) should be measured to the low object in accordance with Fig 3 of **TD 9 [DMRB 6.1.1]**, but for each temporary lane. Sighting outside the line of cones (i.e. across the Works Area) is not permitted when measuring SSD.

4.39 Table 1 gives the absolute minimum requirements for SSD through crossovers for the temporary mandatory speed limit adopted. Cones and barriers should be placed so that Table 1 values are achieved.

4.40 The specification for the traffic management system should be written to include details of the required SSD. Sometimes visibility greater than the absolute minimum SSD requirement can be partially achieved if plant is carefully located to allow some limited enhancement of sightlines across the Works Area.

4.41 Where width is limited and narrow lanes and low setbacks to cones or barriers are to be adopted, it may be necessary to increase horizontal radii purely for the reason of achieving the required SSD. Where adverse factors exist (Table 3), the step increases in radii (Table 4) will also automatically help to improve SSD. Using small radii may compromise SSD in certain circumstances. In all cases SSD should be checked locally, including vertical effects, to ensure that Table 1 values are achieved. Due to the large number of variables at a crossover, using radii from Table 4 does not guarantee SSD compliance in the horizontal plane.

# 5. NON-GEOMETRIC DESIGN

## Lighting

5.1 It is preferable to locate a crossover within a lit section of road.

5.2 The presence of existing lighting columns on the central reserve may reduce the desirability of proposing a crossover at such a location. However, it may be feasible to temporarily remove the lighting columns and supplement the remaining street lighting with temporary replacement lighting, usually in the nearside verges.

5.3 Where existing lighting is to be disrupted, temporary lighting should be designed to provide, so far as is practical, an equal intensity and uniformity of light when compared to the existing permanent arrangement. Temporary lights should normally consist of conventional street lighting columns and lanterns. Floodlighting should only be considered where conventional street lighting is impractical. Floodlights may dazzle drivers, create isolated pools of light and should normally not be considered. Retention of verge lighting for future use should be considered in the case of permanent crossovers.

5.4 Where a crossover is to be located on an unlit section of road, the publication "Guidance for Safer Temporary Traffic Management" gives advice. If a decision to light the crossover is made then the design considerations of paragraph 5.3 should be taken into account.

## Vehicle Restraint Systems

5.5 Layouts for vehicle restraint systems (VRSs) at crossovers are given in the Overseeing Organisation's current standard. Where a new crossover site is constructed, or an existing crossover site is proposed to be re-used, the VRS arrangements shown in the current standard should be installed before the crossover site is brought into operation. This may require amendment to the existing layouts.

5.6 On completion of the works, and if the crossover site is to be retained for future use, the VRS in the "closed" position should be constructed to the details given in the current standard, regardless of the current provision, where sufficient space exists.

## Non-Motorised Users On All Purpose Roads

5.7 Crossovers should not be located where there is a likelihood that non-motorised users (NMUs) will be crossing the road within the crossover length. The presence of bus-stops should be taken into account in this assessment. Temporary closure of bus-stops should be avoided where possible when selecting the crossover location.

5.8 Following a risk assessment, consideration should be given to providing a dedicated NMU bypass route, either outside or within the highway boundary, so that NMUs can avoid the crossover altogether. Dedicated NMU bypasses which involve a substantial additional travelling distance will be unattractive to users. If a bypass is not practicable, NMUs must be adequately provided for on the carriageway. The Traffic Regulation Order will need to be drafted accordingly. Signing will need to be planned carefully to inform NMUs of the most appropriate route.

5.9 Traffic Advisory Leaflet 15/99 gives guidance on safety for cyclists at roadworks, including selection of appropriate lane widths. In carrying out the risk assessment (see above), designers will need to take into account the available lane widths for cyclists.

## Surface Water Drainage

5.10 Additional or temporary drainage may be required as part of the Works. Steps should be taken to ensure that there are no surface water drainage problems at the proposed location. The construction of a new pavement may restrict or even effectively remove the existing drainage arrangements. Problems may include:

- Standing water.
- Water running across the carriageway.
- Blocked or inadequate drainage.
- Open linear drainage systems.

