Design Manual for Roads and Bridges

Highway Structures & Bridges
Design

CD 377
Requirements for road restraint systems

(formerly TD 19/06)

Revision 0

Summary
This document details the requirements for permanent and temporary safety barriers, vehicle parapets, terminals, transitions, crash cushions, pedestrian parapets, pedestrian guardrails and pedestrian restraint and protection, vehicle arrester beds, anti-glare systems and cattle grids.

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

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Release notes

Version	Date	Details of amendments
0	Mar 2020	CD 377 replaces TD 19/06. This full document has been re-written to make it compliant with the new Highways England drafting rules.

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Foreword

Publishing information

This document is published by Highways England.

This document supersedes TD 19/06, and partially supersedes IAN 68/05 and IAN 75/06 which are withdrawn.

Contractual and legal considerations

This document forms part of the works specification. It does not purport to include all the necessary provisions of a contract. Users are responsible for applying all appropriate documents applicable to their contract.

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Introduction

Background

This document is an update to TD 19/06 and reflects changes to the Overseeing Organisations' requirements. It also takes account of updated and new EU standards and legislation.

This document gives requirements for road restraint systems and it, together with the associated RRRAP [Ref 43.N] and RRRAP User Guide [Ref 14.N], assists those involved in determining where road restraint systems are warranted, and the minimum required parameters.

Assumptions made in the preparation of this document

The assumptions made in GG 101 [Ref 18.N] apply to this document.

This document is written on the basis that road restraint systems will be supplied and constructed in accordance with the MCHW [Ref 21.N] and all other works will be designed and specified in accordance with the Design Manual for Roads and Bridges.

Mutual Recognition

Where there is a requirement in this document for compliance with any part of a British Standard, technical specification or quality mark, that requirement may be met by compliance with the Mutual Recognition clause in GG 101 [Ref 18.N].

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Abbreviations and symbols

Abbreviations

Abbreviation	Definition
AADT	Average annual daily traffic
AIP	Approval in Principle
ALARP	As low as reasonably practicable
CPR	Construction Products Regulation
DfT	Department for Transport
ECP	Emergency crossing point
EqIA	Equality Impact Assessment
ISL	Impact severity level
LGV	Large Goods Vehicle
LoN	Length of Need
m	Metres
MCP	Maintenance crossing point
mm	Millimetre
mph	Miles per hour
OLE	Overhead line equipment
PNR	Point of no recovery
Psb	Point from which set-back is measured
RRRAP	Road Restraint Risk Assessment Process
RRS	Road restraint system
SO	Special Order
STGO	Special Types General Order
TTM	Temporary traffic management
VI	Vehicle intrusion
VMS	Variable message sign
VRS	Vehicle restraint system
WMCP	Winter maintenance crossing point
W	Working width

Symbols

Symbol	Definition
kN	Kilo Newtons
Wn	Normalised working width
yfl	Partial factor for load
Y_m	Partial factor on material strength

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Terms and definitions

Terms

Term	Definition
Risk associated terms, also refer to GG 104 [Ref 31.N]	
'Acceptable', 'broadly acceptable' and 'as low as reasonably practicable level of risk.	The Road Restraint Risk Assessment Process (RRRAP [Ref 43.N]) that forms part of this document uses the term 'acceptable' to indicate where a 'broadly acceptable' level of risk is achieved in respect of vehicle restraint system provision. NOTE: Depending on the situation, this can be where safety barrier is not warranted, or can be achieved over a range of safety barrier lengths.
Hazard	A source of potential harm, loss or failure.
Other Parties (referred to as "Others" in the RRRAP [Ref 43.N])	A group or collection of people in a public place, such as a school, hospital or railway, that can be injured in numbers by an errant vehicle or by a hazard that is hit by an errant vehicle; or a high value asset or facility that can be adversely affected by an impact from an errant vehicle or by a hazard this is hit by an errant vehicle.
Safety risk	The expected consequence of a specified hazard being realised with the combination of the likelihood and expected severity of the outcome. NOTE: Safety risk is a measure of harm or loss associated with an activity
Secondary event	An incident that can arise as a result of an initial event. NOTE: For instance, if a lighting column is struck and falls onto a carriageway or a railway, the struck lighting column has the potential to cause a secondary event, such as being hit by a vehicle or train and hence creates a risk of a secondary incident occurring.
Other terms	
Adjoining paved surface	The paved area on the traffic side of a parapet immediately adjacent to the plinth or base of the parapet.
Bi-directional crash cushion	A crash cushion which has successfully been tested with tests 1 to 5 inclusive, in accordance with BS EN 1317-1 [Ref 33.N] and BS EN 1317-3 2010 [Ref 25.N]

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Terms (continued)

Term	Definition
Cattle grid	A device set into a road that consists of a number of transverse members supported over a pit. It forms a barrier to livestock but allows access for vehicles.
Crash cushion	An energy absorption device installed in front of one or more hazards to reduce the severity of an impact.
Deformable safety barrier	A safety barrier that when tested in accordance with BS EN 1317-1 [Ref 33.N] and BS EN 1317-2 [Ref 32.N], deflects from its pre-impact position.
Directional crash cushion	A crash cushion which has successfully been tested with tests 1 to 3 inclusive, and either test 4 or test 5 in accordance with BS EN 1317-3 2010 [Ref 25.N]
Energy absorbing terminal	A terminal attached to a VRS which, in test Approach 1 (i.e. head-on centre - refer to BS DD ENV 1317-4 [Ref 26.N]), does not allow the most forward point of the car to cross the vehicle exit line R, or which crosses line R at a speed less than or equal to 11 km/h.
Front face of parapet	The face or part of the parapet nearest to vehicular traffic.
Impact severity level (ISL)	A measure of the severity of an impact with a vehicle restraint system using a combination of vehicle acceleration and the theoretical head impact velocity. NOTE 1: Refer to BS EN 1317-2 [Ref 32.N]). NOTE 2: Impact severity level A affords a greater level of safety for the occupant of an errant vehicle than level B.
Large goods vehicles (LGV)	A vehicle with a gross combination mass of over 3500kg. NOTE: Previously referred to as heavy goods vehicle (HGV)
Legacy system	Permanent safety barriers, parapets and crash cushions currently on the road network that were manufactured and installed before CE Marking under the Construction Products Regulations (2011/305/EU [Ref 29.N]) became a statutory requirement.

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Terms (continued)

Term	Definition
Length of need	The total minimum length of full containment vehicle restraint systems (VRS) stipulated as being required in advance of, alongside, and after a hazard(s) to achieve a 'broadly acceptable' level of risk. NOTE 1: The length over which various VRS reach full containment can vary and need to be checked with the manufacturer. NOTE 2: When assessing whether the length of need and containment level are sufficient for a temporary situation, the speed limit used in the RRRAP [Ref 43.N] is usually the temporary mandatory limit that is to be in force.
Main structure	Any part of a bridge, viaduct, retaining wall or similar structure upon which a pedestrian or vehicle parapet is mounted, including the plinth.
Non re-directive crash cushion	A crash cushion which has successfully been tested with tests 1 to 3 inclusive, in accordance with BS EN 1317-1 [Ref 33.N] and BS EN 1317-3 2010 [Ref 25.N]
Normalised values (of working width and vehicle intrusion)	Values that have been adjusted to take account of any differences between the specified total mass of a vehicle, its velocity and angle of approach, and the values measured during testing. NOTE: Refer to BS EN 1317-2 [Ref 32.N].
Parapet	A restraint system that is installed on the edge of a bridge, retaining wall or similar elevated structure where there is a vertical drop.
Pedestrian parapet	A restraint system that is installed on the edge of a bridge, retaining wall or similar elevated structure where there is a vertical drop where vehicular traffic is excluded, but where pedestrians, equestrians, cyclists or livestock can be present.
Pedestrian restraint system	A restraint system installed to reduce the risk of a fall from a height at locations where pedestrian movement could occur due to highway use or maintenance activities.
Pedestrian guardrail	A restraint system along the edge of a footway or footpath intended to restrain pedestrians and other users from stepping onto or crossing a road, or entering other areas likely to be hazardous.

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Terms (continued)

Term	Definition
Planned maintenance	Planned work required to parts of the motorway and all-purpose trunk roads that have become unserviceable because of general wear or tear, or due to a major upgrade or changes to parts of the network. NOTE: This excludes work associated with incident damage.
Plinth	A continuous upstand on the edge of a structure upon which a vehicle parapet or pedestrian parapet is mounted.
Point of no recovery	The point at which the driver of an errant vehicle has no chance of recovering an errant vehicle back on the carriageway and, unless hit or diverted by an intervening hazard, is going to end up on (in) the adjacent road, railway, water hazard, etc. NOTE: This point can be the top of an embankment slope, the top of the cutting to a railway, the bank of a water hazard if the road is at grade, etc.
Psb	Point from which set-back of the safety barrier or parapet face is measured. NOTE: Refer to CD 127 [Ref 4.N] for minimum requirements for permanent safety barriers.
Railway authority	Authority responsible for the railway infrastructure (e.g. Network Rail)
Re-directive crash cushion	A crash cushion which has successfully been tested with tests 1 to 4 inclusive for a directional crash cushion, and tests 1 to 5 inclusive for a bidirectional crash cushion, in accordance with BS EN 1317-3 2010 [Ref 25.N]
Rigid safety barrier	A safety barrier that when tested in accordance with BS EN 1317-1 [Ref 33.N] and BS EN 1317-2 [Ref 32.N], does not deflect from its pre-impact position.
Road restraint system (RRS)	General name for vehicle restraint system or pedestrian restraint system used on the road.
Routine maintenance	Works which include all routine and cyclic work, and ad-hoc repairs.

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Terms (continued)

Term	Definition
Running lane	That part of the trafficked carriageway nearest to the verge or central reserve that is under consideration. NOTE: Under normal running conditions, the hard shoulder of a motorway would not be trafficked and would therefore not be classed as the running lane. It can however become a temporary running lane under temporary traffic management.
Safety barrier	A type of vehicle restraint system installed alongside or on the central reserve of a road which is typically comprised of metal and/or concrete and/or plastic components.
Set-back	The distance between the Psb and the traffic face of a RRS. NOTE: Refer to CD 127 [Ref 4.N] for minimum requirements for permanent safety barriers.
Sidelong ground	Ground that falls away from the carriageway, where the road is not on a formed embankment. NOTE: Sidelong ground typically occurs where the road is cut into the side of a hill such that the road is effectively in cutting on one side and the ground drops away from the carriageway on the other.
Smooth face	A face which has a surface finish with a maximum size of any undulation or depression in the surface not exceeding 30mm, when measured with respect to a plane through the peaks, the plane being broadly parallel to the road alignment. A structure having a 25mm wide chamfered construction joint in its surface is also regarded as smooth.
Temporary safety barriers	Safety barriers that are to be in place for less than 4 years.
Vehicle intrusion (VI)	The vehicle intrusion of an LGV is the maximum dynamic lateral position from the undeformed traffic side of the barrier in consideration of a notional load having the width and length of the vehicle platform, and a total height of 4 m. The vehicle intrusion of a bus is the maximum dynamic lateral position of the bus from the undeformed traffic side of the barrier. NOTE: Further detail is given in BS EN 1317-2 [Ref 32.N].

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Terms (continued)

Term	Definition
Vehicle intrusion class	The designation VI1, VI2, VI3, etc for classes of vehicle intrusion levels, as defined in BS EN 1317-2 [Ref 32.N].
Vehicle parapet	A vehicle restraint system that is installed on the edge of a bridge, retaining wall or similar elevated structure where there is a vertical drop.
Vehicle restraint system (VRS)	A tested system installed on a road to provide a level of containment for an errant vehicle. NOTE: A typical system consists of a terminal-safety barrier-terminal, or a terminal-safety barrier-parapet-safety barrier-terminal, and includes transitions where appropriate.
Working width (W)	The maximum lateral distance between any part of a safety barrier on the undeformed traffic side, and the maximum dynamic position of any part of the barrier during impact testing to BS EN 1317-2 [Ref 32.N]. NOTE 1: If the vehicle body deforms around the vehicle restraint system so that the latter cannot be used for the purpose of measuring the working width, the maximum lateral position of any part of the vehicle is the working width. NOTE 2: Further detail is given in BS EN 1317-2 [Ref 32.N]
Working width class	The designation W1, W2, W3, etc for classes of working width levels, as defined in BS EN 1317-2 [Ref 32.N].

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1. Scope

Aspects covered

1.1 This document details the requirements that shall be used for:

1) permanent and temporary safety barriers;
2) vehicle parapets;
3) terminals;
4) transitions;
5) crash cushions;
6) pedestrian parapets;
7) pedestrian guardrails;
8) vehicle arrester beds;
9) anti-glare systems; and
10) cattle grids.

Implementation and application

1.2 This document shall be implemented forthwith on the Overseeing Organisations' motorway and all-purpose trunk roads with speed limits of 50 mph or more, and two-way traffic flows of 5,000 average annual daily traffic (AADT) or more, according to the implementation requirements of GG 101 [Ref 18.N].

1.3 More specifically, this document shall be applied:

1) on all new roads;
2) on schemes where the highway cross-section is being altered permanently;
3) whenever the road restraint system (RRS) is life (serviceable life) expired and needs replacing;
4) whenever a hazard is introduced and/or moved, and/or modified;
5) whenever there is a change in risk at or near the edge of the carriageway;
6) whenever a RRS needs to be dismantled (other than where localised sections need to be removed to gain access), e.g. during planned maintenance schemes.

1.3.1 Unless otherwise agreed with the Overseeing Organisation, this document should also be applied:

1) when other works (excluding routine maintenance) are being carried out near a hazard that is currently without provision, or near an existing RRS that does not meet the requirements of this document (e.g. with regard to its containment level, normalised working width class, normalised vehicle intrusion class);
2) when other works (excluding routine maintenance) are being carried out near an existing vehicle restraint system (VRS) which is life (service life) expired;
3) when other works (excluding routine maintenance) are being carried out near an existing RRS that has less than 5 years serviceable life remaining and no other major maintenance works are planned during the remaining life of the existing RRS.

1.3.2 An existing VRS may be reused if it is CE marked and the declaration of performance meets the specified performance class requirements, and can be reinstalled to meet the normalised working width class and normalised vehicle intrusion class requirements.

NOTE *For post and rail safety barriers, it is normal for posts to be renewed rather than reused.*

1.4 Where a RRS can be made compliant with current requirements without significant undue additional expense and or delay, the opportunity shall be taken.

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1.5 This document shall apply to all structures accommodating vehicles and/or vulnerable users, where the Overseeing Organisation is responsible for that structure.

1.6 Where a length of less than 500 m between terminals in a section of post and rail safety barrier needs to be dismantled or replaced as part of planned maintenance and the remaining length is less than 500 m, the entire length shall be installed in accordance with the requirements of this document.

1.7 On the all-purpose trunk road network where the design speed or imposed speed limit is less than 50 mph, a risk assessment which is acceptable to the Overseeing Organisation, shall determine whether RRS is necessary.

NOTE *Guidance on the specification of vehicle restraint systems for low speed and/or low flow roads can be found within Appendix A of this document.*

1.8 RRS provision and requirements shall be assessed at an early stage in the scheme's development and design processes to:

1) ensure all factors such as land take, road and cross-section geometry, location of hazards, the safety of construction and maintenance workers, road users, those that work on the road, and other parties, are taken account of in determining the overall optimum solution; and
2) minimise the need for departures from requirements; and
3) avoid abortive work.

Use of GG 101

1.9 The requirements contained in GG 101 [Ref 18.N] shall be followed in respect of activities covered by this document.

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2. General requirements

Risk assessment and hazard mitigation

2.1 A site inspection shall be carried out to identify all local hazards which are to be mitigated by the design.

NOTE *A physical site inspection ensures that all local hazards have been identified, and to avoid abortive work if hazards are not identified at an early stage.*

2.2 The RRRAP [Ref 43.N] shall be used to formally record the type and location of all of the hazards which are to be mitigated by the design.

NOTE 1 *The RRRAP is a software tool which is available to assist in making an assessment in many situations, based on risk, as to whether a VRS is warranted to prevent the occupants of a vehicle from hitting near side or offside hazards.*

NOTE 2 *The RRRAP can be used on motorways and all purpose trunk roads having a speed limit of 50 mph or greater, and an AADT of 5,000 or greater.*

NOTE 3 *Guidance is given in Appendix A on how users of the RRRAP can deal with roads that have a low flow (i.e. < 5,000 AADT) and/or low speed limit (i.e. < 50 mph).*

NOTE 4 *The RRRAP is potentially inappropriate for a direct assessment of central reserves, roundabouts and junction areas or lay-bys, due to the complexity and variability of hazards and their locations, traffic speed limits, road layouts and alignments, and variability of traffic incident data in these situations.*

NOTE 5 *In order to estimate the level of risk, the RRRAP uses a combination of road data such as the road type, speed limit and AADT, default data and factors for each hazard type, and user input details relating to the nature and location of each hazard. The output shows the category of risk (unacceptable, tolerable, or acceptable) without a safety barrier and with the optimum length of safety barrier provision and its containment level. Indicative risk and benefit cost ratios can also be obtained.*

NOTE 6 *The RRRAP does not cover pedestrian restraint systems, vehicle arrester beds, anti-glare systems or cattle grids.*

2.3 The effect of mitigation options on the associated risk level and the benefits / cost ratio shall be reviewed within the RRRAP [Ref 43.N], and the risk reduced to an acceptable level or ALARP.

2.3.1 Mitigation options may involve:

1) eliminating the risk (by removing the hazard);
2) reducing the risk of impacting the hazard (by relocating the hazard to a position posing less overall risk and/or by redesigning the hazard to make it less aggressive e.g. by installing passively safe supports);
3) informing road users, road workers and third parties of the risk posed by the hazard (by providing additional signage and lining, for example);
4) controlling the risk (by the installation of a VRS).

NOTE *It is preferable to eliminate the risk over reducing it. In turn, reducing the risk is preferred over informing road users, road workers and third parties of the risk and controlling the risk.*

2.3.2 Other measures which also reduce the level of risk should be identified including:

1) additional risk management requirements contained in the DfT report 'Managing the accidental obstruction of the railway by road vehicles' MAOR [Ref 20.N];
2) a lower speed limit;
3) revision of the road layout and/or cross-section;
4) the installation of high friction road surfacing.

2.4 For each defined hazard, the need for a VRS, its parameters and minimum performance requirements shall be identified by using the RRRAP.

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2.5 Where, having reviewed all the options, a solution is found within the RRRAP that produces an "acceptable" level of risk, then this option shall be used as the basis for the final design.

2.6 A record of the design for hazard mitigation shall include the hazards identified and the assumptions made to mitigate each of these hazards to demonstrate that the design meets the requirements of this document.

Information to be provided and/or specified

2.7 The following shall be provided for each adopted hazard mitigation layout:

1) the risk assessment;
2) the output from the RRRAP;
3) a completed contract specific specification, using contract specific Appendix 4/1 as detailed in MCHW Series NG400 [Ref 23.N];
4) all relevant supporting information for each design as part of the Health and Safety documentation required under the Construction (Design and Management) Regulations SI 2015/51 [Ref 41.N].

NOTE *The minimum risk assessment information required is:*

1) basic common details;
2) collation of data;
3) user comments;
4) detailed results;
5) VRS summary output;
6) temporary hazards (where applicable); and
7) barrier and options costs worksheets.

2.8 Factors relevant to the installation, maintenance and demolition of the RRS that can influence the choice of RRS shall be identified in the contract specific specification, using contract specific Appendix 4/1 as detailed in MCHW Series NG400 [Ref 23.N] to ensure that suitable systems are used.

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3. Requirements for permanent safety barriers

3.1 All VRS installations that include permanent safety barriers shall be compatible with each other throughout the entire installation length (including any other safety barriers, parapets, terminals, transitions and crash cushions) and meet the requirements of this Section 3.

3.2 For each permanent safety barrier installation, based on the site specific conditions, the following and all other relevant requirements of MCHW Series 400 [Ref 22.N] and the associated MCHW Series NG400 [Ref 23.N] shall be specified in the contract specific specification, using contract specific Appendix 4/1 as detailed in MCHW Series NG400 [Ref 23.N]:

1) containment level;
2) impact severity level (ISL);
3) set-back;
4) normalised working width class (W);
5) normalised vehicle intrusion class (VI);
6) location and maximum height that allows the required visibility (refer to CD 127 [Ref 4.N] and CD 109 [Ref 15.N]);
7) length of need;
8) any special requirements (e.g. environmental considerations, motorcyclist protection, lengths of removable safety barrier, ground conditions, proximity to embankment slopes, requirements to accommodate pedestrians on verges, clearance to hazards that are vulnerable to residual loading and loading requirements for structures, measures to reduce the risk of injury to pedestrians, equestrians and other vulnerable users (e.g. no sharp edges));
9) specific connection requirements to existing safety barriers, vehicle parapets or other structures.