5.11 The existing drainage and any new drainage required for the Works should be checked to ensure that it conforms with good surface water drainage practice **[DMRB 4.2]** appropriate for the class of road. In particular, areas of minimal crossfall that create standing water or combinations of crossfall and gradient that cause 'streams' of water to flow across the carriageway or have the potential for the formation of ice should be avoided.

5.12 If slot drains or linear drainage systems with continuous gratings are used, the effect on rollover should be checked.

5.13 Linear drainage systems that could "trap" the wheel of a vehicle should not be trafficked.

5.14 All drainage elements that are to be trafficked must be designed to meet the minimum requirement of Class D400 of BS EN 124.

**Road Pavement**

5.15 The design of the pavement for crossover sites should be in accordance with **HD 26 [DMRB 7.2.3]**. Construction should be in accordance with the Specification for Highway Works [SHW]. Any existing foundations or pavements should be assessed for their contribution to requirements and be incorporated, if possible, into the new construction. It may be necessary to match the pavements of existing carriageways that, because of previous overlays or other treatments, may be thicker than that required by **HD 26 [DMRB 7.2.3]**.

5.16 Consideration needs to be given to the design length of service for the crossover site. For temporary crossover sites, design traffic loading may be calculated using the advice contained in **HD 24 [DMRB 7.2.1]**. Traffic flow data obtained for the main carriageway pavement design should be used and an estimate of the design traffic calculated using the programmed length of service for the crossover site in question.

5.17 For permanent crossover sites it is likely that the pavement design will be related to the main carriageway design. However, when designing to a minimum construction requirement, it will be necessary to consider the design life of the main carriageway and the likely usage of the crossover site during this period. The design traffic for a permanent crossover site should be assumed to be no less than 1.0 million standard axles or 5% of the design traffic for the main carriageway, whichever is the greater.

5.18 There is no restriction on the type of material or pavement design to be laid at a crossover site, providing the material conforms with the requirements of SHW and the design is in accordance with **HD 26 [DMRB 7.2.3]**. Further advice on pavement options is contained in **HD 27 Chapter 2 [DMRB 7.2.4.2]**.

5.19 Foundations should be designed in accordance with **HD 25 [DMRB 7.2.2]**.

5.20 Advice on the compatibility of adjacent pavement types is available in **HD 27 Chapter 2 [DMRB 7.2.4.2]**.

5.21 Particular attention should be paid to the implications of new pavement construction on drainage paths. Pavement designs should, where possible, match the total thickness of the main carriageway pavement so that formation levels are in the same plane and drainage paths are not interrupted. Where drainage features pass through or lie within the area of a proposed crossover site, the design should incorporate provision for these features within the construction. Surface water drainage is discussed at paragraphs 5.10 to 5.14.

5.22 Attention should be given to the interruption of drainage flows when overlaying hardened central reserves containing linear drainage systems. In such cases, to accommodate water that previously flowed through the crossover site, it will be necessary to provide alternative outfalls.

5.23 Surfacing materials should be in accordance with **HD 36 [DMRB 7.5.1]**, with the exception that a brushed, burlap dragged or tined concrete surface is permitted for a temporary crossover site.

5.24 Skidding Resistance: The psv of the aggregate used in the surfacing on a new crossover site shall be 60. For existing sites an assessment should be carried out to ensure that the skid resistance is equivalent to a SCRIM value (MSSC) of not less than 0.45 (unless Site Category G2 applies, when value will be 0.50). There may be exceptional circumstances where new or existing crossover sites cannot comply with the above requirements without significant disruption or disproportionate cost. In such cases, and with prior agreement of the Overseeing Organisation to a Departure from Standard, lower values may be considered. For new sites, an aggregate of psv value higher than 60 may be used in exceptional circumstances at the discretion of the designer where the risks are considered to be high, or where economies result through bulk ordering and laying of similar material.

5.25 The skidding resistance of an existing crossover site should be investigated using the Portable Skid Resistance Tester (Pendulum Test) which provides a measure of skidding resistance that may be converted in accordance with **HD 28 [DMRB 7.3.1 Para 3.79]** to comparable SCRIM values.