NOTE 1 *The objective of installing safety barriers alongside or within a motorway and/or all-purpose trunk road is to reduce the consequences of vehicles leaving the carriageway and entering areas where hazards exist.*

NOTE 2 *Safety barriers are intended to contain and redirect vehicles along the line of the barrier in the direction of travel, so they do not rotate or overturn, for the benefit of road users.*

3.3 The design shall be the optimum solution for the hazard having achieved compliance with the mandatory requirements, the conditions of a relaxation (where applicable), a broadly acceptable level of risk, or having obtained a departure from requirements.

3.3.1 Guidance may be sought from safety barrier manufacturers on the most appropriate arrangement to prevent vehicles from hitting the ends of parapets, hazards in the verges and the adjacent road at entry slip and link roads, where the safety barrier arrangement is determined by the local geometry.

Minimum containment levels

3.4 On roads with a speed limit of 50 mph or more, the minimum containment level for permanent safety barriers shall be:

1) normal containment level: N2;
2) higher containment level: H1;
3) very high containment level: H4a.

3.5 On roads with a speed limit of less than 50 mph, the minimum containment level for permanent safety barriers shall be:

1) normal containment level: N1;
2) higher containment level: H1;
3) very high containment level: H4a.

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3.6 Where a site-specific risk assessment indicates that a containment level higher than the minimum level is required, the higher containment level shall be specified.

3.7 Where the need for a higher containment level or very high containment level safety barrier has been identified, the nature of the risk, any mitigation with the steps taken to reduce the risk and the resulting containment level required shall be recorded.

Impact severity level

3.8 The impact severity level (ISL) shall be either level A or B.

Normalised working width classes and normalised vehicle intrusion classes

3.9 For normal containment level safety barriers, the maximum identified value of normalised working width class that the local hazard(s) allow, shall be used.

3.10 For higher and very high containment level safety barriers, the maximum identified values of normalised working width class and normalised vehicle intrusion class that the local hazard(s) allow, shall be used.

3.11 For all higher and very high containment level safety barriers included in the contract specific specification Appendix 4/1 as detailed in MCHW Series NG400 [Ref 23.N], the required clearance to any hazard that is vulnerable to residual loading shall be given in the site specific information.

Length of need

3.12 During testing to BS EN 1317-2 [Ref 32.N], the test length of the safety barrier shall be sufficient to demonstrate the full performance characteristics of the barrier at the length of need.

3.13 The length of full containment safety barrier, i.e. the length of need in advance of and beyond a hazard(s), required to reduce the risk to occupants of an errant vehicle and to other parties that can be affected to an acceptable level as identified by the RRRAP [Ref 43.N], shall be specified (refer to contract specific specification Appendix 4/1 as detailed in MCHW Series NG400 [Ref 23.N]).

3.13.1 In the case of structures, part of the length of need may be provided by a vehicle parapet of sufficient containment, connected to lengths of safety barrier via transitions.

3.13.2 Where traffic can travel in both directions along the same carriageway, either under normal conditions or under temporary traffic management such as contraflow, it should be determined whether the minimum length of need is sufficient under both conditions.

3.13.3 The greater of the two lengths of need should be used.

3.13.4 Where the length of need for a temporary situation exceeds the length of need for normal conditions, the extra length of need may be provided only for the period of time that the temporary situation is in operation, or provided as a permanent solution.

3.14 The total length of safety barrier shall be the length of need plus the additional lengths declared by the manufacturer in advance of, and after the length of need, to ensure that the safety barrier attains full containment at the points required (see Figure 3.19).

NOTE 1 *Example 1: a gantry in the verge of a dual carriageway has a length of 5.5m. If the length of need of an N2 safety barrier is 43 m (30m + hazard length of 5.5m + 7.5m), but full containment is only achieved 20m from the safety barrier end of the terminal, then the minimum required length of safety barrier between terminals will be 83 m (i.e. 20 m + 30 m + hazard length of 5.5 m +7.5 m + 20 m).*

NOTE 2 *Example 2: a gantry in the verge of a single carriageway has a length of 5.5 m. If the length of need of an N2 safety barrier is 65.5 m (30m + hazard length of 5.5m + 30m), but full containment is only achieved 20m from the safety barrier end of the terminal, then the minimum required length of safety barrier between terminals will be 105.5 m (i.e. 20 m + 30 m + hazard length of 5.5 m + 30 m + 20 m).*

Set-back

3.15 All parts of a permanent VRS, including the terminals, shall meet the minimum set-back requirements of CD 127 [Ref 4.N].

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3.15.1 Greater set-back should be provided where space allows.

3.16 Rates of change of set-back shall not be greater than that declared by the manufacturer.

3.17 The proposed design layout of the safety barrier shall be such that it:

1) has a flowing alignment along the length of the safety barrier;
2) changes in safety barrier profile do not occur abruptly;
3) any changes in angle of the safety barrier presented to oncoming traffic (i.e. the approach angle) are not going to be significantly different in effect on an errant vehicle or on the safety barrier, to the angle(s) of approach at which the safety barrier has been tested or those declared by the manufacturer;
4) changes in alignment do not give rise to a 'pocketing' effect.

3.18 On the approach to structures, where the existing site geometry is restricted, if the taper or part of the taper is included in the length of need, the structure shall be fully collision resistant.

3.19 At locations other than the approach to structures, any taper catering for changes in set-back shall not be placed beyond point A on the approach and in advance of point D on the departure to a hazard, as shown in Figure 3.19.

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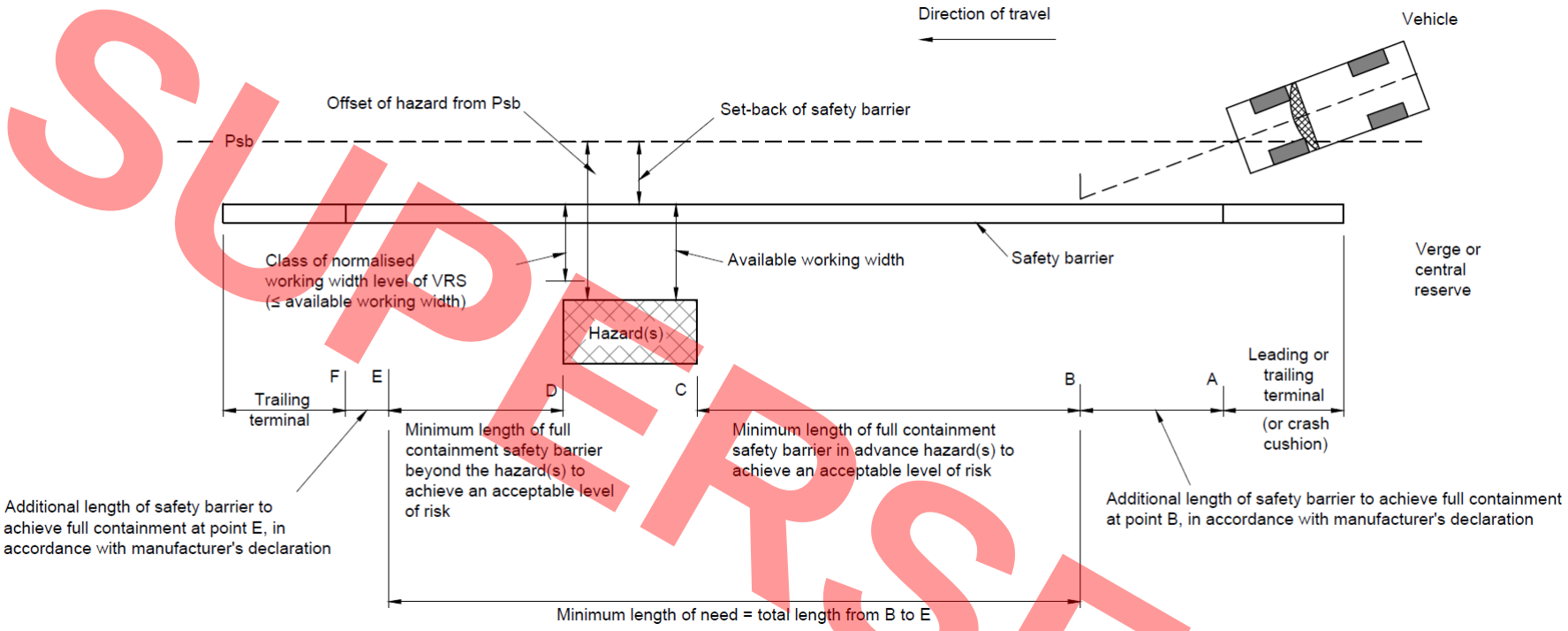
Figure 3.19 Set-back, working width, and length of need of safety barrier at an individual hazard



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General requirements

3.20 All hazards within or immediately adjacent to the highway boundary that can cause a danger to the occupants of a vehicle or give rise to a secondary event were the vehicle to reach the hazard, or affect other parties shall be identified and assessed.

3.20.1 Where appropriate, hazards within or immediately adjacent to the highway boundary that can cause a danger to the occupants of a vehicle or give rise to a secondary event were the vehicle to reach the hazard, or affect other parties should also be listed in the risk assessment.

3.20.2 Examples of common hazards which should be included in the risk assessment are listed below:

1) above ground structural supports, bases or foundations positioned less than 3 m above the adjacent paved carriageway where local conditions at the site make it possible for the hazard to be reached;
2) drainage culvert head walls and ditches where the depth of the ditch relative to the adjacent ground level is 1 m or greater;
3) restricted headroom at a structure or part of a structure (refer to CD 127 [Ref 4.N]);
4) surface of a rigid structure or construction (such as retaining and abutment walls) that do not have a smooth face adjacent to the traffic that extends at least 1.5 m above the adjacent carriageway level;
5) exposed rock faced cutting slopes, rock filled gabions, crib walling or similar structures;
6) soil cutting slopes and earth bunds greater than 1 m high and with a side slope gradient of 1:1 or steeper;
7) embankments and vertical drops;
8) parapets (although these can form part of the VRS, their traffic facing ends can be a hazard and their presence needs to be identified);
9) strengthened or geotextile reinforced slopes;
10) environmental barriers or screens;
11) highway boundary fences and walls;
12) dwarf retaining walls surrounding hazards such as drainage access manholes and communication cabinets;
13) permanent or expected water hazard with a depth of water of 0.6 m or more, such as a river, reservoir, stilling pond or lake or other hazard which, if entered, can potentially cause harm to the vehicle occupants;
14) road lighting columns, not certified as meeting the requirements of BS EN 12767 [Ref 24.N];
15) high mast road lighting columns;
16) sign and signal gantry supports including variable message signs (VMS);
17) sign/signal posts not certified as meeting the requirements of BS EN 12767 [Ref 24.N] and/or which exceed the equivalent section properties of a tubular steel post having an external diameter of 89 mm and a nominal wall thickness of 3.2 mm;
18) large signs (typically those higher than 2m) located in a position where the fascia is 1.5m or less above the adjacent carriageway and can potentially be struck by a vehicle;
19) above ground communications control cabinets, pillars and equipment (other than emergency telephones), CCTV masts and telephone masts (refer to CD 354 [Ref 7.N], and TD 131 [Ref 34.N]);
20) stores for emergency/diversion signs and similar permanent structures;
21) wooden telegraph poles;
22) A tree or trees having, or expected to have, trunk girths of 250 mm or more (measured at a height of 0.3 m above ground level) at maturity;
23) hazards where other parties can be affected:
    a) subway entrance for vulnerable users or agricultural underbridge passing under the highway;
    b) a railway, canal or separate road or carriageway;

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c) public meeting places where a number of people are present for a significant time such as bus shelters, places of worship, schools, hospitals, recreational, retail facilities or factories;

d) chemical works, petroleum storage tanks or depots, domestic gas canisters or tanks, facilities manufacturing or storing hazardous materials in bulk;

e) other infrastructure, where the impact on the community / society as a whole is disproportional to the damage caused. This can include significant utility (electrical, gas) or communications infrastructure.

NOTE *Vegetation such as small trees, shrubs and hedges in front of a safety barrier can cause a vehicle to impact the safety barrier at a point higher than that at which it was tested, causing the vehicle to mount the vegetation and/or launch the vehicle over the barrier.*

3.21 Where assessment identifies which hazards or groups of hazards require a safety barrier, the length of need, set-back, normalised working width class, normalised vehicle intrusion class (where applicable) and other parameters for each hazard shall be determined.

3.22 Neither road furniture nor equipment shall be positioned on the carriageway side of the safety barrier, adjacent to a terminal or, with reference to Figure 3.19, within the length AC in advance of a hazard(s) or the length DF beyond a hazard(s).

3.23 A VRS shall not be placed within the normalised working width class or normalised vehicle intrusion class of an adjacent VRS other than where a double sided safety barrier is designed to bifurcate into two separate single sided safety barriers.

3.24 Safety barrier layouts shall be planned to minimise the number of approach ends of safety barriers, gaps of 50 m or less between adjacent safety barrier installations closed, and the safety barrier made continuous, unless gaps are required for access or maintenance or the safety barriers are at different offsets.

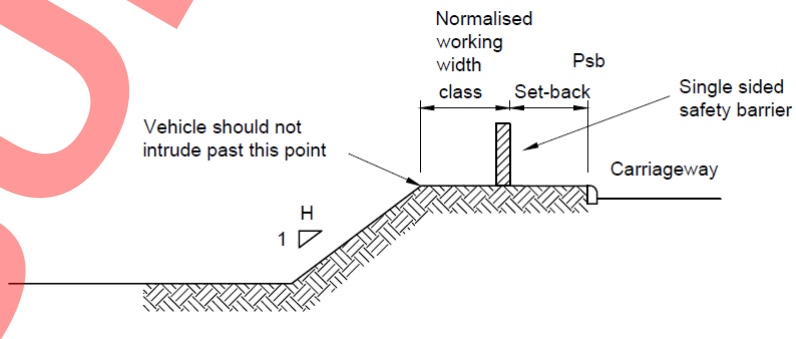
3.25 Gaps of up to 100 m shall be closed, unless there are significant cost, technical and/or access requirements for the gap to remain open.

3.26 Where a gap between safety barrier installations cannot be physically closed due to the safety barriers being at different offsets, or where maintenance or access for vulnerable users is required, the installations shall be arranged to minimise the probability of a vehicle impacting the first safety barrier and being directed into the leading terminal of the second safety barrier, or into the hazard that the second safety barrier is protecting.

3.27 The verge and central reserve below and immediately in front of and behind the safety barrier shall be without abrupt changes in level.

3.28 Where a safety barrier is required by this document, the top of a slope that exceeds 200mm in height shall not be within the normalised working width class of the safety barrier, as shown in Figure 3.28.

Figure 3.28 Safety barrier location relative to the top of a slope that exceeds 200 mm in height.



3.29 Where a safety barrier is required by this document, the toe of a slope that exceeds 200mm in height shall not be within the normalised working width class of the safety barrier, as shown in Figure 3.29.

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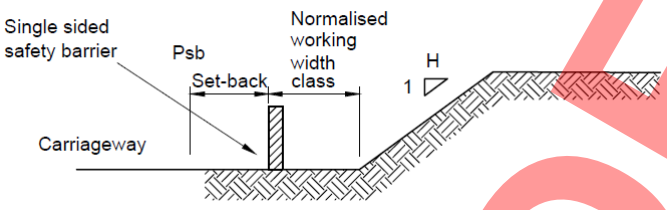
Figure 3.29 Safety barrier location relative to the toe of a slope that exceeds 200 mm in height.



3.30 On embankments and sidelong ground where the proximity of the safety barrier to the top of the slope and/or the ground conditions are likely to affect the integrity of the barrier, this shall be included as part of the contract specific specification, using contract specific Appendix 4/1 as detailed in MCHW Series NG400 [Ref 23.N].

Drainage and kerbs

3.31 Positioning of RRS components relative to infrastructure such as drainage and kerbs shall be such that it does not compromise the durability or effectiveness of the RRS or the infrastructure.

Motorcyclists

3.32 Where a specific risk to motorcyclists is identified, appropriate mitigation measures to reduce the risk shall be specified in the contract specific specification, using contract specific Appendix 4/1 as detailed in MCHW Series NG400 [Ref 23.N].

3.33 The risks to motorcyclists, including details of the measures adopted, shall be recorded as part of the design.

Other factors

3.34 The design of the permanent safety barrier system shall:

1) accommodate its safe and efficient installation, repair, and removal, and allow access to and maintenance of above and below ground services, equipment and other highway assets, including temporary signs;
2) allow for the safe and efficient maintenance of the safety barrier system;
3) allow for the safe and efficient maintenance of the adjacent verge/central reserve.

3.35 Where the safety barrier system is on a supporting structure, the maximum dead and impact loading limits that can be applied by the safety barrier system to the structure shall be identified within the design and specified in the contract specific specification, using contract specific Appendix 4/1 as detailed in MCHW Series NG400 [Ref 23.N].

3.36 The form of safety barrier and its height above the adjacent carriageway(s)/verge level(s) shall be such so as to permit future pavement overlay or reconstruction.

3.37 Where appropriate, the range of heights over which the safety barrier needs to be effective and the level(s) relative to which they are to be set, shall be in accordance with the manufacturers' specification.

3.38 In areas where environmental conditions can affect the choice and positioning of the safety barrier, any restrictions on the type or material for the barrier shall be specified in the contract specific specification, using contract specific Appendix 4/1 as detailed in MCHW Series NG400 [Ref 23.N].

NOTE *Environmental considerations can include snow (where a safety barrier with a solid traffic face can give rise to levels of drifting and difficulties in snow or sand clearance), or marine environments (where metal products can be subject to high levels of corrosion and concrete adversely affected).*

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3.39 Where there is a risk of falling materials/rocks reaching the verge, mitigation shall be put in place to ensure the safety barrier is not required to contain or restrain this material.

3.40 Any mitigation to reduce the risk of falling materials/rocks shall not effect the performance characteristics of the safety barrier.

3.41 As part of the assessment of appropriate VRS provision, the costs of protecting an asset identified as a hazard against the costs of replacing the asset and/or the costs and implications of the asset being out of service or unavailable for a period of time shall be assessed and recorded.

Passively safe road furniture and equipment, and vehicle restraint systems

3.42 Passively safe road furniture shall be used in accordance with the National Annex to BS EN 12767 [Ref 24.N], such as sign/signal supports and lighting columns, as an alternative to protecting the hazard through safety barriers:

1) unless there is another hazard at the location which cannot be removed, relocated or made passively safe and that requires the provision of VRS;
2) at roundabouts or junctions where there is insufficient room for full VRS provision;
3) where VRS can be vulnerable to full frontal impact or cannot be provided with the correct orientation for all the anticipated directions of traffic movement.

3.43 Passively safe road furniture or equipment placed within the normalised working width class of a safety barrier shall have an energy absorption category of NE (as defined by BS EN 12767 [Ref 24.N]).

3.43.1 Passively safe road furniture or equipment may be located within the normalised working width class of a single sided safety barrier in the verge, as long as it is demonstrated that:

1) space is limited and the passively safe furniture cannot be located outside the normalised working width class of the existing safety barrier; and
2) a safety barrier with a sufficiently small normalised working width class cannot be used; and
3) it is necessary to install the safety barrier for hazard(s) other than the passively safe furniture (i.e. the barrier cannot be removed); and
4) the sign/signal posts demonstrates the same collapse mechanism(s) as that witnessed in the BS EN 12767 [Ref 24.N] testing if impacted in the proposed installation location; and
5) the arrangement does not present a risk of a secondary incident.

3.43.2 Passively safe sign/signal posts (excluding those with slip bases) may be located within the normalised working width class of a single sided safety barrier in the central reserve, as long as it is demonstrated that:

1) space is limited and the sign/signal posts cannot be placed outside the working width of the safety barrier; and
2) a safety barrier with a sufficiently small working width class cannot be used; and
3) it is necessary to install the safety barrier for hazard(s) other than the passively safe furniture (i.e. the barrier cannot be removed); and
4) the sign/signal posts demonstrates the same collapse mechanism(s) as that witnessed in the BS EN 12767 [Ref 24.N] testing if impacted in the proposed installation location; and
5) the arrangement does not present a risk of a secondary incident.

3.43.3 Reducing the size of sign/signal support posts by providing more posts should not be used to overcome the requirement to provide a safety barrier.

NOTE *As post spacing decreases, there is an increasing tendency for more than one post to be hit by a vehicle and for the sign and posts to act together as a relatively stiff and rigid hazard, thus significantly increasing its aggressiveness and potential to cause damage and injury. Further information can be found within BS EN 12767 [Ref 24.N].*

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Safety barrier provision at structural supports

3.44 Where a safety barrier is required at a collision resistant structure or abutment to give an acceptable level of risk to the occupants of an errant vehicle, the structure or abutment's structural integrity shall be maintained following an impact (see CS 453 [Ref 40.N]).

NOTE 1 *Where a normal containment level safety barrier is required, this safety barrier is generally not intended to provide protection for the structure, only to reduce the risk of injury to road users.*

NOTE 2 *Abutments are not normally considered to be at risk as a result of vehicle collision as they are assumed to have sufficient mass to withstand the collision loads for global purposes; (see CS 453 [Ref 40.N] (for existing bridges) or BS EN 1991-1-7 [Ref 11.N] (for new structures).*

3.45 Structural supports, such as bridge abutments and piers shall be assessed in accordance with CS 453 [Ref 40.N] (existing structures) or designed in accordance with BS EN 1991-1-7 [Ref 11.N] (new structures) to determine the minimum containment level and normalised working width class required by a safety barrier.

3.46 Where a safety barrier is required and a CS 453 [Ref 40.N] assessment or BS EN 1991-1-7 [Ref 11.N] design determines that the structure is assessed/designed for main load conditions, a minimum N2 containment level safety barrier with full normalised working width class shall be specified in the contract specific specification Appendix 4/1 as detailed in MCHW Series NG400 [Ref 23.N].

3.47 Where a safety barrier is required and a CS 453 [Ref 40.N] assessment or BS EN 1991-1-7 [Ref 11.N] design determines that the structure is not assessed/designed for main load or residual load conditions, higher or very high containment level safety barrier shall be specified in the contract specific specification Appendix 4/1 as detailed in MCHW Series NG400 [Ref 23.N].

3.48 Where a safety barrier is required and a CS 453 [Ref 40.N] assessment or BS EN 1991-1-7 [Ref 11.N] design determines that the structure is not assessed/designed for main load or residual load conditions, the normalised working width class and normalised vehicle intrusion class shall be specified to minimise the risk of the structure being struck by a vehicle.

3.49 Where the assessment of impact of an overhanging or intruding part of a vehicle with the structure is accepted by the Overseeing Organisation, a higher or very high containment level safety barrier with a minimum height of 1.5 m shall be specified in the contract specific specification Appendix 4/1 as detailed in MCHW Series NG400 [Ref 23.N].

3.50 Where the assessment of impact of an overhanging or intruding part of a vehicle with the structure is accepted by the Overseeing Organisation, the structure shall be assessed/designed for residual loading.

3.51 Where the minimum headroom to an overbridge in the verge is less than the required maintained headroom, a safety barrier shall be placed no closer to the point where the maintained headroom is lost, than as shown in Figure 3.51.

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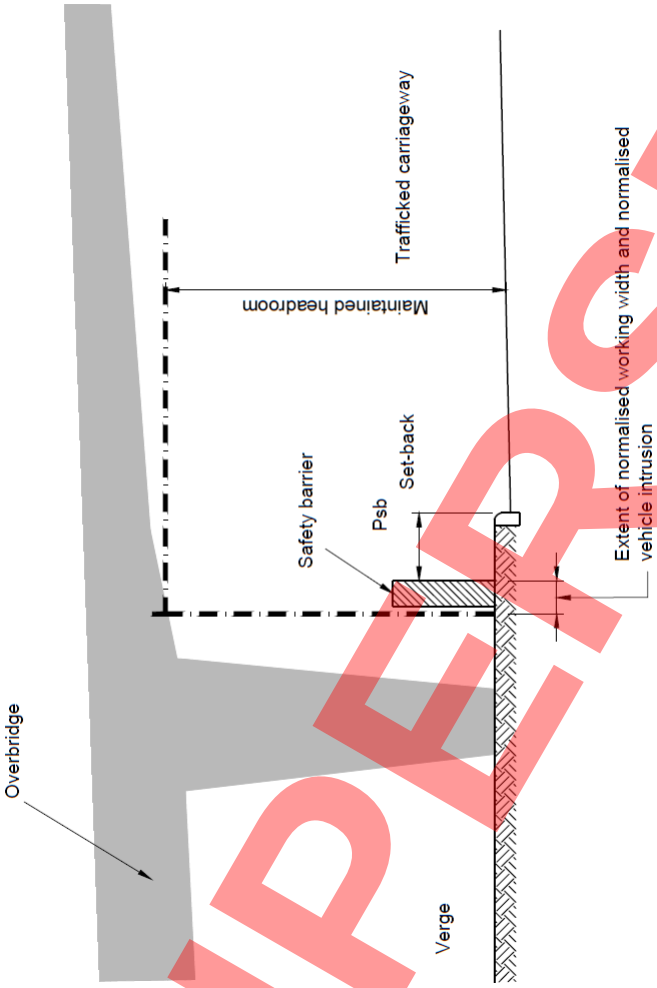

Figure 3.51 Provision of safety barrier at restricted headroom

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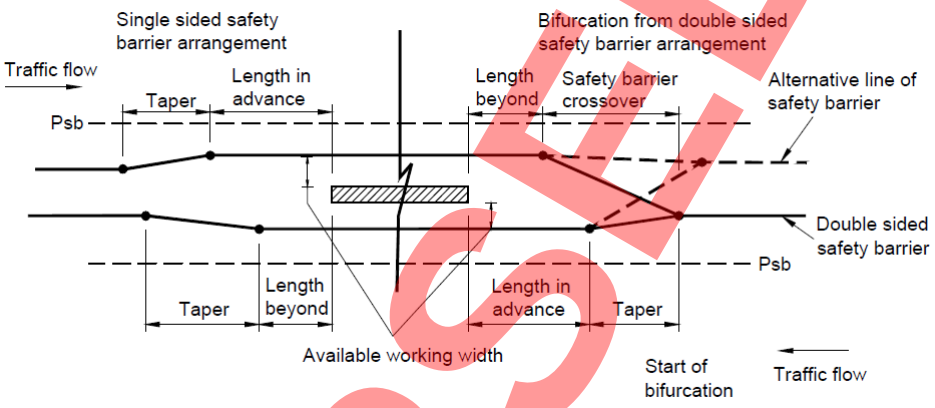
3.52 Where the minimum headroom to an overbridge in the verge is less than the required maintained headroom, and where the set-back to the safety barrier is greater than or equal to 1.5 m, the maintained headroom shall be measured from the adjacent verge level rather than from the edge of carriageway level.

3.53 Where any part of an abutment or structure that is less than the maintained headroom above the adjacent edge of carriageway level is within the normalised working width class and/or normalised vehicle intrusion class, it shall be assessed for main and residual loading.

3.54 Safety barrier alignment around a structural support shall follow the layout described within Figure 3.54 unless there is a restricted width of carriageway.

Figure 3.54 Provision of safety barrier at a structural support



NOTE *Figure 3.54 shows the central reserve situation only. For verge situations, the layout is similar, but with only one single sided safety barrier.*

3.54.1 Where it is not possible to incorporate the layout described within Figure 3.54 due to a restricted width of carriageway, a safety barrier may be installed in line with the face of a structural support, providing the following conditions apply:

1) the abutment or structure has been assessed/designed for impact load in accordance with CS 453 [Ref 40.N] (existing structures) or BS EN 1991-1-7 [Ref 11.N] (new designs); and
2) the structural support has a smooth face, with a minimum height of 1.5m; and
3) in the case of bridge piers, the pier is a leaf pier; and
4) the structural support's geometric design is such that it does not lean towards on-coming traffic; and
5) approved transitions are used between the safety barrier and the structural support.

3.54.2 Where it is not possible to incorporate the layout described within Figure 3.54 due to a restricted width of carriageway, a safety barrier may be installed in line with a collar constructed around the base of a structural support, providing the following conditions apply:

1) the concrete collar has been assessed/designed for impact load in accordance with CS 453 [Ref 40.N] (existing collars) or BS EN 1991-1-7 [Ref 11.N] (new designs); and
2) the concrete collar has a smooth face, with a minimum height of 1.5m.

Safety barrier provision at vehicle parapets

3.55 Where a vehicle parapet is required, a safety barrier shall be provided to prevent direct impact with each end of the parapet, and an approved transition provided between the safety barrier and the vehicle parapet.

NOTE *The performance classes of the parapet and safety barrier can differ in containment level, normalised working width class and ISL.*

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3.56 On two-way roads both ends of the parapet shall be treated as approach ends.

3.57 The safety barrier shall continue the line of the traffic face of the vehicle parapet.

3.58 The safety barrier containment level at each end of the parapet shall be N2, unless a containment level higher than N2 has been determined by assessment.

3.59 At each end of the vehicle parapet, the safety barrier shall have full containment for at least the minimum length at the appropriate containment level.

3.60 The minimum length required for full containment can include the length of any transition between the parapet and safety barrier, but shall not include any taper, change in horizontal alignment, nor terminal.

3.61 The assessment shall be used to determine whether the minimum length of need of safety barrier in advance and beyond the parapet is sufficient to protect a vehicle from the end of the parapet, and from the hazard that the parapet is protecting.

3.62 Where the length of need determined by the assessment is greater than the minimum length, then the length of need determined by the assessment shall be provided.

3.63 The parapet shall be capable of resisting forces applied via or through the safety barrier or transition.

Safety barrier provision at gantries

3.64 For central reserves, safety barrier shall be provided on both sides of the gantry.

3.65 The safety barrier containment levels at gantries shall be dependant on the outcome of the risk assessment from CD 365 [Ref 27.N] and the UK National Annex NA to BS EN 1991-1-7 [Ref 47.N], as agreed with the Overseeing Organisation.

Vulnerable users

3.66 Where a safety barrier is required and there is a defined movement of maintenance workers and/or vulnerable users, any proposed safety barrier installation shall allow for such movement by complying with CD 143 [Ref 9.N].

3.67 Where accommodating a right of way through a continuous safety barrier where a need for a pedestrian guardrail has not been identified, the details shown in Figures 3.67a and 3.67b shall be followed.

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Figure 3.67a Accommodating a right of way through a continuous verge safety barrier

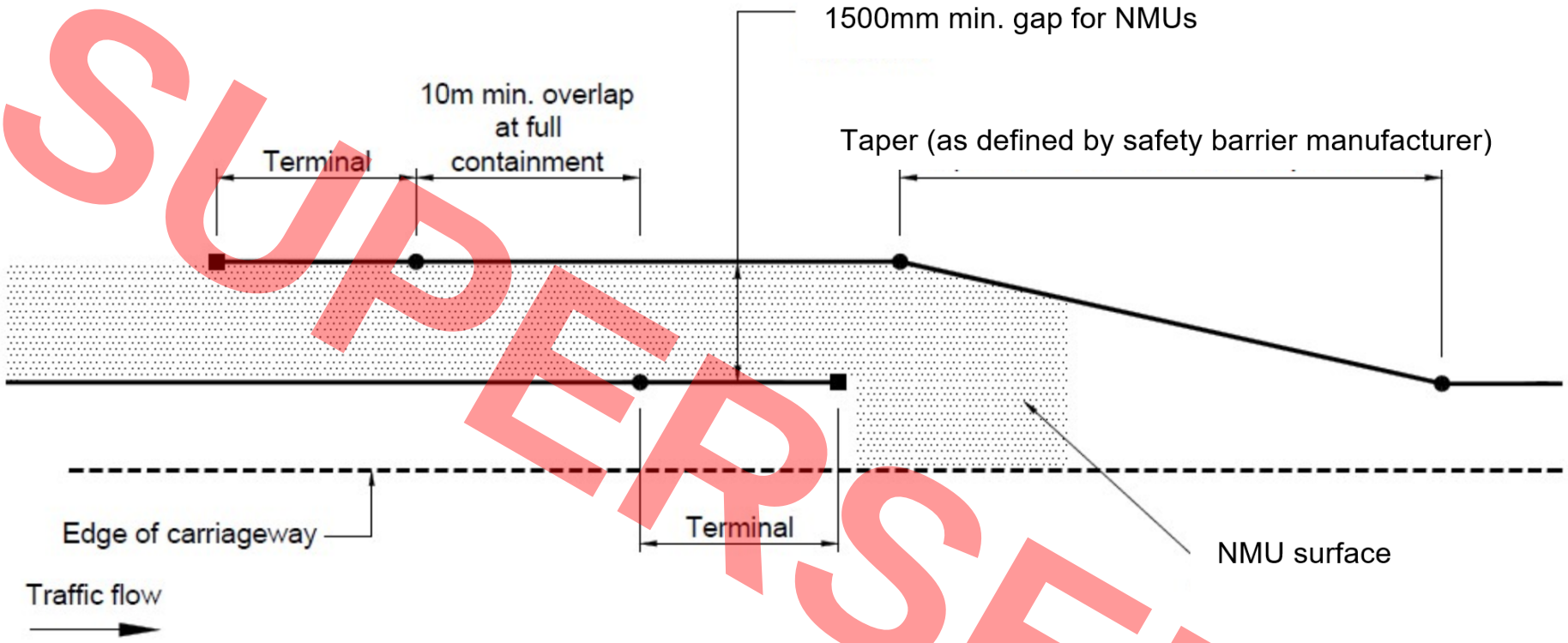

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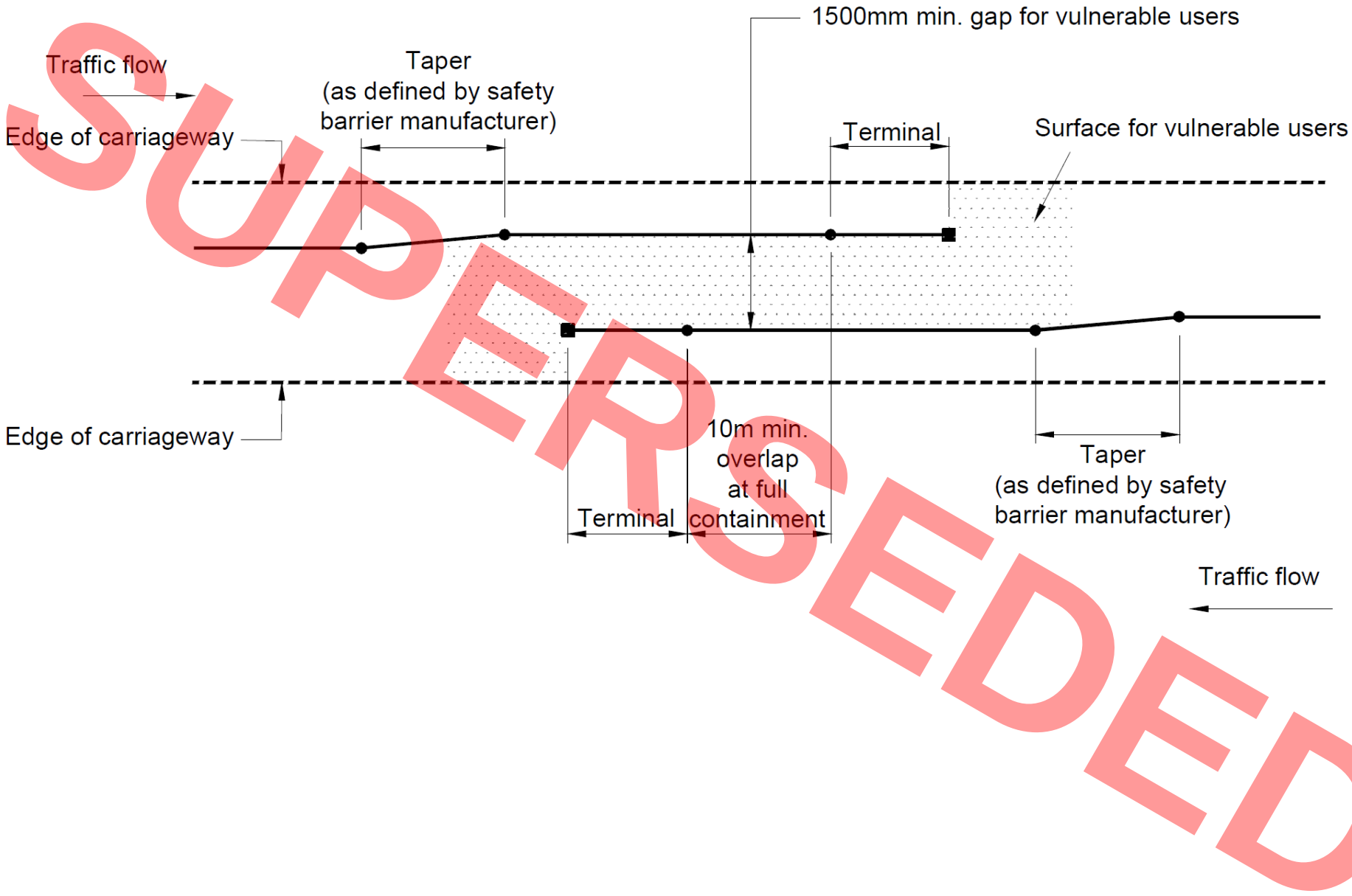
Figure 3.67b Accommodating a right of way through a continuous central reserve safety barrier



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NOTE *The detail shown in Figure 3.67b is for high speed limit roads where pedestrian use is expected to be low, and either there is no requirement for pedestrian guardrail, or its use cannot be justified.*

3.68 Where accommodating a right of way through a continuous safety barrier where a need for a pedestrian guardrail has been identified, the details shown in Figures 3.68a and 3.68b shall be followed.

Figure 3.68a Accommodating a right of way through a continuous verge safety barrier, incorporating pedestrian guardrail

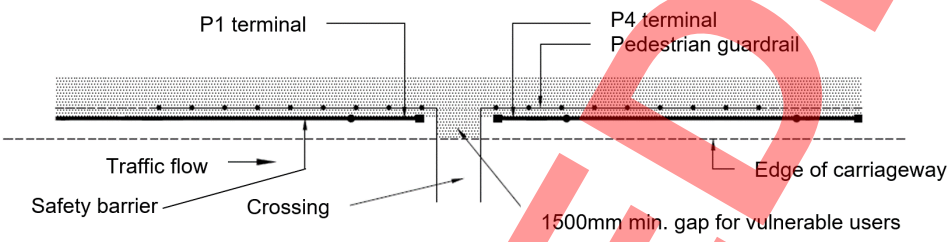
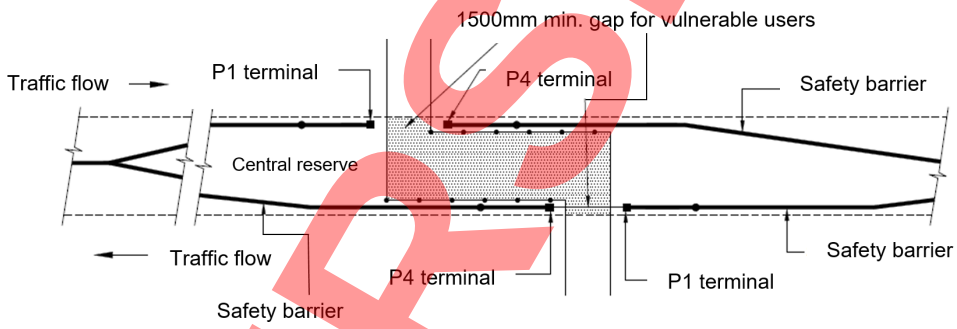


Figure 3.68b Accommodating a right of way through a continuous central reserve safety barrier, incorporating pedestrian guardrail



3.69 Safety barrier adjacent to vulnerable users shall not have any sharp edges.

3.70 Any add-on protective measures shall be checked with the VRS manufacturer to ensure they do not adversely effect the performance of the VRS.

3.71 Vulnerable user routes shall be located as far from the rear of the safety barrier as possible.

Safety barrier provision at nosing areas and junctions

3.72 Nosing areas, where one carriageway diverges from another, shall be kept flat and free of hazards (including VRS) whilst being designed to discourage over-running.

3.73 Street furniture and other hazards shall be kept to a minimum and placed as far downstream from the back of the nose as possible commensurate with their function and the physical, and horizontal and vertical constraints of the location.