5.26 Prior to opening any crossover site to traffic, its surface should be clean and free of any debris, detritus or fuel spillage.

# 6. SIZING THE CROSSOVER

6.1 Sizing the gap in the VRS, the length of the pavement in the central reserve and the overall length of crossover involves complex geometric calculations and a software macro has been developed specially by TRL for the Overseeing Organisation. The software gives Microsoft Excel output, including graphics. The attached excel application allows designers to size a crossover layout (as described in Chapter 6 of TA92). Before entering any parameters, users must first enter an excel filename to allow the program to deposit output data. The program has a Help function included. Excel software and licences must be held to use the software. If reading this document electronically then click here to access software. Otherwise please e-mail roadlayout@highways.gsi.gov.uk and a copy will be sent by return.

6.2 Tables 3 and 4 are used to select the desired radius, with due recognition of SSD considerations. Designers wishing to use the software will need to input radius, lane widths and offsets of lanes and VRS. The macro assumes a straight road.

6.3 The software is primarily aimed at early design stages to aid early understanding of the size of the crossover required. Designers should ensure that detailed checks are carried out to satisfy themselves about the adequacy of the design e.g. the type of VRS and the necessary setbacks and working widths will require detailed checks.

6.4 Within the software, the user must enter an Excel output file name at the opening screen before the calculations can commence.

# 7. REFERENCES

**1. References to Design Manual For Roads and Bridges**


**Volume 2**

BD 78 Design of Road Tunnels

**Volume 4**

Section 2 Drainage

**Volume 6**

TD 9 Highway Link Design

**Volume 7**

HD 24 Traffic Assessment

HD 26 Pavement design

HD 27 Pavement Construction Methods

HD 28 Skidding Resistance

HD 36 Surfacing Material for New and Maintenance Construction

**Volume 8**

TA 64 Narrow Lane and Tidal Flow Operations at Road Works on Motorways and Dual Carriageway Trunk Roads with Full Width Hardshoulders.


**2. Other References**


DETR Traffic Advisory Leaflet 15/99: Cyclists at Roadworks.

Department of Transport (1991) The Traffic Signs Manual – Chapter 8 'Traffic Safety Measures and Signs for Road Works and Temporary Situations'.

Specification for Highway Works (MCHW).

"The Movement of Abnormal Indivisible Loads through Planned Roadworks": joint Highways Agency/ACPO policy statement 2001.

"Guidance for Safer Temporary Traffic Management": joint Highways Agency/Health and Safety Executive/County Surveyors Society publication 2002.

BS EN 124: Gully tops and manhole tops for vehicular and pedestrian areas. Design requirements, type testing, marking, quality control.

# 8. ENQUIRIES

All technical enquiries or comments on this Advice Note should be sent in writing as appropriate to:

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# ANNEX A: GEOMETRIC DESIGN TABLES

**Use of Tables**

1. Use Table 1 and TSM Chapter 8 to select design speed.
2. Assess geometry through centre of proposed temporary route (including use of Tables 2 and 5) and insert findings into Table 3.
3. Use Table 4 to select radius.
4. Check SSD meets Table 1 requirements and confirm appropriate radius.
5. If required, use software to size the crossover (see Chapter 6).

**Table 1: Design Speeds And Stopping Sight Distances For Crossovers**

| TEMPORARY MANDATORY SPEED LIMIT (MPH) (DERIVED FROM TSM CHAPTER 8) | DESIGN SPEED FOR CROSSOVER (KPH) | ABSOLUTE MINIMUM SSD REQUIRED (METRES) |
|---|---|---|
| 30 | 60 | 50 |
| 40 | 70 | 70 |
| 50 | 85 | 90 |

Note: see paragraphs 4.1 to 4.5 for details of design speed & paragraphs 4.38 to 4.41 for details of SSD.