3.74 VRS shall be placed further than 10 m from the back of the nosing (refer to Figure 3.74).

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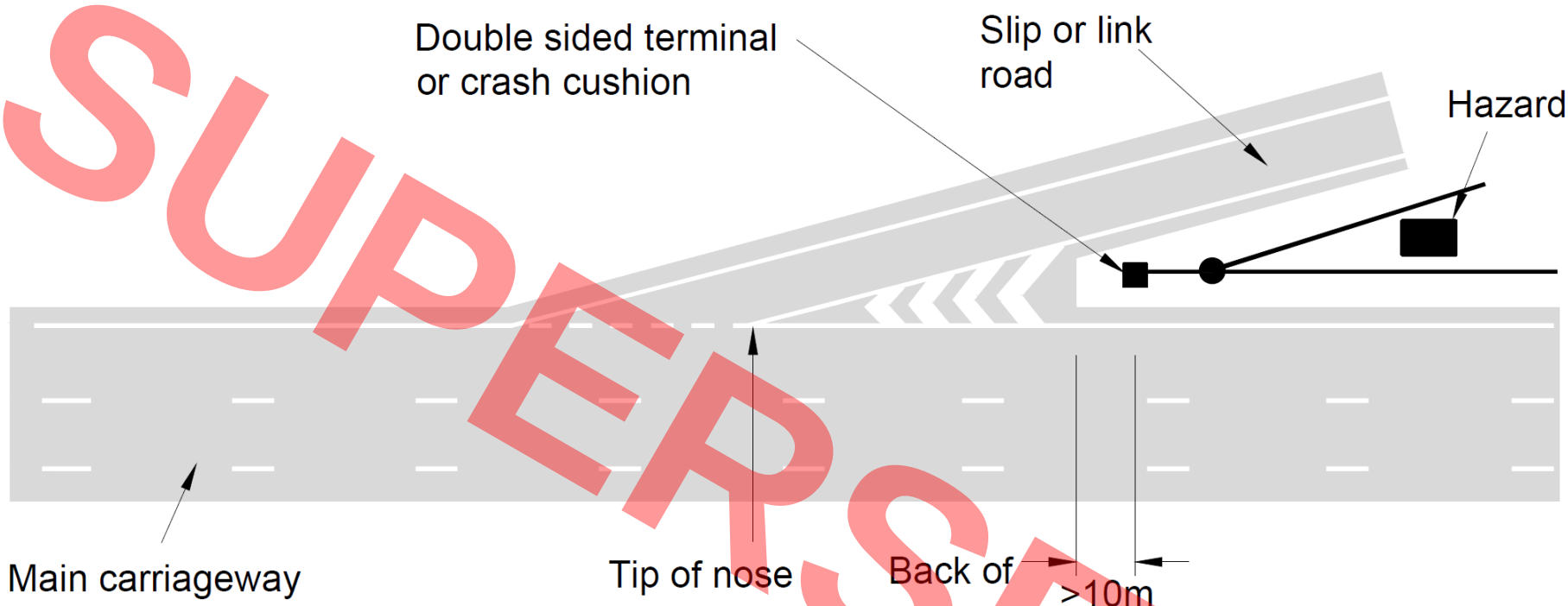
Figure 3.74 Hazards and safety barrier adjacent to nosing areas - typical exit slip/link road layout



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3.75 Where safety barrier protection is required to protect hazards, (including the level difference between the adjacent carriageways), the safety barrier shall be positioned relative to the hazard such that the minimum requirements of the safety barrier and its associated terminals (or crash cushions), transitions and tapers are met.

NOTE 1 *Traffic on an adjacent slip or link road that is following a broadly parallel alignment and similar level to the mainline carriageway is not seen as a hazard to traffic on the mainline carriageway, and vice versa.*

NOTE 2 *Safety barrier can be warranted due to the intervening ground profile and the presence of hazards such as street furniture.*

3.76 At junctions without VRS, the level of risk of injury to road users shall be minimised.

3.76.1 The risk of injury may be mitigated through the use of passively safe signs, larger signs placed further from the carriageway, vehicle actuated signs, road markings, high friction surfacing, improved sight lines.

3.76.2 At junctions, where other solutions are unavailable to lower the level of risk of injury to road users, then VRS may be proposed.

Safety barrier provision in central reserves - general

3.77 Where the distance across the central reserve between the points from which set-back for each carriageway is measured (i.e. Psb to Psb) is 10m or less, a central reserve safety barrier shall be provided.

3.78 Where the distance Psb to Psb across the central reserve is more than 10m, a risk assessment shall be used to determine the need for, location and extent of safety barrier(s) and their containment level based on:

1) the hazards that are present and their location; and
2) the intervening topography; and
3) the likelihood of a vehicle crossing to the other carriageway.

3.79 Where a safety barrier in the central reserve is required, it shall be provided on both sides of a hazard except:

1) where the topography of the central reserve makes it impossible for the hazard to be reached from one carriageway, or
2) where the Overseeing Organisation agrees that road lighting columns, signals or signs, passively safe or fully collision resistant gantry legs or signs can be mounted on the central reserve safety barrier, and the width of the safety barrier is increased to accommodate the column or post and its fixings.

3.80 Where the topography of the central reserve makes it impossible for the hazard to be reached from one carriageway, the safety barrier shall be placed only on the side of the hazard that can be reached.

3.81 Where there are no hazards in the central reserve and there is a difference in the opposing edge of carriageway levels of 200 mm or more, the safety barrier shall be installed adjacent to the higher carriageway.

3.82 Where there is a risk of vehicle impact with a non-traffic face of a safety barrier, vehicles mounting or getting under it or overturning on the slope due to the height difference between the carriageways and the ground profile across the central reserve, a separate safety barrier shall be placed adjacent to the lower carriageway.

3.83 The Overseeing Organisation's specific requirements for the containment level and performance of the central reserve safety barrier shall apply.

NOTE *The specific requirements for the minimum containment level and performance of central reserve safety barrier are provided in the National Application Annexes.*

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Requirements for gaps in the central reserve

3.84 Other than where it has been determined that no safety barrier is required, there shall be no gaps in the central reserve safety barrier on motorways or on roads constructed to motorway requirements.

3.85 Existing gaps in central reserve safety barriers on motorways or all-purpose trunk roads shall be closed unless they are required for the efficient operation and management of the road.

3.86 On other dual carriageway roads, gaps in an otherwise continuous central reserve safety barrier shall be restricted to the absolute minimum necessary for the efficient operation and management of the road.

General requirements for an emergency crossing point/maintenance crossing point (ECP/MCP)

3.87 An emergency crossing point/maintenance crossing point (ECP/MCP) shall only be installed with the approval of the Overseeing Organisation.

NOTE *For the majority of the time, the ECP/MCP is in the closed configuration and hence, is required to function as a permanent safety barrier.*

3.88 Where an ECP/MCP exists on a road which is to be improved or which is subjected to major maintenance, assessment shall be undertaken to confirm the need for the ECP to be retained with the Overseeing Organisation and relevant Emergency Services.

3.89 An ECP shall have a maximum length of 25 m and be designed using a location specific swept path analysis.

NOTE *An ECP will typically have a minimum length of 16 m, but this can be as short as 4 m, for specific applications.*

3.90 The safety barrier system for an ECP/MCP shall be specified in the contract specific specification Appendix 4/1 as detailed in MCHW Series NG400 [Ref 23.N], in terms of containment level and normalised working width class.

3.91 The ECP/MCP containment level shall be equal to or greater than that of the adjacent safety barrier.

3.92 Transitions in accordance with the requirements of this document shall be used between the safety barrier and the ECP/MCP system.

3.93 The normalised working width class of the ECP/MCP shall not encroach into the opposing carriageway.

3.94 Any location specific requirements for the ECP/MCP shall be specified in contract specific Appendix 4/1 as detailed in MCHW Series NG400 [Ref 23.N], such as maximum acceptable time taken for opening and closing, and storage requirements whilst the ECP/MCP is open (where applicable).

NOTE *An opening time of 30 minutes or less is generally acceptable for an ECP.*

Use of gates at an ECP/MCP

3.95 Where a gate is provided at an ECP/MCP, the gate shall meet the requirements of BS DD ENV 1317-4 [Ref 26.N].

3.95.1 The length of the openable leaves of the gate (and hence, the overall length of the crossing) should be identified so that it is ensured that, when in the open position, the requisite number of lanes are protected by the safety barrier.

3.95.2 The means by which the openable leaves of the gate are opened/closed and the effect that this operation can have on the practicability of opening and closing the gate, should be identified.

3.95.3 Any tools required for the operation of a gate at an ECP should be supplied within the ECP and/or be easily accessible.

Use of demountable permanent barrier at an MCP

3.96 For an MCP, it shall be possible to dismantle and reinstate the permanent safety barrier quickly.

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3.96.1 Socketed posts may be specified to allow the permanent safety barrier to be dismantled and reinstated quickly.

NOTE *The time for the dismantling and reinstatement of barriers varies depending on the safety barrier and, if used, can mean a lot of repair work to reinstate the safety barrier.*

3.97 With the exception of emergency usage, whenever a section of safety barrier is removed, the ends of the safety barrier shall be made safe.

NOTE *The ends of a safety barrier can be made safe through the use of terminals, crash cushions, transitions and/or a gate.*

Additional requirements for "open" ECPs

3.98 Retained "open" ECPs shall be closed with a row of suitable traffic cylinders of at least 600 mm in height.

3.98.1 Retained "open" ECPs should be gated.

3.99 Traffic cylinders used in retained "open" ECPs shall be spaced at a maximum of 1.0m centres between the end terminals of the safety barriers.

3.100 Verge and central reserve marker posts and/or reflectors shall be erected on each approach to the ECP.

3.101 The alignment of the two opposing sections of safety barrier and their end terminals at an "open" ECP (or other open central reserve crossing point) shall be such that a vehicle impacting the safety barrier prior to the gap is directed away from and not towards the leading terminal of the downstream safety barrier.

3.102 At "open" ECPs, the terminal specification shall be in accordance with Section 5 of this document.

NOTE *Typical alignments are shown in Figure 3.102N.*

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Figure 3.102N Typical arrangements for safety barrier at approaches to an Emergency Crossing Point in the central reserve

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Additional requirements for maintenance crossing points and maintenance access

3.103 Where MCPs (see CD 192 [Ref 42.N]) are provided to facilitate contraflow traffic flows during schemes and tunnel maintenance, the layout shall be such that the open and closed layouts and the gate deployment do not present additional hazards to the road user or road worker.

NOTE *Guidance on factors relating to ECPs and MCPs is given in Appendix B of this document.*

3.104 Allowance shall be made in the length of gate specified for any impact resistant terminal end to the safety barrier.

3.105 Where the regular routine maintenance regime requires short period contraflow operation, the safety barrier used to close the gap shall have a minimum containment level equal to that of the adjacent safety barrier.

3.106 Where the regular routine maintenance regime does not require short period contraflow operation, on completion of the works, any MCP gap(s) shall be closed by re-instating the original safety barrier(s).

3.107 Any 'above ground' elements of the temporary end termination(s) of the safety barrier shall be removed.

3.108 Transitions shall be used between the permanent sections of safety barrier and 'removable' sections and temporary end termination(s).

Winter maintenance crossing points (WMCP)

3.109 Where directed by the Overseeing Organisation, a central reserve WMCP shall be provided.

3.110 The WMCP shall preclude unauthorised access or use.

3.111 The central reserve at a WMCP shall safely accommodate transversely between the carriageway and the gate, all winter maintenance vehicles and associated equipment likely to be deployed.

3.112 When open, gates shall not encroach into the set-back of either carriageway.

3.113 Signs and traffic cylinders complying with Diagram 7103 of TSRGD [Ref 45.N] and of the TSR(NI) 1997 [Ref 44.N] at 1.0m (maximum) centres shall be placed within the WMCP and either side of any gate that is installed to limit misuse of the WMCP.

Other gaps in the central reserve, and provision at start and end points of dual carriageways

3.114 Where directed by the Overseeing Organisation to provide a gap complying with CD 123 [Ref 13.N], the arrangement of the safety barrier ends shall comply with the requirements of this document.

3.115 Assessment shall investigate and weigh options and mitigation (other than the provision of safety barrier) against the use of safety barrier, and mitigation in combination with safety barrier, identifying where fully compliant and partially compliant safety barrier installations can be achieved.

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4. Requirements for vehicle parapets

4.1 All VRS installations that include vehicle parapets shall be compatible with each other throughout the entire installation length (including any safety barriers, other parapets, terminals, transitions and crash cushions) and meet the requirements of this Section 4.

4.2 For each vehicle parapet installation, based on the site specific conditions, the following and all other relevant requirements of MCHW Series 400 [Ref 22.N] and the associated MCHW Series NG400 [Ref 23.N] shall be specified in the contract specific specification, using contract specific Appendix 4/1, as detailed in MCHW Series NG400 [Ref 23.N]:

1) containment level;
2) impact severity level (ISL);
3) set-back;
4) normalised working width class (W);
5) normalised vehicle intrusion class (VI);
6) maximum height that allows the required visibility (refer to CD 127 [Ref 4.N] and CD 109 [Ref 15.N]);
7) length of need;
8) any special requirements (e.g. environmental considerations, minimum height above the paved surface for the purpose intended, clearance to hazards that are vulnerable to residual loading and loading requirements for structures, parapet plinth width).

NOTE 1 *Vehicle parapets are intended to contain errant vehicles and protect road users from a vertical or near vertical drop that is not protected by a safety barrier or other suitable restraint. In addition, they can be required to protect the area below.*

NOTE 2 *A vehicle parapet typically extends along the full length of a bridge deck (including the wing-walls) and/or along the full length of any other structure.*

4.3 The design shall be the optimum solution for the hazard having achieved compliance with the mandatory requirements, the conditions of a relaxation (where applicable), a broadly acceptable level of risk or having obtained a departure from requirements.

Minimum containment levels where the road is not carried over or adjacent to a railway

4.4 On roads with a speed limit of 50 mph or more, the minimum containment levels for vehicle parapets shall be:

1) normal containment level: N2;
2) higher containment level: H2;
3) very high containment level: H4a.

4.5 On roads with a speed limit of less than 50 mph, the minimum containment level for vehicle parapets shall be:.

1) normal containment level: N1;
2) higher containment level: H2;
3) very high containment level: H4a.

4.6 Where a site-specific risk assessment indicates that a containment level higher than the minimum level is required, the higher containment level shall be specified.

4.7 Where the need for a higher containment level or very high containment level vehicle parapet has been identified, the nature of the risk, any mitigation with the steps taken to reduce the risk and the resulting containment level required shall be recorded.

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Minimum containment level requirements where the road is carried over or adjacent to a railway

New bridges and structures (except accommodation bridges)

4.8 On a new bridge or structure (except accommodation bridges) over or adjacent to a railway, an H4a containment level vehicle parapet shall be provided, regardless of the road class.

Existing bridges and structures (except accommodation bridges)

4.9 On an existing structure over or adjacent to a railway (except accommodation bridges), an H4a containment parapet shall be provided.

4.9.1 Where an H4a parapet cannot be provided without undue cost, the highest containment provision possible should be provided, which incorporates the output from the RRRAP and the cost of providing a suitable support structure.

4.9.2 Where an H4a parapet cannot be provided without undue cost, the vehicle parapet containment level should not be lower than the normal containment level.

4.9.3 Where an H4a parapet cannot be provided without undue cost, agreement should be sought through early engagement with the Railway Authority and the Overseeing Organisation.

New and existing accommodation bridges

4.10 The minimum vehicle parapet containment level shall be the normal containment level.

4.11 Where a site-specific risk assessment indicates that a containment level higher than the minimum level is required, the higher containment level shall be specified following confirmation from the Overseeing Organisation and the Railway Authority.

4.12 Where the need for a higher containment level or very high containment level vehicle parapet has been identified, the nature of the risk, any mitigation with the steps taken to reduce the risk and the resulting containment level required shall be recorded.

Impact severity level

4.13 The ISL shall be either level A or B.

Normalised working width class and normalised vehicle intrusion class

4.14 For normal containment level vehicle parapets, the maximum identified value of normalised working width class that the local hazard(s) allow, shall be used.

4.15 For higher and very high containment level vehicle parapets, the maximum identified values of normalised working width class and normalised vehicle intrusion class that the local hazard(s) allow, shall be used.

4.15.1 The edge of the bridge deck should be included as a hazard in the risk assessment.

4.16 An assessment shall be undertaken to determine whether modification of the structure is viable and an AIP obtained.

Length of need

4.17 During testing to BS EN 1317-2 [Ref 32.N], the test length of the vehicle parapet shall be sufficient to demonstrate the full performance characteristics of the vehicle parapet at the length of need.

4.18 Where higher containment level (H2) or very high containment level (H4a) vehicle parapet is required at a hazard adjacent to the vehicle parapet where other parties can be affected (such as at an adjacent road or railway), the length of the higher or very high containment parapet shall extend to the lesser of:

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1) the length of the bridge deck and along the full length of the wing-walls where they broadly follow the road alignment, or along the full length of the structure where it runs alongside and or over the adjacent hazard;
2) on two-way carriageways, between a position 25m in advance of the nearer point of no recovery to the adjacent hazard in each direction i.e. 25m plus length of adjacent hazard between these points of no recovery plus 25m; but not further at either end than required by (1) above;
3) on one-way carriageways, from a position 25m in advance of the nearer point of no recovery to the adjacent hazard to a position 10m beyond the further point of no recovery to the adjacent hazard, i.e. 25m plus length of adjacent hazard between these points of no recovery plus 10m; but not further at either end than required by (1) above.

4.18.1 On a long structure spanning more than one adjacent hazard, where the higher containment or very high containment level parapet extents from clause 4.18(2) or clause 4.18(3) do not overlap or extend to the limits in clause 4.18(1) above, normal containment level parapet with suitable transitions may be used over the intermediate length(s).

4.19 Where the length of need for each hazard overlaps and the required containment levels differ, the risk assessment shall confirm that the higher of the containment levels starts/finishes so as to achieve the correct length of need for the hazard requiring the higher containment.

NOTE *Refer to Figure 4.19N for examples of length of need and localised parapet containment level, where A and B are short structures and C and D are long structures (such as viaducts).*

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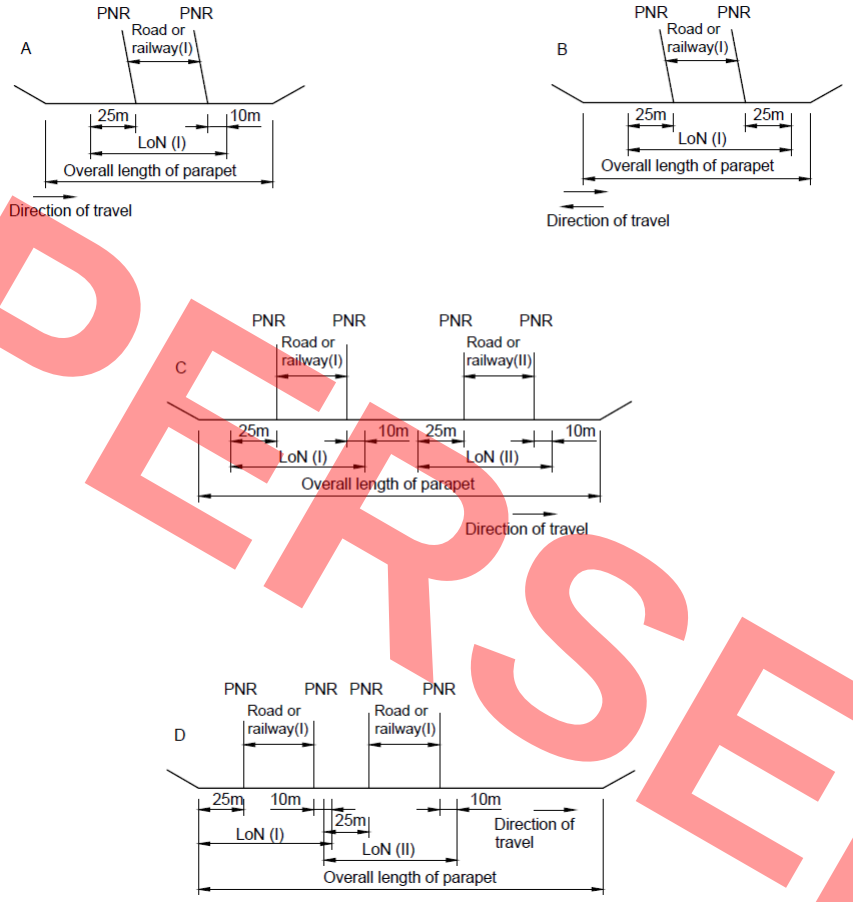
Figure 4.19N Examples of localised parapet containment requirements on short and long structures



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Minimum height of parapets

4.20 The height of vehicle parapets (including combined vehicle/pedestrian parapets) shall not be less than 1000mm.

4.21 For cycleways immediately adjacent to the vehicle parapet and for accommodation bridges, the minimum height of the parapet shall be 1500mm.

4.22 For very high containment level applications that are not over or adjacent to a railway, the minimum height of the parapet shall be 1500mm.

4.23 For bridleways or equestrian usage immediately adjacent to the vehicle parapet , the minimum height of the parapet shall be 1800mm.

4.24 For all bridges and structures over railways, the minimum height of the parapet shall be 1800mm.

4.25 The height of vehicle parapets (including combined vehicle/pedestrian parapets) shall be measured above the adjoining paved surface.

4.26 At particular sites where a feasibility study as outlined in CD 353 [Ref 6.N] has been undertaken, any height and form of parapet requirements so determined shall be agreed with the Overseeing Organisation and any other responsible authority.

NOTE 1 *Particular sites where a feasibility study as outlined in CD 353 [Ref 6.N] could be undertaken include those where there is a high risk of suicide, vandalism, unauthorised access and/or antisocial behaviour.*

NOTE 2 *Other responsible authorities can include the Railway Authority/Environment Agency/Canals and River Trust.*

4.27 Where it is necessary to increase the height of an existing legacy parapet, any extension shall be compatible with, and not be detrimental to, the performance of the parapet system to which it is attached.

4.27.1 The additional height may be provided by the use of a suitable additional non-participating structural extension to the parapet (designed neither to become detached under impact nor participate in containment and redirection of the vehicle).

4.27.2 The addition of a non-participating structural extension to a legacy parapet should be confirmed as acceptable by the manufacturer/promoter of the parapet system, where the manufacturer/promoter of the system still exists.

4.27.3 The addition of a non-participating structural extension to a legacy parapet should be confirmed as acceptable by the Overseeing Organisation, where the manufacturer/promoter of the system no longer exists.

4.27.4 Where repair parts are available and the increased height variant of the parapet exists, the change in height should be achieved by the exchange of standard parts compliant with the original manufacturer's specification.

4.28 Where it is necessary to increase the height of an existing CE marked parapet product, any extension shall not invalidate the Declaration of Performance for the parapet system to which it is attached.

4.29 Where the height of an existing parapet is to be increased, the effect of any additional loading on the supporting structure as a result of this modification, shall be assessed and remedial measures undertaken, where necessary.

General requirements

4.30 Vehicle parapets shall be provided on bridges and structures where a safety risk assessment determines that there is a risk of a vehicle falling over a vertical or near vertical drop that is not protected by a safety barrier or other suitable restraint.

4.31 The risk assessment shall determine whether the minimum requirements are sufficient in the particular circumstances being examined and record the proposed containment level and length of need.

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Verges on bridges and structures

4.32 Where deck limitations permit, a raised verge with a kerb shall be provided to discourage the stationing of vehicles with their wheels close to the vehicle parapet.

4.33 The design of the verge on bridges and structures shall minimise the build up of effluents and debris against the base of the vehicle parapet.

4.33.1 Build up may be reduced by ensuring that any paved surfaces and verges fall away from the base of the vehicle parapet.

NOTE *The dimensions of kerbs and raised verges at parapets are given in CD 524 [Ref 10.N] and CD 127 [Ref 4.N] respectively.*

4.33.2 Where a wide verge, for example one used for vehicle access, is carried over a bridge or structure and where agreed by the maintenance authority and the emergency services, the safety barrier may be continued across it on its conventional alignment as long as normalised working width class and set-back requirements are met.

4.34 The crossfall of any designed verge with pedestrian access shall be in the region of 5% (1:20), but no more than 10% (1:10) or less than 2.5% (1:40).

4.34.1 Where there is no pedestrian access permissible, the crossfall of any designated verge may be increased to 20% (1:5).

4.35 The parapet system used shall be suitable for use on the particular bridge, taking into account the height, width and gradient of the verge.

4.36 Any generated gradient shall meet the parapet manufacturer's specifications.

4.37 Where the road does not have a continuous kerb, the kerb and verge shall slope down gradually to the level of the paved surface on the approaches.

4.38 The verge width requirements to accommodate pedestrians and other users shall be met by complying with CD 143 [Ref 9.N] and CD 143 [Ref 9.N].

4.39 A separate pedestrian parapet of the appropriate height and infill for the expected usage shall be provided on the bridge or structure's edge where a need is identified by assessment.

4.40 Protection to prevent injury to the users of the wide verge from the vehicle parapet shall be provided, where necessary.

4.41 Any non-compliance in the above requirements shall be identified in contract specific Appendix 4/1 as detailed in MCHW Series NG400 [Ref 23.N].

Plinth upstands

4.42 Where metal parapets are proposed, a plinth upstand of 50mm high with a tolerance of -0/+50mm shall be specified.

NOTE *Not having a plinth affects the overall parapet height and rail positions relative to vehicle impact.*

4.43 Any non-compliance with the requirement for a plinth upstand of 50mm high with a tolerance of -0/+50mm shall be identified in the parapet specification in contract specific Appendix 4/1 as detailed in MCHW Series NG400 [Ref 23.N].

4.43.1 An upstand to aid drainage and/or reduce the amount of small stones and other debris kicked over the edge of the bridge may be specified in contract specific Appendix 4/1 as detailed in MCHW Series NG400 [Ref 23.N].

Parapets on historic monuments and bridges

4.44 Where a structure is subject to a cultural heritage management plan (refer to LA 116 [Ref 5.N]), it shall managed in accordance with the conservation strategies of conservation of highway structures (refer to CG 304 [Ref 3.N]).

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4.44.1 New and replacement parapets on historical monuments and bridges may be designed from first principles to meet the requirements of the cultural heritage asset management plan and the particular performance class requirements.

Infilling of parapets

4.45 Metal vehicle parapets of open construction shall be fitted with anti-climb infill complying with Chapter 8 of BS 6779-1 [Ref 17.N].

4.46 The parapet shall not provide toe-holds nor have projections that would assist climbing of the parapet.

4.47 The bottom 600mm height of infill panel shall be solid where there is a bridleway or equestrian usage adjacent to the vehicle parapet.

4.48 Full height infilling shall be used on motorway underbridges and structures where they cross or are adjacent to a railway.

4.49 Where full height infilling is proposed, the effect of wind loading on the structure to which the parapet is attached, shall be assessed.

Provision for divided structures

4.50 Where the longitudinal gap between the two decks on a divided structure is less than 100 mm, vehicle parapets shall not be installed in the central reserve, unless warranted by risk assessment.

4.51 Where a gap between 100 mm and 2 m is unavoidable, a horizontal grid or slab designed in accordance with BS 6779-2 [Ref 16.N] shall be provided, unless it is impractical to do so.

4.52 Where the provision of a horizontal grid or slab designed in accordance with BS 6779-2 [Ref 16.N] is impractical, or the gap is more than 2 m, vehicle parapets shall be provided.

4.53 Where vehicle parapets are provided on structures other than those over railways and the longitudinal gap is between 100 mm and 2 m, the gap shall be protected by a horizontal grid, slab, mesh or plate designed to carry the following nominal loads:

1) uniformly distributed load – 0.75 kN/m2;
2) patch load – 1kN over area of 200 mm x 200 mm positioned to give the most adverse effect.

4.54 Where the divided structure is over a railway and the longitudinal gap is between 100 mm and 2 m, the gap shall be infilled by a solid slab or plate designed to carry special types general order (STGO) and special order (SO) vehicles loading, irrespective of the type of VRS.

Additional requirements for vehicle parapets over or adjacent to railways

4.55 Assessment shall confirm local overhead line equipment (OLE) clearances and / or trespass risk through early liaison with the Railway Authority, British Transport Police or any other Police Authority.

4.56 Parapets on new structures over or adjacent to railways shall comply with the Railway Authority requirements for height, electrical clearance and protection; refer to NR/L3/CIV/020 Issue 1 [Ref 8.N] incorporating NR/BS/LI/331 Issue 2 [Ref 30.N] and/or any successor documents.

4.57 Where existing vehicle or pedestrian parapets on bridges and structures over or adjacent to a railway are to be replaced, reconstructed or strengthened, the location specific desirable parapet height and electrical clearance and protection requirements shall be met.

4.58 Vehicle parapets over the railway shall be provided with steeple copings that comply NR/BS/LI/331 Issue 2 [Ref 30.N] and/or any successor documents.

4.59 A safety barrier shall be provided on both the vehicle parapet approach and departure ends to prevent a vehicle reaching the railway.

4.60 The minimum lengths of safety barrier required by this document shall be increased where the assessment determines that a significant risk still exists from a vehicle leaving the highway at a greater distance from the bridge and reaching the railway.

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Infilling of parapets over railways

4.61 Infilling for vehicle parapets on bridges or structures over or adjacent to railways shall meet with the requirements of BS EN 12676-1 [Ref 1.N], and this section.

NOTE *Where reference is made in BS EN 12676-1 [Ref 1.N] to "where electrification is likely" this denotes electrification included within the Railway Authority's Investment Programme current at the time when the vehicle parapet provision is being considered.*

4.62 Metal vehicle parapets of open construction shall have smooth solid infill.

NOTE *Toe-holds on the traffic face of the parapet are prohibited.*

4.62.1 Metal vehicle parapets should be provided with additional solid sheeting on the outer (non-traffic) face of the parapet/parapet posts.

4.62.2 The sheeting should extend vertically to the full height of the parapet with the lower part shaped to cover the outer ledge and horizontally for at least the greater of one panel length or 2m.

4.62.3 Sheeting should be fitted at the ends of the vehicle parapet or on both sides of the railway tracks.

4.63 The parapet, the infill sheeting and all conductive (metal) components shall be at least 3m from the outer limit of any railway tracks or any live overhead electrification equipment.

4.64 In the event of failure of or damage to any part of the parapet, no part of the parapet or infill sheeting shall come into contact with any live overhead electrification equipment.

4.65 The outer ledge of a parapet shall not be accessible from any area adjacent to the bridge.

4.65.1 Sheeting should be extended for situations where the outer ledge is accessible from any area adjacent to the bridge.

4.66 All methods of denying access to the outer ledge of the vehicle parapet shall be subject to the agreement of the Railway Authority and the Railway Inspectorate.

Design requirements for parapets and supporting structures

4.67 Main structural members of bridges shall not be designed to act as vehicle parapets.

NOTE *The design requirements given in this document for vehicle parapets are based on a cantilever action from the bridge deck.*

4.68 The resistance of the member supporting the parapet shall be assessed in accordance with CS 454 [Ref 2.N].

4.69 Any need to modify a bridge or structure to accommodate a CE marked parapet shall be discussed with the structures representatives of the Overseeing Organisation at the earliest opportunity to agree a way forward.

NOTE 1 *For existing bridges and structures, the aim is to provide a CE marked parapet that is compatible with the existing site specific restrictions.*

NOTE 2 *It can be uneconomical or undesirable, perhaps for aesthetic reasons, to strengthen an existing structure to take a parapet of the required containment level and normalised working width class, and or to strengthen the verge of the bridge deck to take the full vehicle loading requirements.*

NOTE 3 *If so, strengthening to allow provision of a vehicle safety barrier meeting the containment level and normalised working width class requirements of this document between the existing parapet and edge of carriageway could warrant investigation.*

4.69.1 In cases where it is decided to strengthening to allow provision of a vehicle safety barrier (meeting the containment and working width requirements of this document) between the existing parapet and edge of carriageway, the existing parapet may be deemed a pedestrian restraint system in accordance with this document.

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4.70 For structures with non-carriageway elements that are unsuitable for unrestricted live loading, the assessment shall determine the suitability of intermediate VRS with reference to CS 470 [Ref 19.N].

Anchorages and structural loading

4.71 The anchorages, plinth and main structure shall be designed to resist, without damage, all loads which the vehicle parapet is theoretically capable of transmitting, up to and including failure, in any mode that can be induced by vehicular impact.

4.72 Removal and replacement of damaged sections of the vehicle parapet shall be readily achievable, without damage to the supporting structure.

4.73 The design shall allow for replacement of holding down bolts or sleeved threaded bar that can be withdrawn from the plinth.

4.74 For new concrete highway bridges and structures, BS EN 1992-2 [Ref 12.N] and, for existing concrete highway bridges and structures on motorways and other trunk roads, CS 455 [Ref 39.N], respectively, shall be used to determine the design resistance of the reinforced concrete support member for concrete cone failure.

4.75 Loads applied to the supporting structure by the parapet potentially have to be estimated, and any limitations arising shall be clearly identified.

4.76 The loading and anchorage requirements that the structure is capable of meeting shall be specified in contract specific Appendix 4/1 as detailed in MCHW Series NG400 [Ref 23.N] such that a compliant parapet product and its associated anchorages can be selected.

4.77 Where a parapet system complying with the minimum containment level and normalised working width class requirements but imparting loads on the structure exceeding those specified is proposed, the adequacy of the proposed anchors shall be checked and calculations undertaken to confirm that the structure is capable of resisting, without damage, all loads which the vehicle parapet system is theoretically capable of transmitting, in any mode that can be induced by vehicular impact.

Reinforced concrete parapets

4.78 Vehicle parapets in concrete construction shall be CE marked in accordance with BS EN 1317-5 [Ref 28.N].

4.78.1 Vehicle parapets in concrete construction may, subject to a departure from requirements, be designed in accordance with BS 6779-2 [Ref 16.N].

4.78.2 Where vehicle parapets in concrete construction are designed in accordance with BS 6779-2 [Ref 16.N], the following amendments to BS 6779-2 [Ref 16.N] should apply:

1) reinforced concrete vehicle parapet panel walls are to have a minimum thickness of 180mm for normal containment level (N2), and 325mm at the critical design section for very high containment level (H4a).
2) reinforced concrete vehicle parapet panel walls are to have a minimum length of 2.0m and a maximum length of 3.5m.
3) Y_m for the reinforcement in the in-situ vehicle parapet wall is to be 1.0, and not 0.8 as given in Table 4 of BS 6779-2 [Ref 16.N].

4.78.3 Where N2 containment vehicle parapets in concrete construction are designed in accordance with BS 6779-2 [Ref 16.N], the following amendments should also apply:

1) the parapets are to be designed for an equivalent static nominal load for a nominal bending moment of 100kN over 1.0m, and not 50kN over 1.0m as given in Table 2 of BS 6779-2 [Ref 16.N];
2) the parapets are to be designed with shear transfer provision between adjacent panels;
3) an equivalent static nominal load of 50kN is to be transferred between adjacent panels within the top 0.5m of the sections.

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NOTE *When designing to BS 6779-2 [Ref 16.N], the normal level of containment of BS 6779-2 [Ref 16.N] is considered to be equivalent to the normal containment (N2) in BS EN 1317-2 [Ref 32.N], and the high containment level of BS 6779-2 [Ref 16.N] is considered to be equivalent to the very high containment level (H4a) in BS EN 1317-2 [Ref 32.N].*

Stone or precast concrete copings

4.79 Stone or precast concrete copings shall only be used with vehicle parapets of concrete construction where the permitted speed limit is 30 mph or less.

Masonry or brickwork facings

4.80 Masonry or brickwork facings shall only be provided after consultation with the responsible authorities and with the prior agreement by the Overseeing Organisation.

Masonry parapets

4.81 New and replacement masonry vehicle parapets shall not be installed except where agreed by the Overseeing Organisation.

4.82 New and replacement masonry vehicle parapets shall not be used on road bridges and structures over or adjacent to railways except where agreed by the Overseeing Organisation and the Railway Authority.

4.83 The treatment of existing masonry parapet structures shall be agreed with the Overseeing Organisation.

NOTE *Existing parapets can have a number of faults and need to be examined and assessed.*

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5. Requirements for terminals

5.1 All VRS installations that include terminals shall be compatible with each other throughout the entire installation length (including any safety barriers, parapets, other terminals, transitions and crash cushions) and meet the requirements of this Section 5.

5.2 For each terminal installation, based on the site specific conditions, the following and all other relevant requirements of MCHW Series 400 [Ref 22.N] and the associated MCHW Series NG400 [Ref 23.N] shall be specified in the contract specific specification, using contract specific Appendix 4/1 as detailed in MCHW Series NG400 [Ref 23.N]:

1) performance class;
2) impact severity level (ISL);
3) set-back;
4) permanent lateral displacement zone;
5) vehicle exit box class;
6) maximum height that allows the required visibility (refer to CD 127 [Ref 4.N] and CD 109 [Ref 15.N]);
7) any special requirements [e.g. environmental considerations, ground conditions, measures to reduce the risk of injury to pedestrians, equestrians and other vulnerable users (e.g. no sharp edges)];
8) specific connection requirements to existing safety barriers, vehicle parapets or other structures.

5.3 Terminal performance class shall be specified in accordance with BS DD ENV 1317-4 [Ref 26.N] for both the approach and departure ends of safety barriers.

NOTE 1 *Terminals are applied to the end of safety barriers such that the barrier ends do not represent a hazard. They are designed to provide a smooth transition from no containment to the containment of the barrier without introducing additional hazards for head on vehicle impacts.*

NOTE 2 *The performance or mode of operation of some types of terminal can make them unsuitable for use in certain situations, e.g. where there is a hazard close to the end of the full height safety barrier, in the central reserve, where space is limited, restricted clear zone, narrow verge, distance to side road or other access, or on the elevated approaches to bridges and other structures.*

NOTE 3 *A full height anchor based on legacy systems details is not considered to be a terminal in the context of this section.*

Performance class

5.4 On roads with a speed limit of 50 mph or more, terminals that face oncoming traffic, e.g. on both ends of a safety barrier on a two-way single carriageway road, shall have a performance class of P4 and be energy absorbing.

5.5 On roads with a speed limit of 50 mph or more, terminals that do not face oncoming traffic, e.g. on departure ends on dual carriageways or on a one-way road, shall have a minimum performance class of P1.

5.6 On other roads, terminals shall have a minimum performance class of P1.

Impact severity level

5.7 The ISL shall be either level A or B.

Permanent lateral displacement zone class

5.8 The maximum permissible permanent lateral displacement zone class (D.x.y) for the terminal shall be selected to ensure that clearance of the terminal to any hazard or area used by motorists and/or non-motorised users is maintained and not compromised.

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5.9 Where the safety barrier is to be flared to maintain set-back to the end terminal, this shall be included in the measurement of the permanent lateral displacement zone characteristic D.x.y.

Vehicle exit box class

5.10 For each installation, the maximum vehicle exit box class that the local hazard(s) allow, shall be used.

5.11 The vehicle exit box class for the terminal (Z1, Z2, Z3 or Z4) shall be selected to ensure that any redirected impacting vehicle can not encroach into any hazard or area used by road users, road workers and/or other parties.

5.11.1 Errant vehicles can end up on the departure side of terminals with exit box classes Z3 and Z4 and therefore systems with exit box classes Z3 and Z4 should be used with caution because of the unlimited dimension for the exit box on the departure side.

General requirements

5.12 Factors that limit the choice of terminal for a particular situation shall be clearly identified in Appendix 4/1 as detailed in MCHW Series NG400 [Ref 23.N].

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6. Requirements for transitions

Introduction

6.1 All VRS installations that include transitions shall be compatible with each other throughout the entire installation length (including any safety barriers, parapets, terminals, other transitions and crash cushions) and meet the requirements of this Section 6.

6.2 For each transition installation, based on the site specific conditions, the following and all other relevant requirements of MCHW Series 400 [Ref 22.N] and the associated MCHW Series NG400 [Ref 23.N] shall be specified in the contract specific specification, using contract specific Appendix 4/1 as detailed in MCHW Series NG400 [Ref 23.N]:

1) containment level;
2) impact severity level (ISL);
3) set-back;
4) class of normalised working width class (W);
5) class of normalised vehicle intrusion class (VI);
6) maximum height that allows the required visibility (refer to CD 127 [Ref 4.N] and CD 109 [Ref 15.N]);
7) length of need;
8) any special requirements (e.g. environmental considerations, motorcyclist protection, ground conditions, proximity to embankment slopes, requirements to accommodate pedestrians on verges, clearance to hazards that are vulnerable to residual loading and loading requirements for structures, measures to to reduce the risk of injury to pedestrians, equestrians and other vulnerable users (e.g. no sharp edges))
9) specific connection requirements to existing safety barriers, vehicle parapets or other structures.

6.3 A transition complying with BS DD ENV 1317-4 [Ref 26.N] shall be specified between two VRS of different cross section and/or lateral stiffness and/or containment level and/or material, whose working widths differ by more than one class.

6.4 The transition shall provide a smooth change in alignment and not allow the safety barrier or parapet as applicable to become exposed to end on impact.

NOTE 1 *The purpose of transitions is to provide a gradual change in performance from the first barrier to the second, and to prevent the hazards of abrupt variations.*

NOTE 2 *A transition is designed to connect two specified VRS.*

NOTE 3 *The length of a transition is the distance between the ends of the two VRS which are connected by the transition.*

Minimum containment levels

6.5 On roads with a speed limit of 50 mph or more, the minimum containment level for transitions shall be:

1) normal containment level: N2;
2) higher containment level: H1;
3) very high containment level: H4a.

6.6 On roads with a speed limit of less than 50 mph, the minimum containment level for transitions shall be:

1) normal containment level: N1;
2) higher containment level: H1;
3) very high containment level: H4a.

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Transitions and vehicle parapets

6.7 Where a transition is used to connect an H4a containment vehicle parapet to an N1 containment vehicle parapet, the end section of the N1 containment vehicle parapet shall be strengthened to N2 containment.

6.8 Where a connection is required between a vehicle parapet and a transition, the parapet shall be capable of providing an anchorage to the transition and attached safety barrier such that the full strength of the transition and the safety barrier can be realised.

6.8.1 Adding a connection between the vehicle parapet and a transition may require the end post(s) of the parapet to be modified.

Impact severity level

6.9 The ISL shall be either level A or B.

Normalised working width classes and normalised vehicle intrusion classes

6.10 For each transition installation, the maximum identified value of normalised working width class that the local hazard(s) allow, shall be used.