**Table 2: Resultant Value Of Adverse Camber For Gradient-Crossfall Combinations For Downhill Fitted Curves**

| DOWNHILL GRADIENT OF FITTED VERTICAL CURVE [F] | ADVERSE CROSSFALL [C] | | | |
|---|---|---|---|---|
| | 2.5% | 3.5% | 5% | 7% |
| 1% | 2.7% | 3.6% | 5.1% | X |
| 2% | 3.2% | 4.0% | 5.4% | X |
| 2.5% | 3.5% | 4.3% | 5.6% | X |
| 3% | 3.9% | 4.6% | 5.8% | X |
| 3.5% (*) | 4.3% | 4.9% | 6.1% | X |
| 4% (*) | 4.7% | 5.3% | 6.4% | X |
| 5% (**) | 5.6% | 6.1% | X | X |
| 6% (**) | 6.5% | 6.9% | X | X |

Notes

1. Formula used is Resultant = $\sqrt{[C^2 + F^2]}$.

2. X = not recommended for design.

   * = not recommended for new motorways, but may be present where crossover is envisaged.

   ** = not recommended for new dual carriageways or motorways, but may be present where crossover is envisaged.

3. C is adverse when the existing crossfall falls from central reserve to nearside verge on either carriageway. Take worst case of entry and exit curve.

4. For uphill situations insert value of C directly into Table 3.

5. Table 2 also to be used to check acceptable level difference between carriageways.

**Table 3: Number Of Step Increases In Radii (See Table 4) Required if Adverse Conditions Exist Through Crossover**

| Reference | Adverse Condition | No. Steps Increase Required |
|---|---|---|
| | No Adverse Factor | 0 |
| 4.28 & Table 2 | Worst Case Resultant Adverse Camber ≥2.5% and ≤5% | 1 |
| | Worst Case Resultant Adverse Camber >5% and ≤7% | 2 |
| | Worst Case Resultant Adverse Camber >7% | X |
| 4.12 | Any change of value of Superelevation/Adverse Camber Through Entry or Exit Curve | 1 |
| | Change from assisting Superelevation to Adverse Camber Through Entry or Exit Curve | 2 |
| 4.21 & Table 5 | Desirable Minimum Crest K Value | 0 |
| | One Step below Minimum Crest K Value | 1 |
| 4.22 & Table 5 | Absolute Minimum Sag K Value | 1 |
| 4.11 | Approach Bend with Superelevation of 2.5% | 1 |
| | Approach Bend with Superelevation >2.5% and ≤7% | 2 |
| 4.36 | Rollover: Change in Camber ≥5% and ≤7% | 1 |
| | Rollover: Change in Camber >7% and ≤10% | 2 |
| | Rollover: Change in Camber > 10% | X |

Notes:

1. The number of step increases is cumulative for all tests and is the same for all design speeds.
2. ‘Bend’ and ‘curve’ have specific meanings: see Definitions.
3. X denotes “Not recommended”.





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**Table 4: Horizontal Curve Radii For Design Speeds**

| STEPS FROM TABLE 3 | DESIGN SPEED | | |
|---|---|---|---|
| | **85 kph** | **70 kph** | **60 kph** |
| 0 | 510 m | 360 m * | 255 m * |
| 1 | 720 m | 510 m | 360 m * |
| 2 | 1020 m | 720 m | 510 m |
| 3 | 1440 m | 1020 m | 720 m |
| 4 or more | 2040m | 1440m | 1020m |

Notes:

1. * denotes curve widening may be required in accordance with **TD 9 [DMRB 6.1.1]** if a lane used by LGVs is less than 3.65m wide and radius is less than 400m. If lane widening is not practical then radius may need to be increased.

2. Refer to Chapter 4 for SSD requirements which may affect use of Table 4.

**Table 5: Limiting 'K' Values Of Vertical Curvature For Crest & Sag Curves**

| **DESIGN SPEED** | **85 kph** | **70 kph** | **60 kph** |
|---|---|---|---|
| Desirable minimum crest K value | 55 | 30 | 17 |
| One step below desirable minimum crest K value | 30 | 17 | 10 |
| Absolute minimum sag K value | 20 | 20 | 13 |

Note: The K values given in Table 5 should be checked against the fitted curves shown in Figure 2.