6.11 For higher and very high containment level transition installations, the maximum identified values of normalised working width class and normalised vehicle intrusion class that the local hazard(s) allow, shall be used.

6.12 For all higher and very high containment systems included in the contract-specific specification Appendix 4/1 as detailed in MCHW Series NG400 [Ref 23.N]), the required clearance to any hazard that is vulnerable to residual loading shall be given in the site specific information.

Transitions between safety barriers not on a motorway or all-purpose trunk road, and parapets over a motorway or all-purpose trunk road

6.13 Where a safety barrier not on a motorway or all-purpose trunk road connects to a bridge parapet (via transitions) on a bridge which cross over a motorway or all-purpose trunk road, the safety barrier and transitions shall meet the requirements of this document.

6.14 Where a safety barrier not on a motorway or all-purpose trunk road connects to a bridge parapet (via transitions) on a bridge which cross over a motorway or all-purpose trunk road, the design and specification for the safety barriers and transitions shall be agreed between all parties.

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7. Requirements for crash cushions

Introduction

7.1 All VRS installations that include crash cushions shall be compatible with each other throughout the entire installation length (including any other safety barriers, parapets, terminals, and transitions) and meet the requirements of this Section 7.

7.2 For each crash cushion installation, based on the site specific conditions, the following and all other relevant requirements of MCHW Series 400 [Ref 22.N] and the associated MCHW Series NG400 [Ref 23.N] shall be specified in the contract specific specification, using contract specific Appendix 4/1 as detailed in MCHW Series NG400 [Ref 23.N]:

1) performance level;
2) re-directive or non re-directive type of crash cushion;
3) directional or bidirectional type of crash cushion;
4) impact severity level (ISL);
5) set-back;
6) vehicle redirection zone class
7) permanent lateral displacement zone class
8) maximum height that allows the required visibility (refer to CD 127 [Ref 4.N] and CD 109 [Ref 15.N]);
9) any special requirements (e.g. environmental considerations, ground conditions, proximity to embankment slopes, measures to to reduce the risk of injury to pedestrians, equestrians and other vulnerable users (e.g. no sharp edges));

7.3 Crash cushions shall be provided in front of fixed and/or rigid objects which cannot be removed, relocated or made passively safe, to reduce the risk of injury to vehicle occupants in the event of an impact.

NOTE *Fixed and/or rigid objects include roadside features such as bridge piers and toll booths.*

Performance levels

7.4 For roads with a speed limit greater than 50 mph, the performance level of the crash cushion shall be 110, as defined by BS EN 1317-3 2010 [Ref 25.N].

7.5 For roads with a speed limit of 50 mph or less, the minimum performance level of the crash cushion shall be 100, as defined by BS EN 1317-3 2010 [Ref 25.N].

Re-directive and non re-directive types of crash cushion

7.6 Where an assessment has identified that the redirection of an errant vehicle by a crash cushion results in additional risk to the road user, road workers, or other parties, a non re-directive crash cushion shall be specified in the contract-specific specification Appendix 4/1 as detailed in MCHW Series NG400 [Ref 23.N]).

7.7 Where an assessment has not identified that the redirection of an errant vehicle by a crash cushion results in additional risk to the road user, road workers, or other parties, a re-directive crash cushion shall be specified in the contract-specific specification Appendix 4/1 as detailed in MCHW Series NG400 [Ref 23.N]).

Bi-directional and directional types of crash cushion

7.8 Crash cushions located such that they could be struck in either direction shall be bi-directional.

7.9 Crash cushions located such that can be struck in one direction only (e.g. on a one-way road) shall be directional.

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7.9.1 A check should be made to ensure that the direction in which the crash cushion has been tested is the same as the direction in which it could be struck, when installed.

7.10 The type of crash cushion (bidirectional or directional) shall be specified in the contract-specific specification Appendix 4/1 as detailed in MCHW Series NG400 [Ref 23.N]).

Impact severity level

7.11 The ISL shall be either level A or B.

Vehicle redirection zone class

7.12 The vehicle redirection zone class for the crash cushion (Z1, Z2, Z3 or Z4) shall be selected to ensure that any redirected impacting vehicle does not encroach into any hazard or area used by motorists and/or non-motorised users.

Permanent lateral displacement zone class

7.13 The permanent lateral displacement zone class for the crash cushion (D1 to D8) shall be selected to ensure that no part of the deformed crash cushion encroaches into any hazard or area used by motorists and/or non-motorised users.

Crash cushions used in temporary situations

7.14 Crash cushions used in temporary situations shall be subject to site specific risk assessment in accordance with the TSM Chapter 8 [Ref 46.N].

NOTE *Crash cushions are one of a suite of options possible for the termination of temporary safety barriers.*

7.15 Crash cushions used in temporary situations shall be successfully tested to BS EN 1317-1 [Ref 33.N] and BS EN 1317-3 2010 [Ref 25.N], and CE marked to BS EN 1317-5 [Ref 28.N] in combination with the system and arrangement they are proposed to be used with, or as a stand-alone system.

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8. Requirements for pedestrian restraint systems

8.1 Pedestrian restraint systems shall:

1) reduce the risk to vulnerable users;
2) withstand envisaged impact loading;
3) avoid creating a visibility hazard; and
4) not become disconnected or break on impact in such a way as to cause a hazard for other road users, road workers, or other parties.

8.2 Pedestrian restraint systems shall not act as a vehicle restraint system.

General requirements for pedestrian parapets

8.3 For each pedestrian parapet installation, based on the site specific conditions, the following and all other relevant requirements of MCHW Series 400 [Ref 22.N] and the associated MCHW Series NG400 [Ref 23.N] shall be specified in the contract-specific specification Appendix 4/1 as detailed in MCHW Series NG400 [Ref 23.N]:

1) designation (the loading class)
2) infill material (if infill required) and protection;
3) infill class (Class C or D) and height;
4) type of holding down bolts (if required), foundations method of fixing, and whether a passively safe support system is required;
5) detailed layout;
6) length of need;
7) set-back;
8) minimum height above the adjacent paved surface;
9) plinth width, and whether a continuous plinth or continuous upstand is required;
10) any additional corrosion protection system required, and any special requirements for maintenance to the corrosion protection system;
11) any special requirements (e.g. environmental considerations).

8.4 All footbridges, cycleways and bridleway bridges shall be provided with a pedestrian parapet.

8.5 Pedestrian parapets shall comply with the requirements of BS 7818 [Ref 36.N] and CG 300 [Ref 38.N].

8.6 The minimum height of a new pedestrian parapet shall be in accordance with Table 8.6.

Table 8.6 Minimum heights of pedestrian parapets above the adjacent paved surface

Use	Not over railway	Over railway
Pedestrian	1150mm	1800mm
Cyclist	1500mm	
Equestrian	1800mm	

8.7 On cycleway bridges and accommodation overbridges frequently used by equestrians, the height of the parapet above the adjoining paved surface shall be increased to 1800mm.

8.8 For bridges not over railways that are used by equestrians and/or cyclists, and the parapet height is 1800mm, a solid infill panel of at least 600mm height shall be provided at the bottom of the parapet in order to obstruct the view of the road below.

8.9 Pedestrian parapets over railways, irrespective of parapet height shall have solid infilling to their full height.

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8.10 Steel pedestrian parapets shall be of framed construction consisting of posts and longitudinal members with suitable infilling.

8.11 Pedestrian parapets shall be mounted on a continuous plinth or continuous upstand of 50mm height with a tolerance of -0/+50 mm above the adjoining paved surface.

8.12 The pedestrian parapet specification in contract specific Appendix 4/1 as detailed in MCHW Series NG400 [Ref 23.N]) shall identify where the parapet does not have a continuous plinth or continuous upstand of 50mm height with a tolerance of -0/+50 mm above the adjoining paved surface.

NOTE *Not having a plinth affects the overall height.*

8.13 The rails and posts shall meet the Class 3 nominal live loads in BS 7818 [Ref 36.N].

8.14 The bar, sheet or mesh infill shall meet the Class C nominal loads in BS 7818 [Ref 36.N].

8.15 Where the Class 3 nominal live loads for posts and rails and/or the Class C nominal loads for infill are assessed to be inadequate, Class 4 nominal live loads for posts and rails and/or Class D nominal loads for infill shall be used.

8.16 Pedestrian parapets of concrete construction shall be designed in accordance with BS 5400-4 [Ref 37.N].

8.17 Pedestrian parapets of solid construction shall be designed to resist the more severe of a nominal live load of 1400 N/m applied transversely at the level of the top of the pedestrian parapet or wind loading in accordance with CS 454 [Ref 2.N].

8.17.1 The partial load factor γ_{fl} should be taken as 1.5 for live load and 1.4 for wind load at the ultimate limit state, or 1.0 for both at the serviceability limit state.

8.17.2 The strength of infilling panels may be proved for a prototype design by test loading with the loads situated in the most adverse positions.

8.17.3 The minimum overload factor should be taken as equal to the product of the partial safety factors used for ultimate limit state design.

8.17.4 When the appropriate design document given in the Technical Approvals Schedule is not to limit state format, a 50% overload should be assumed.

8.18 Stone or precast copings used with pedestrian parapets shall be secured to the concrete backing by fixings capable or resisting at the ultimate limit state a horizontal force of 33 kN per metre of coping.

Additional requirements for pedestrian parapets over or adjacent to railways

8.19 No toeholds shall be provided on the pedestrian traffic face of the parapet or the infill panel.

8.20 Infill panels on the front face of a parapet over a railway shall be of a design and material approved by the Railway Authority.

General requirements for pedestrian guardrails

8.21 For each pedestrian guardrail installation, based on the site specific conditions, the following and all other relevant requirements of MCHW Series 400 [Ref 22.N] and the associated MCHW Series NG400 [Ref 23.N] shall be specified in the contract-specific specification Appendix 4/1 as detailed in MCHW Series NG400 [Ref 23.N]:

1) designation (the loading class)
2) infill material (if infill required) and protection;
3) infill class (Class C or D) and height;
4) type of holding down bolts (if required), foundations method of fixing, and whether a passively safe support system is required;
5) detailed layout;

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6) length of need;
7) set-back;
8) minimum height above the adjacent paved surface;
9) any additional corrosion protection system required, and any special requirements for maintenance to the corrosion protection system;
10) any special requirements (e.g. environmental considerations).

8.22 Pedestrian guardrails shall be of steel construction.

8.23 Pedestrian guardrails shall comply with BS 7818 [Ref 36.N].

8.24 Where a guardrail is required for pedestrian safety in close proximity to a road, the guardrail and its end posts shall be designed to be passively safe in accordance with BS EN 12767 [Ref 24.N] unless it is installed outside the working width of safety barrier that is required for other reasons.

8.24.1 Pedestrian guardrails should not be provided as a deterrent to kerbside vehicle parking.

Requirements for pedestrian restraint and protection to prevent a fall from a height

8.25 Pedestrian restraint and protection, where determined through design and assessment, shall be specified where any pedestrian movement can occur within the highway boundary from use or maintenance and there is a risk to health and safety from a fall from a height.

NOTE *Typical locations requiring pedestrian restraint and protection are shown in the Figure 8.25N.*

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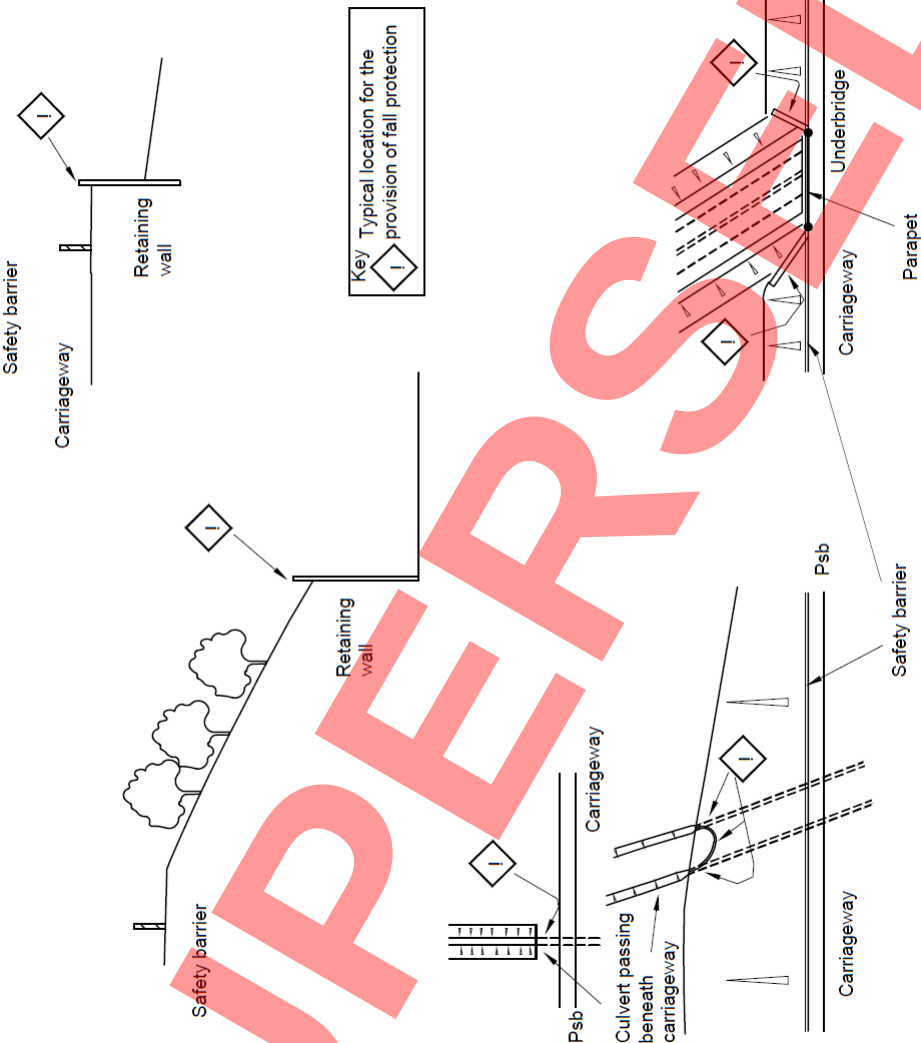
Figure 8.25N Typical locations requiring fall protection



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8.26 Where a structure, such as a retaining wall, head wall or wing wall, presents a vertical or near vertical face 1.5 m or more in height and it is possible for a person to gain access to the upper edge of the structure, a pedestrian restraint system such as a protective barrier or guardrail shall be installed close to, or on top of, the structure.

8.27 A pedestrian protective barrier or guardrail shall be installed at walls less than 1.5 m high if a particular hazard, such as a watercourse or road, is in close proximity to the wall.

8.28 The form of pedestrian restraint and protection provided, its components, articulation, location and arrangement shall be designed to minimise the risk of injury to the occupants of vehicles, e.g. by penetration of a vehicle cab.

8.29 Handrails within 2 m of Psb that can be reached by an errant vehicle shall be designed to be passively safe unless they are protected by a safety barrier that is required for other purposes.

8.30 Where appropriate, the VRS (if deployed) shall be extended to include the approaches to the structure or potentially hazardous differences in ground levels.

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9. Requirements for temporary safety barriers at roadworks

9.1 All VRS installations that include temporary safety barriers shall be compatible throughout the entire installation length (including any other safety barriers, parapets, terminals, transitions and crash cushions) and meet the requirements of this Section 9.

9.1.1 A temporary safety barrier may be either a permanent type safety barrier erected temporarily, or a purpose made temporary safety barrier.

NOTE *Temporary safety barriers are classed as safety barriers that are to be in place for less than 4 years.*

9.2 All safety barriers used in temporary situations shall be successfully tested to BS EN 1317-1 [Ref 33.N] and BS EN 1317-2 [Ref 32.N].

9.3 All safety barriers used in temporary situations shall be assessed by one of the independent reviewers appointed by the Overseeing Organisation.

Minimum containment levels

9.4 On roads where road works are being undertaken and a speed limit of 50 mph or more is in operation, the minimum containment levels for temporary safety barriers shall be:

1) normal containment level: N2;
2) higher containment level: H1;
3) very high containment level: H4a.

9.5 On roads where road works are being undertaken and a speed limit of less than 50 mph is in operation, the minimum containment levels for temporary safety barriers shall be:

1) normal containment level: N1;
2) higher containment level: H1;
3) very high containment level: H4a.

9.6 Low angle containment safety barrier systems referenced in Table 2 of BS EN 1317-2 [Ref 32.N] shall not be used.

9.7 At temporary or permanent bridge supports and other vulnerable structures, very high containment level (H4a) temporary safety barriers shall be used unless the assessment determines that normal containment level (N1 or N2) is sufficient, or no barrier is required.

9.8 At temporary or permanent bridge supports and other vulnerable structures, the principles shown within Figure 9.8a and Figure 9.8b shall be followed, and the structures assessed in accordance with CS 453 [Ref 40.N].

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Figure 9.8a Temporary safety barrier provision adjacent to temporary or permanent bridge supports - temporary propping - no collision loading requirement

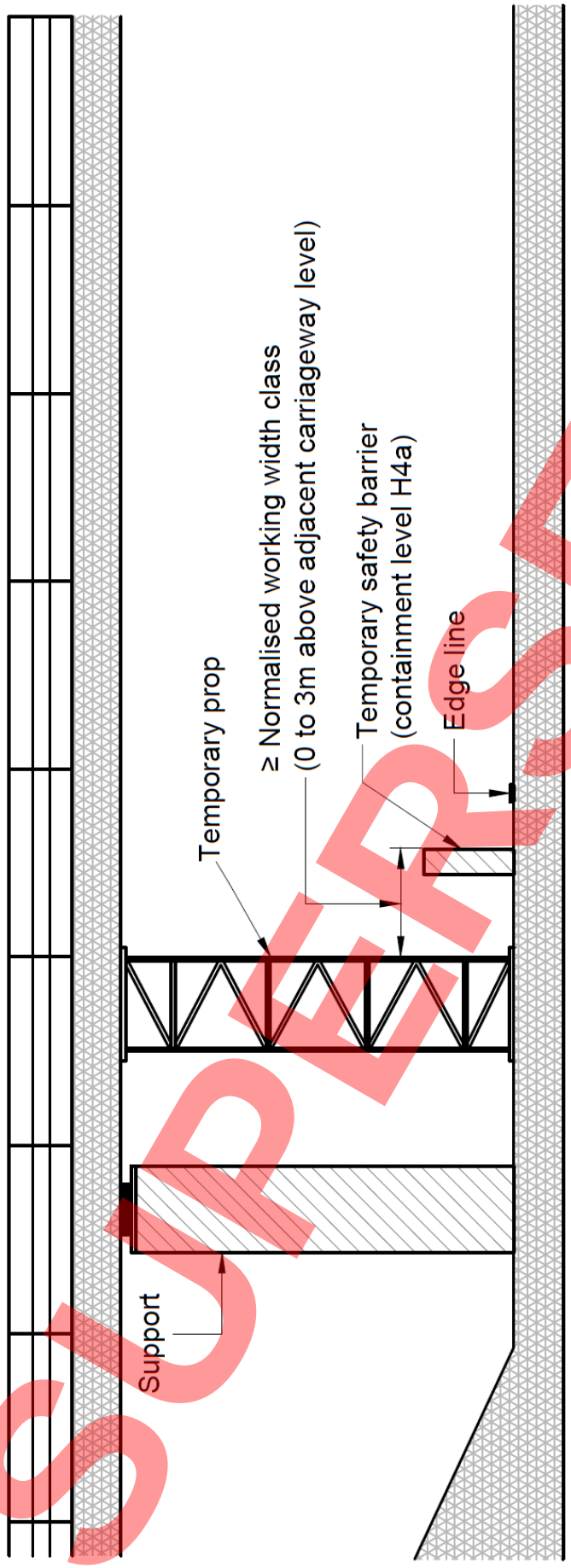

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Figure 9.8b Temporary safety barrier provision adjacent to temporary or permanent bridge supports - temporary propping - to carry residual loading

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Impact severity level

9.9 The ISL shall be either level A or B.

Normalised working width classes and classes of normalised vehicle intrusion classes

9.10 For normal containment level temporary safety barriers, the maximum identified value of normalised working width class that the local hazard(s) allow, shall be used.

9.11 For higher and very high containment level temporary safety barriers, the maximum identified values of normalised working width class and normalised vehicle intrusion class that the local hazard(s) allow, shall be used.

9.12 For all higher and very high containment temporary safety barrier systems, the required clearance to any hazard that is vulnerable to residual loading shall be provided for within the design of the temporary works.

NOTE *Where the distance between a line projected vertically from the traffic face of a temporary very high containment level (H4a) safety barrier and the face of a temporary structural support is greater than the normalised working width class of the safety barrier for at least 3m above the adjacent carriageway level, and the distance exceeds the normalised vehicle intrusion class, the temporary support does not need to be designed to resist collision loading.*

Length of need

9.13 During testing to BS EN 1317-2 [Ref 32.N], the test length of the safety barrier shall be sufficient to demonstrate the full performance characteristics of the safety barrier at the length of need.

9.14 Where the traffic can temporarily travel in both directions along the same carriageway or along the hardshoulder under temporary traffic management, the assessment shall determine the length of need in the temporary situation.

9.15 Where the length of need for the temporary situation is longer than the length of need for normal conditions, the extra length of need shall be provided for the period that the temporary situation is operative.

9.16 As assessment shall be carried out to ensure the length of full containment safety barrier in advance and beyond the hazard(s) or work zone(s) results in an ALARP level of risk with regard to a vehicle reaching the hazard(s) and/or work zone(s).

NOTE *A vehicle entering from the access point can potentially be channelled further into the works than normal due to both the verge/central reserve and the temporary safety barrier preventing a vehicle exiting that restricted area.*

Set-back

9.17 The minimum set-back for temporary safety barriers shall be in accordance with Table 9.17.

Table 9.17 Temporary safety barrier minimum set-back requirements (in mms)

Temporary speed limit	Desirable set-back	Relaxed set-back
70mph	1000	600
60mph	1000	500
50mph	600	375

9.17.1 At 70mph and 60mph, where it is agreed by the manufacturer of the temporary VRS, set-back should be measured to exclude base plates.

9.17.2 Where a desirable set back is to be used with a temporary 50mph speed limit, and where it is agreed by the manufacturer of the temporary VRS, set-back should be measured to exclude base plates.

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9.17.3 Where a relaxed set back is to be used with a temporary 50mph speed limit, set-back should be measured to include base plates.

9.18 Where relaxed values of set-back are proposed, a risk assessment compliant with TSM Chapter 8 [Ref 46.N] shall be undertaken and documented.

NOTE *A TSM Chapter 8 [Ref 46.N] risk assessment can include where extra lanes or extra lane width can be generated, or where other space can be released for operative working and where such space is important.*

9.18.1 Where space is available, an increase in lane widths should be specified as the risk to drivers has the potential to be minimised where lane widths are greater than the minimum in TSM Chapter 8 [Ref 46.N].

9.19 Temporary safety barrier performance in restricted situations is unpredictable and siting of the barrier shall allow for deflection into the lateral clearance safety zone or into the adjacent running lane(s) depending upon demonstrated system performance.

Method of termination for temporary safety barriers

9.20 The safety barrier and terminal provision shall be assessed in the temporary situation taking account of any temporary traffic flow direction and location, and mandatory speed limit.

9.21 Individual temporary safety barrier ends and the temporary safety barrier shall be installed to the manufacturer's instructions.

9.22 A risk assessment shall be conducted as part of the TSM Chapter 8 [Ref 46.N] temporary traffic management (TTM) design and the benefits and dis-benefits of the options available for the site specific circumstances evaluated.

9.22.1 The risk assessment may include the use of crash cushions for the termination of a temporary safety barrier.

9.23 A record shall be made of the termination layout adopted and reasons for that layout.

General requirements

9.24 Permanent and temporary local hazards having the potential to cause danger to the occupants of a vehicle, the workforce or to other parties shall be identified within a site specific risk assessment, as required by TSM Chapter 8 [Ref 46.N].

9.24.1 Examples of common design factors that should be evaluated when using temporary safety barriers at road works are listed below:

1) length of time for which a temporary safety barrier is likely to be deployed;
2) speed limits both existing and proposed;
3) traffic flows including the percentage of large goods vehicles (LGVs);
4) containment level required and vehicle intrusion class for 'L' containment safety barriers;
5) length of safety barrier;
6) road alignments, cross-section-pinch points, set-back, headroom clearance, available working widths, etc;
7) sight lines;
8) drainage of carriageway;
9) ground support for temporary safety barrier;
10) clearances for operation and construction;
11) requirements for temporary signing, lighting and road markings;
12) obstructions that can affect the performance of the safety barrier, e.g. lighting columns, signposts, etc;
13) other VRS in the vicinity of the works;

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14) access arrangements for works vehicles, emergency and recovery vehicles;
15) end of safety barrier details to ensure errant vehicles cannot pass behind into the work zone; the reduced risk of the leading end of a temporary safety barrier being impacted by a vehicle if flared away from the running lane, but the reduced space available for site vehicles;
16) the risk of an errant vehicle stopping abruptly in the running lane if a crash cushion is installed;
17) the risk of a ramped leading end being installed causing a vehicle to end up in either the running lane or the works area in the event of an impact;
18) traffic movements approaching the safety barrier;
19) where applicable, the effect of a safety barrier on movement of road workers, pedestrians, cyclists, etc;
20) maintenance requirements;
21) traffic management and working space and widths required for installation and removal of safety barriers;
22) where a temporary very high containment level (H4a) safety barrier is to be used, whether it is to be be surface mounted or inset into the carriageway;
23) compliance with contract specific details.

NOTE 1 *This list is not exhaustive and other factors potentially need to be assessed.*

NOTE 2 *The sight stopping distances and visibility requirements of CD 127 [Ref 4.N] and CD 109 [Ref 15.N] are to be taken into account when positioning the temporary safety barrier.*

9.25 The factors evaluated and decisions made shall be recorded and temporary safety barriers with appropriate terminations provided where the conclusion from the site specific risk assessment indicates they are necessary to adequately control the risks.

Temporary speed limits

9.26 A temporary speed limit of less than 50 mph shall not be imposed on roads to protect short sections of work that can be carried out without closure or restriction of any of the running lanes, solely to allow use of temporary safety barriers with a containment level of N1.

9.27 Where, after undertaking a risk assessment, it is determined that it is necessary to provide protection over a short length (e.g. for the replacement of a vehicle parapet) then a temporary safety barrier with a containment level of N2, H1, or H4a shall be incorporated into the temporary works.

Use of temporary safety barriers in contraflow operations

9.28 Where temporary safety barrier is used within contraflow, the following parameters shall also apply:

1) a buffer zone between opposing traffic flows of a width relevant to the mandatory speed limit in force, but not less than two times the normalised working width of the temporary safety barrier minus the width of the temporary safety barrier, or the width of the temporary safety barrier plus twice the set-back value, whichever is the greater;
2) the ends of the safety barrier continue beyond the end of the contraflow into a coned off area, to reduce the risk of traffic impacting the ends;
3) no gaps created in the temporary safety barrier between the two opposing flows of traffic in the contraflow;
4) an acceptable means of access provided for the emergency services and recovery vehicles to attend to accidents or breakdowns within the contraflow, if identified as a necessary measure.

NOTE *An acceptable means of access provided for the emergency services and recovery vehicles to attend can include temporary removable sections in the barrier.*

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10. Legacy systems

10.1 Where a new hazard is introduced in advance of, alongside or beyond an existing legacy system, an assessment shall be made to compare the merits of merging and retaining the legacy system, or replacing it.

10.2 Where a new hazard is introduced in advance of, alongside or beyond an existing legacy system, any proposal to maintain an existing legacy system shall be justified to the Overseeing Organisation.

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11. Vehicle arrester beds

11.1 On an existing road where there is a known problem involving runaway vehicles on a downhill gradient, both in terms of personal injuries and damage to vehicles or property, the provision of an arrester bed shall be evaluated in conjunction with the relevant landowners, Police, local authorities and the Overseeing Organisation.

NOTE 1 *The function of an arrester bed is to decelerate a runaway vehicle on long, steep descending gradients without causing significant damage to the vehicle, its occupants, other road users, adjacent buildings or property.*

NOTE 2 *Whilst arrester beds are suitable for most types of vehicle, they are particularly effective in bringing to rest large commercial vehicles which suffer brake or gear change mechanism failures.*

NOTE 3 *There are two basic layouts for arrester beds; 'remote' which are incorporated into a separate escape lane leading off the main carriageway and 'adjacent' which are constructed adjacent to the nearside of the carriageway in a widened section of the highway.*

11.2 On new or improved roads where a long, downhill gradient is unavoidable and a potential problem associated with runaway vehicles is identified, the possibility of including an escape lane arrester bed shall be investigated.

NOTE *At severely restricted sites, it is potentially not feasible to construct a full width 'remote' or 'adjacent' arrester bed. In such cases a reduced width 'adjacent' arrester bed, which just accommodates the nearside wheels of a runaway vehicle, can be the only feasible option.*

11.2.1 A 'single track' type of arrester bed only has about 50% of the stopping effect of a full width bed, so requires an increased bed length and should only be proposed when there are no suitable alternatives.

11.3 The provision of any type of arrester bed shall be supported by a risk assessment and details of discussions with the Overseeing Organisation, relevant local authorities and emergency services.

11.4 The bed material shall be free draining and the base of the bed drained to avoid water ponding and potential freezing in winter conditions.

11.5 The sides of the bed shall be restrained by kerbing which restricts sideways movement and scatter of the aggregate.

11.6 On 'remote' arrester beds the horizontal alignment of the bed shall diverge from that of the main carriageway to minimise the potential for the nearside wheels of the vehicle being in the gravel bed and the offside wheels being on an increasingly adverse cross slope, which can induce vehicle overturning.

11.7 On the 'adjacent' type of arrester bed any kerbing used for the edge restraint between the gravel bed and the main carriageway pavement shall be level with the carriageway so that a vehicle driver, who has the potential to overshoot the signed entry to the bed, can still steer into the arrester bed.

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12. Anti-glare systems

12.1 All new anti-glare systems shall be specified to BS EN 12676-1 [Ref 1.N] and the specific requirements of MCHW Series 400 [Ref 22.N] and the associated MCHW Series NG400 [Ref 23.N].

NOTE *The purpose of an anti-glare system is to cut off light from oncoming vehicle headlights on adjacent roads.*

12.2 Anti-glare screens shall be designed so that light directed towards the driver at oblique angles (12° to 20°) is reduced whilst relatively open vision (around 70°) is maintained in the sideways direction.

NOTE *The height to effectively screen headlight glare from all types of vehicles on level ground is 2.0m.*

12.3 The risks associated with attaching an anti-glare system to a new or existing VRS shall be assessed prior to installation.

12.3.1 The risk assessment should include the change in the performance of the VRS due to the attachment of the anti-glare system, and the risks associated with the detachment of the anti-glare system in the event of an impact with the VRS.

12.4 The police authority responsible for road surveillance and patrol shall be consulted prior to the installation of any anti-glare system that can restrict the police's view of the opposing carriageway.

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13. Cattle grids

Design of cattle grids

13.1 Cattle grids shall be designed in accordance with BS 4008 [Ref 35.N].

NOTE *The Office of Rail Regulation document 'Level Crossings: A guide for managers, designers and operators' ORR Level crossings [Ref 1.I] provides additional requirements and advice for the provision of cattle grids at railway level crossings.*

13.1.1 Cattle grids should only be provided where alternative measures, such as gates, have been investigated and found unsuitable.

13.2 An alternative means of by-passing a cattle grid shall be provided for users that are unable to safely cross the grid but are entitled by law to travel along the particular highway in question (such as pedestrians and equestrians).

NOTE *BS 4008 [Ref 35.N] provides design criteria for by-pass facilities.*

Siting of cattle grids

13.3 Cattle grids and any associated by-pass shall be located within highway land unless a legal agreement with the relevant land owner has been entered in to.

13.3.1 New cattle grids should be located within the highway boundary.

NOTE *The legal responsibility for animals straying or lying on or at the side of the highway lies with their keepers; however, the Overseeing Organisation has a vested interest in ensuring animals cannot access the motorway and trunk road network due to the safety implications this can have. Placing cattle grids within the highway boundary therefore provides the Overseeing Organisation with a greater level of control over this risk.*

13.4 Cattle grids shall not be located within 18 metres of a junction, measured from the projected kerb line, or edge of carriageway if kerbs are not present, of the adjoining road to the start of the grid.

13.4.1 Cattle grids should only be located where there is a minimum of 18 metres of straight road on either side of the grid.

NOTE *Cattle grids can be a skid/slip hazard, which is a particular problem for pedal and motor cycles. Providing a straight section on the approaches removes the need for road users to turn while traversing the grid, which reduces the risk of skidding/slipping.*

13.4.2 Cattle grids should only be sited where there is desirable minimum stopping sight distance available on each approach to the grid in accordance with CD 109 [Ref 15.N] for the relevant design speed.

13.4.3 In situations where a cattle grid is to be placed closer to a major road junction than the desirable minimum stopping sight distance, unobstructed visibility should be available between the edge of the major road and the grid, measured from centre point to centre point in the approach lane.

NOTE *It is necessary for vehicles to cross cattle grids at relatively low speeds. It is therefore important that adequate visibility is available on the approach to cattle grids to ensure that road users can react and slow down safely prior to reaching them.*

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14. Normative references

The following documents, in whole or in part, are normative references for this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

Ref 1.N	BSI. BS EN 12676-1, 'Anti-glare systems for roads. Performance and characteristics'
Ref 2.N	Highways England. CS 454, 'Assessment of highway bridges and structures'
Ref 3.N	Highways England. CG 304, 'Conservation of highway structures'
Ref 4.N	Highways England. CD 127, 'Cross-sections and headrooms'
Ref 5.N	Highways England. LA 116, 'Cultural heritage asset management plans'
Ref 6.N	Highways England. CD 353, 'Design criteria for footbridges'
Ref 7.N	Highways England. CD 354, 'Design of minor structures'
Ref 8.N	Network Rail. NR/L3/CIV/020 Issue 1, 'Design of Railway Bridges'
Ref 9.N	Highways England. CD 143, 'Designing for walking, cycling and horse riding (vulnerable users)'
Ref 10.N	Highways England. CD 524, 'Edge of pavement details'
Ref 11.N	BSI. BS EN 1991-1-7, 'Eurocode 1 - Actions on structures - Part 1-7 General actions - Accidental actions'
Ref 12.N	BSI. BS EN 1992-2, 'Eurocode 2. Design of concrete structures. Part 2: Concrete bridges. Design and detailing rules'
Ref 13.N	Highways England. CD 123, 'Geometric design of at-grade priority and signal-controlled junctions'
Ref 14.N	Highways England. RRRAP User Guide, 'Guidance on the use of the Road Restraint Risk Assessment Process (RRRAP) associated with CD 377'
Ref 15.N	Highways England. CD 109, 'Highway link design'
Ref 16.N	BSI. BS 6779-2 , 'Highway parapets for bridges and other structures - Part 2: Specification for vehicle containment parapets of concrete construction'
Ref 17.N	BSI. BS 6779-1, 'Highway parapets for bridges and other structures. Part 1: Specification for vehicle containment parapets of metal construction.'
Ref 18.N	Highways England. GG 101, 'Introduction to the Design Manual for Roads and Bridges'
Ref 19.N	Highways England. CS 470, 'Management of sub-standard highway structures'
Ref 20.N	Department for Transport. MAOR, 'Managing the accidental obstruction of the railway by road vehicles'
Ref 21.N	Highways England. MCHW, 'Manual of Contract Documents for Highway Works'
Ref 22.N	Highways England. MCHW Series 400, 'Manual of Contract Documents for Highway Works, Volume 1 Specification for Highway Works, Series 400 Road Restraint Systems'
Ref 23.N	Highways England. MCHW Series NG400, 'Manual of Contract Documents for Highway Works, Volume 2 Notes for Guidance on the Specification for Highway Works, Series 400 Road Restraint Systems'
Ref 24.N	BSI. BS EN 12767, 'Passive safety of support structures for road equipment. Requirements, classification and test methods.'

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Ref 25.N	BS EN 1317-3, 'Performance classes, impact test acceptance criteria and test methods for crash cushions' , 2010
Ref 26.N	BSI. BS DD ENV 1317-4, 'Performance classes, impact test acceptance criteria and test methods for terminals and transitions of safety barriers'
Ref 27.N	Highways England. CD 365, 'Portal and cantilever signs/signals gantries'
Ref 28.N	BS EN 1317-5, 'Product requirements and evaluation of conformity for vehicle restraint systems'
Ref 29.N	2011/305/EU, 'Regulation (EU) No 305/2011 of the European Parliament and of the Council of 9 March 2011 laying down harmonised conditions for the marketing of construction products and repealing Council Directives 89/106/EEC'
Ref 30.N	Network Rail. NR/BS/LI/331 Issue 2, 'Requirements for parapet heights on over bridge and footbridge structures spanning overhead line electrification equipment'
Ref 31.N	Highways England. GG 104, 'Requirements for safety risk assessment'
Ref 32.N	BSI. BS EN 1317-2, 'Road restraint systems. Performance classes, impact test acceptance criteria and test methods for safety barriers including vehicle parapets '
Ref 33.N	BSI. BS EN 1317-1, 'Road restraint systems. Terminology and general criteria for test methods.'
Ref 34.N	Highways England. TD 131, 'Roadside technology and communications'
Ref 35.N	BSI. BS 4008, 'Specification for Cattle Grids'
Ref 36.N	BSI. BS 7818, 'Specification for pedestrian restraint systems in metal '
Ref 37.N	BSI. BS 5400-4, 'Steel, concrete and composite bridges. Code of practice for design of concrete bridges'
Ref 38.N	Highways England. CG 300, 'Technical approval of highway structures'
Ref 39.N	Highways England. CS 455, 'The assessment of concrete highway bridges and structures'
Ref 40.N	Highways England. CS 453, 'The assessment of highway bridge supports'
Ref 41.N	The National Archives. legislation.gov.uk. SI 2015/51, 'The Construction (Design and Management) Regulations 2015'
Ref 42.N	Highways England. CD 192, 'The design of crossovers and changeovers'
Ref 43.N	Highways England. RRRAP, 'The Road Restraint Risk Assessment Process '
Ref 44.N	The Stationery Office (TSO). Department for Infrastructure (DfI). TSR(NI) 1997, 'The Traffic Signs Regulations (Northern Ireland) 1997'
Ref 45.N	The Stationery Office. TSRGD, 'The Traffic Signs Regulations and General Directions 2016'
Ref 46.N	TSO. Department for Transport. TSM Chapter 8, 'Traffic Signs Manual Chapter 8 - Road works and temporary situations'
Ref 47.N	BSI. NA to BS EN 1991-1-7, 'UK National Annex to Eurocode 1 - Actions on structures - Part 1-7 General actions - Accidental actions'

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15. Informative references

The following documents are informative references for this document and provide supporting information.

Ref 1.I	Office of Rail Regulation. ORR Level crossings, 'Level Crossings: A guide for managers, designers and operators'

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Appendix A. Guidance on the specification of vehicle restraint systems for low speed and/or low flow roads

The guidance given below is intended to assist in dealing with situations where the use of a fully compliant vehicle parapet or vehicle safety barrier system may be impracticable or may itself present a similar or greater hazard to the public. These situations, where the application of these requirements is not appropriate, are particularly prevalent on local roads.

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Table A.1 Considerations for the specification of parapets for low speed and/or low flow roads

Function	Potential non-function	Possible reasons for non-function	Assessment criteria	Commentary
Vehicle parapet	Does not redirect safely	1) Redirects effectively, but into oncoming traffic due to narrow carriageway (less than 6.0m). 2) Redirects effectively, but into pedestrians on adjacent footway. 3) Insufficient length of parapet.	1) For roads with a speed limit of 50 mph or more and traffic flow less than 5000 AADT, use RRRAP; or 2) For roads with a speed limit of less than 50 mph or traffic flow of less than 5,000 AADT, use local in-house risk assessment process to review risk to: a) vehicle occupants and others below or near to the bridge if vehicle is not contained; b) vehicle occupants and others on the bridge (other traffic and pedestrians) if vehicle is redirected effectively. The assessment of risk includes an assessment of actual traffic speed, traffic flows, incident records and the hazards present beneath the bridge.	1) If the risk from lack of containment is acceptable and the risk from effective redirection is unacceptable, then a parapet may not be necessary other than to delineate for pedestrian safety. 2) If the risk from lack of containment is unacceptable and the risk from effective redirection is unacceptable, then a parapet that provides vehicle containment only may optimise the balance of risk. 3) If the risk from lack of containment is unacceptable and the risk from effective redirection is acceptable, then a compliant vehicle parapet system should be used if it is practicable to do so. If not, then any alternative (bespoke) system provided should contain the vehicle and reduce risk to the vehicle occupants to ALARP.

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Table A.2 Considerations for the specification of VRS for low speed and/or low flow roads

Function	Potential non-function	Possible reasons for non-function	Assessment criteria	Commentary
VRS on bridge approach fully compliant to: 1) prevent impact on the end of the parapet, 2) prevent a vehicle from travelling behind the parapet to the hazard below 3) contain and safely redirect an errant vehicle	1) An errant vehicle impacts on the end of the parapet. 2) An errant vehicle gets behind the parapet. 3) The vehicle is not redirected safely.	1) Insufficient space to accommodate a compliant VRS due to: a) adjacent entrances/junctions restricting length; b) verges used as passing bays due to a narrow carriageway (less than 6.0 m); c) insufficient verge/footway width to provide required set-back/working width/vehicle intrusion.	1) For roads with a speed limit of 50 mph or more, use RRRAP; or 2) For roads with a speed limit of less than 50 mph or traffic flow of less than 5,0 00 AADT, use local in-house risk assessment process to review risk to: a) vehicle occupants and others below or near to the bridge if vehicle is not contained; b) vehicle occupants and others on the bridge (other traffic and pedestrians) if vehicle is redirected effectively.	1) If the risk from access behind the parapet is acceptable and the risk from effective redirection is unacceptable, then a VRS may not be necessary. 2) If the risk from access behind the parapet is unacceptable and the risk from effective redirection is unacceptable then an alternative local vehicle restraint system at the bridge that provides vehicle containment only may optimise the balance of risk. Possible solutions could include splayed wing walls or a short (angled) length of barrier. Such bespoke protection should contain the vehicle and reduce risk to the occupants to ALARP.

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Table A.2 Considerations for the specification of VRS for low speed and/or low flow roads (continued)

Function	Potential non-function	Possible reasons for non-function	Assessment criteria	Commentary
VRS on bridge approach fully compliant to: 1) prevent impact on the end of the parapet, 2) prevent a vehicle from travelling behind the parapet to the hazard below 3) contain and safely redirect an errant vehicle	1) An errant vehicle impacts on the end of the parapet. 2) An errant vehicle gets behind the parapet. 3) The vehicle is not redirected safely.	2) Redirects effectively, but into oncoming traffic due to narrow carriageway (less than 6.0 m) 3) Redirects effectively, but into pedestrians on adjacent footway.	3) If a non compliant vehicle restraint system or none at all is to be used on the approach to the bridge then review the risk arising from impact on end of parapet. The assessment of risk at the bridge approaches include an assessment of of actual traffic speed, traffic flows and accident records, the hazard faced beneath the bridge and the existence of equivalent hazards elsewhere on the route such as parallel ditches/houses/footways	3) If the risk from access behind the parapet is unacceptable and the risk from effective redirection is acceptable, then a compliant vehicle restraint system should be used if it is practicable to do so. If not then protection at the bridge may again be the solution. Such bespoke protection should contain the vehicle and reduce risk to the occupants to ALARP. 4) As a result of assessment criteria 3, a crash cushion may be required here to reduce the consequences of an accidental impact on the vehicle occupants to ALARP.

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Appendix B. Guidance on factors for ECPs and MCPs

B1 Emergency and maintenance crossing points

There are various options available to create an ECP/MCP. They may take the form of a gate or a permanent safety barrier. Each option varies in cost and ease of operation. Systems that are not suitable to be removed should be avoided near ECPs and MCPs.

For ECPs, the main requirement is the speed with which the ECP can be opened and operational; this depends on the option chosen. It also depends on whether specialist equipment or personnel are required to operate or open the ECP. In most cases, a time of less than 30 minutes to open the gate or dismantle a permanent safety barrier would be desirable.

For MCPs, speed may not be an issue as the opening can be planned. Where regular maintenance is required, for example, near tunnels or on long structures, then it may be beneficial to provide permanent MCPs at each end that can be opened and closed quickly. For other situations, there are two options. Provide an MCP from the outset, or create an MCP only when required (i.e. take down or break out the permanent system; this can often be the most cost effective solution).

B1.1 Gates at MCP/ECP

A gate is the easiest to open, generally requires no, or minimal, specialist equipment and can be opened in less than 30 minutes. However, personnel do need to be trained to ensure that they know how to operate the gate and close it properly so that it is correctly fixed to the permanent or temporary safety barrier when not in operation. Gates are generally quite expensive. They also have large working widths that can make them unsuitable for narrow central reserves. If they are used, where there is a mismatch in the working widths between the gate and the permanent system, a transition is required to connect the two systems. Any transitions increase the length of the MCP.

B1.2 Permanent safety barrier at ECP/MCP

A permanent safety barrier may be used to form an ECP/MCP.

If this option is chosen for an ECP, specialist personnel and equipment may be required to dismantle or remove the safety barrier and this can take some time and may exceed the normal 30 minute recommendation required for operational reasons. For an MCP it is a viable option.

Where a concrete H1 or H2 safety barrier is used, an MCP can be created by breaking out the concrete and removing the debris. This operation might take some time depending on length and require specialist equipment. An in-situ concrete section can then be inserted when the MCP is no longer required.

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Notification

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Highway Structures & Bridges
Design

CD 377
England National Application Annex to CD 377 Requirements for road restraint systems

(formerly TD 19/06)

Revision 0

Summary
This National Application Annex contains the Highways England specific requirements related to road restraint systems.

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

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Release notes

Version	Date	Details of amendments
0	Mar 2020	Highways England National Application Annex to CD 377.

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Foreword

Publishing information

This document is published by Highways England.

This document supersedes TD 19/06, and partially supersedes IAN 68/05 and IAN 75/06 which are withdrawn.

Contractual and legal considerations

This document forms part of the works specification. It does not purport to include all the necessary provisions of a contract. Users are responsible for applying all appropriate documents applicable to their contract.

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Introduction

Background

This National Application Annex contains the Highways England specific requirements related to road restraint systems.

This document is an update to TD 19/06 and reflects changes to the Overseeing Organisations' requirements. It also takes account of updated and new EU standards and legislation.

This document gives requirements for road restraint systems and it, together with the associated RRRAP [Ref 9.N] and RRRAP User Guide [Ref 2.N], assists those involved in determining where road restraint systems are warranted, and the minimum required parameters.

Assumptions made in the preparation of this document

The assumptions made in GG 101 [Ref 4.N] apply to this document.

This document is written on the basis that road restraint systems will be supplied and constructed in accordance with the MCHW [Ref 5.N] and all other works will be designed and specified in accordance with the Design Manual for Roads and Bridges.

Mutual Recognition

Where there is a requirement in this document for compliance with any part of a British Standard, technical specification or quality mark, that requirement may be met by compliance with the Mutual Recognition clause in GG 101 [Ref 4.N].

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Abbreviations

Abbreviations

Abbreviation	Definition
AADT	Average annual daily traffic
EA	Emergency area
ESS	Entry slip signal
LGV	Large Goods Vehicle
m	Metres
Psb	Point from which set-back is measured
RRS	Road restraint system
VRS	Vehicle restraint system

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Terms and definitions

Terms

Term	Definition
Cattle grid	A device set into a road that consists of a number of transverse members supported over a pit. It forms a barrier to livestock but allows access for vehicles.
Normalised values (of working width and vehicle intrusion)	Values that have been adjusted to take account of any differences between the specified total mass of the vehicle, its velocity and angle of approach and the values measured during testing. NOTE: Refer to BS EN 1317-2 [Ref 7.N].
Parapet	A safety barrier that is installed on the edge of a bridge, retaining wall or similar structure where there is a vertical drop.
Pedestrian restraint system	A restraint system installed to reduce the risk of a fall from a height at locations where pedestrian movement could occur due to highway use or maintenance activities.
Psb	Point from which set-back of the safety barrier or parapet face is measured. NOTE: Refer to CD 127 [Ref 1.N] for minimum requirements for permanent safety barriers.
Rigid safety barrier	A safety barrier that when tested in accordance with BS EN 1317-1 [Ref 8.N] and BS EN 1317-2 [Ref 7.N], does not deflect from its pre-impact position.
Road restraint system (RRS)	General name for vehicle restraint system or pedestrian restraint system used on the road.
Set-back	The distance between the Psb and the traffic face of a RRS. NOTE: Refer to CD 127 [Ref 1.N] for minimum requirements for permanent safety barriers.
Vehicle restraint system (VRS)	A tested system installed on a road to provide a level of containment for an errant vehicle. NOTE: A typical system consists of a terminal-safety barrier-terminal, or a terminal-safety barrier-parapet-safety barrier-terminal, and includes transitions where appropriate.

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Terms (continued)

Term	Definition
Vehicle intrusion	The vehicle intrusion of an LGV is the maximum dynamic lateral position from the undeformed traffic side of the barrier in consideration of a notional load having the width and length of the vehicle platform, and a total height of 4 metres. The vehicle intrusion of a bus is the maximum dynamic lateral position of the bus from the undeformed traffic side of the barrier. NOTE: Further detail is given in BS EN 1317-2 [Ref 7.N].
Working width	The maximum lateral distance between any part of a safety barrier on the undeformed traffic side, and the maximum dynamic position of any part of the barrier during impact testing to BS EN 1317-2 [Ref 7.N]. NOTE 1: If the vehicle body deforms around the road vehicle restraint system so that the latter cannot be used for the purpose of measuring the working width, the maximum lateral position of any part of the vehicle is the working width. NOTE 2: Further detail is given in BS EN 1317-2 [Ref 7.N]

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E/1. Requirements for permanent safety barriers

General requirements (additional to CD 377)

E/1.1 For post mounted entry slip signal (ESS) sites, a lack of protection by a vehicle restraint system (VRS), or provision of the required approach length of safety barrier, shall be permitted as acceptable.

E/1.2 Each ESS site shall be assessed, and the decision as to whether to provide VRS, the length of VRS, and the decision making process, recorded in the design strategy record.

E/1.3 Clause 3.26 of CD 377 shall not apply.

E/1.4 Gaps of up to 100 m shall be closed, unless the road is within a smart motorway scheme where the closure of a gap is subject to a risk assessment.

E/1.4.1 A gap may not be closed if there are significant cost, technical and/or access requirements for the gap to remain open.

Safety barrier provision in central reserves - general (CD 377, 3.85)

E/1.5 On motorways with a two-way annual average daily traffic (AADT) greater or equal to 25,000 vehicles/day where a safety barrier is required in accordance with this document and the distance Psb to Psb is 10 metres or less, the safety barrier shall have a minimum containment level of H1.

E/1.5.1 Where the length of safety barrier to be installed in the central reserve is 500 m or less, an N2 containment level non rigid safety barrier may be installed instead.

NOTE *The installation of a minimum H1 containment rigid safety barrier is to minimise cross-over incidents and reduce the need for safety barriers to be repaired or maintained and hence, minimise the costs and congestion arising from temporary traffic management and reduce the risk to maintenance workers.*

E/1.6 On motorways with a two-way AADT greater or equal to 25,000 vehicles/day where a VRS greater than 500m in length is required in accordance with this document, and the distance Psb to Psb is 10 m or less, the safety barrier shall be rigid, have a serviceable life of not less than 50 years, and be designed such that after testing in accordance with BS EN 1317-1 [Ref 8.N] and BS EN 1317-2 [Ref 7.N], it does not require realignment, replacement or repair.

E/1.7 On new and upgraded all-purpose trunk roads, the requirements of GD 300 [Ref 6.N] shall apply.

E/1.8 On all other roads where a safety barrier is required in accordance with this document and the distance Psb to Psb is 10 m or less, the safety barrier shall have a minimum containment level of N2.

Requirements for gaps in safety barrier (additional to CD 377)

Emergency areas (EA) on smart motorway schemes

E/1.9 Full height anchorages shall only be used at EA locations where VRS is required and where there is insufficient room for two full length terminals.

E/1.10 Full height anchorages shall only be used at EA locations where they do not face oncoming traffic, unless behind another VRS (and outside of its working width and vehicle intrusion).

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E/2. Cattle grids

Siting of cattle grids (CD 377, 13.3)

E/2.1 Cattle grids and any associated by-pass shall be located within highway land unless a legal agreement with the relevant land owner has been entered in to.

NOTE *For cattle grids to be located on non-highway land, a legal agreement is entered into under Section 87 of the Highways Act 1980 [Ref 3.N].*

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E/3. Normative references

The following documents, in whole or in part, are normative references for this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

Ref 1.N	Highways England. CD 127, 'Cross-sections and headrooms'
Ref 2.N	Highways England. RRRAP User Guide, 'Guidance on the use of the Road Restraint Risk Assessment Process (RRRAP) associated with CD 377'
Ref 3.N	The National Archives. legislation.gov.uk. Highways Act 1980, 'Highways Act 1980'
Ref 4.N	Highways England. GG 101, 'Introduction to the Design Manual for Roads and Bridges'
Ref 5.N	Highways England. MCHW, 'Manual of Contract Documents for Highway Works'
Ref 6.N	Highways England. GD 300, 'Requirements for new and upgraded all-purpose trunk roads (expressways)'
Ref 7.N	BSI. BS EN 1317-2, 'Road restraint systems. Performance classes, impact test acceptance criteria and test methods for safety barriers including vehicle parapets '
Ref 8.N	BSI. BS EN 1317-1, 'Road restraint systems. Terminology and general criteria for test methods.'
Ref 9.N	Highways England. RRRAP, 'The Road Restraint Risk Assessment Process '

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Department for Infrastructure
An Roinn Bonneagair

Highway Structures & Bridges
Design

CD 377
Northern Ireland National Application Annex to CD 377 Requirements for road restraint systems

(formerly TD 19/06)

Revision 0

Summary
This National Application Annex contains the Department for Infrastructure Northern Ireland specific requirements for road restraint systems.

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 team in the Department for Infrastructure, Northern Ireland. The email address for all enquiries and feedback is: dcu@infrastructure-ni.gov.uk

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Release notes

Version	Date	Details of amendments
0	Mar 2020	Department for Infrastructure Northern Ireland National Application Annex to CD 377.

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Foreword

Publishing information

This document is published by Highways England on behalf of Department for Infrastructure, Northern Ireland.

This document supersedes TD 19/06, and partially supersedes IAN 68/05 and IAN 75/06 which are withdrawn.

Contractual and legal considerations

This document forms part of the works specification. It does not purport to include all the necessary provisions of a contract. Users are responsible for applying all appropriate documents applicable to their contract.

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Introduction

Background

This National Application Annex contains the Department for Infrastructure Northern Ireland specific requirements related to road restraint systems.

This document is an update to TD 19/06 and reflects changes to the Overseeing Organisations' requirements. It also takes account of updated and new EU standards and legislation.

This document gives requirements for road restraint systems and it, together with the associated RRRAP [Ref 8.N] and RRRAP User Guide [Ref 3.N], assists those involved in determining where road restraint systems are warranted, and the minimum required parameters.

Assumptions made in the preparation of this document

The assumptions made in GG 101 [Ref 4.N] apply to this document.

This document is written on the basis that road restraint systems will be supplied and constructed in accordance with the MCHW [Ref 5.N] and all other works will be designed and specified in accordance with the Design Manual for Roads and Bridges.

Mutual Recognition

Where there is a requirement in this document for compliance with any part of a British Standard, technical specification or quality mark, that requirement may be met by compliance with the Mutual Recognition clause in GG 101 [Ref 4.N].

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Abbreviations

Abbreviations

Abbreviation	Definition
AADT	Average annual daily traffic
LGV	Large Goods Vehicle
m	Metres
mph	Miles per hour
Psb	Point from which set-back is measured
RRS	Road restraint system
VRS	Vehicle restraint system

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Terms and definitions

Terms

Term	Definition
Cattle grid	A device set into a road that consists of a number of transverse members supported over a pit. It forms a barrier to livestock but allows access for vehicles.
Parapet	A restraint system that is installed on the edge of a bridge, retaining wall or similar elevated structure where there is a vertical drop.
Pedestrian restraint system	A restraint system installed to reduce the risk of a fall from a height at locations where pedestrian movement could occur due to highway use or maintenance activities.
Psb	Point from which set-back of the safety barrier or parapet face is measured. NOTE: Refer to CD 127 [Ref 2.N] for minimum requirements for permanent safety barriers.
Railway Authority	Authority responsible for the railway infrastructure.
Rigid safety barrier	A safety barrier that when tested in accordance with BS EN 1317-1 [Ref 7.N] and BS EN 1317-2 [Ref 6.N], does not deflect from its pre-impact position.
Road restraint system (RRS)	General name for vehicle restraint system or pedestrian restraint system used on the road.
Set-back	The distance between the Psb and the traffic face of a RRS. NOTE: Refer to CD 127 [Ref 2.N] for minimum requirements for permanent safety barriers.
Vehicle restraint system (VRS)	A tested system installed on a road to provide a level of containment for an errant vehicle. NOTE: A typical system consists of a terminal-safety barrier-terminal, or a terminal-safety barrier-parapet-safety barrier-terminal, and includes transitions where appropriate.

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NI/1. Scope

Implementation and application

NI/1.1 Clause 1.2 of CD 377 shall not apply.

NI/1.2 This document shall apply to all trunk and non-trunk roads with permanent speed limits of 50mph or more and two-way traffic flows of 5,000 annual average daily traffic (AADT) or more.

NI/1.3 For the application of clause 1.3.1 across the NI road network, contact shall be made with the Overseeing Organisation.

NI/1.4 For all trunk and non-trunk roads with permanent speed limits of less than 50 mph, contact shall be made with the Overseeing Organisation for design standards and guidance on the introduction or replacement of RRS.

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NI/2. Requirements for permanent safety barriers

Safety barrier provision in central reserves - general (CD 377, 3.77- 3.83)

NI/2.1 On motorways with a two-way AADT greater or equal to 25,000 vehicles/day where a safety barrier is required in accordance with this document and the distance Psb to Psb is 10 m or less, the safety barrier shall have a minimum containment level of H1.

NOTE *The installation of a minimum H1 containment rigid safety barrier is to minimise cross-over incidents and reduce the need for safety barriers to be repaired or maintained and hence, minimise the costs and congestion arising from temporary traffic management and reduce the risk to maintenance workers.*

NI/2.2 On motorways with a two-way AADT greater or equal to 25,000 vehicles/day where a VRS is required in accordance with this document and the distance Psb to Psb is 10 m or less, the safety barrier shall be rigid, have a serviceable life of not less than 50 years, and be designed such that after testing in accordance with BS EN 1317-1 [Ref 7.N] and BS EN 1317-2 [Ref 6.N], it does not require realignment, replacement or repair.

NI/2.2.1 Where the length of rigid safety barrier to be installed in the central reserve is 500 m or less, an N2 containment level non rigid safety barrier may be installed instead.

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NI/3. Requirements for vehicle parapets

Minimum containment level requirements where the road is carried over or adjacent to a railway

NI/3.1 Clauses 4.8 to 4.12 inclusive of CD 377 shall not apply.

New and existing bridges, structures and accommodation bridges (additional to CD 377)

NI/3.2 The minimum vehicle parapet containment level shall be normal containment level (N2).

NI/3.3 Where a site-specific risk assessment indicates that a containment level higher than the minimum level is required, the higher containment level shall be specified following confirmation from the Overseeing Organisation and the Railway Authority.

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NI/4. Cattle grids

Siting of cattle grids (CD 377, 13.3)

NI/4.1 Cattle grids and any associated by-pass shall be located within highway land unless a legal agreement with the relevant land owner has been entered in to.

NOTE *For cattle grids to be located on non-highway land, a legal agreement is entered into under Article 63 of the R(NI)O 1993 Art 63 [Ref 1.N].*

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NI/5. Normative references

The following documents, in whole or in part, are normative references for this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

Ref 1.N	R(NI)O 1993 Art 63, 'Article 63 of the Roads (Northern Ireland) Order 1993'
Ref 2.N	Highways England. CD 127, 'Cross-sections and headrooms'
Ref 3.N	Highways England. RRRAP User Guide, 'Guidance on the use of the Road Restraint Risk Assessment Process (RRRAP) associated with CD 377'
Ref 4.N	Highways England. GG 101, 'Introduction to the Design Manual for Roads and Bridges'
Ref 5.N	Highways England. MCHW, 'Manual of Contract Documents for Highway Works'
Ref 6.N	BSI. BS EN 1317-2, 'Road restraint systems. Performance classes, impact test acceptance criteria and test methods for safety barriers including vehicle parapets '
Ref 7.N	BSI. BS EN 1317-1, 'Road restraint systems. Terminology and general criteria for test methods.'
Ref 8.N	Highways England. RRRAP, 'The Road Restraint Risk Assessment Process '

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Highway Structures & Bridges
Design

CD 377
Scotland National Application Annex to CD 377 Requirements for road restraint systems

(formerly TD 19/06)

Revision 0

Summary
Please contact Transport Scotland for the application of CD 377. The email address is: TSStandardsBranch@transport.gov.scot

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 Transport Scotland team. The email address for all enquiries and feedback is: TSStandardsBranch@transport.gov.scot

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Release notes **2**

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Release notes

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Llywodraeth Cymru
Welsh Government

Highway Structures & Bridges
Design

CD 377
Wales National Application Annex to CD 377 Requirements for road restraint systems

(formerly TD 19/06)

Revision 0

Summary
Please contact Welsh Government for the application of CD 377. The email address is: Standards_Feedback_and_Enquiries@gov.wales

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 Welsh Government team. The email address for all enquiries and feedback is: Standards_Feedback_and_Enquiries@gov.wales

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