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Specification for Road Works Series 400 - Road Restraints Systems (Vehicle and Pedestrian)

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For all documents that existed within the NRA DMRB or the NRA MCDRW prior to the launch of TII Publications, the NRA document reference used previously is listed above under 'historical reference'. The TII Publication Number also shown above now supersedes this historical reference. All historical references within this document are deemed to be replaced by the TII Publication Number. For the equivalent TII Publication Number for all other historical references contained within this document, please refer to the TII Publications website.

ROAD RESTRAINT SYSTEMS (VEHICLE AND PEDESTRIAN)

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ROAD RESTRAINT SYSTEMS (VEHICLE AND PEDESTRIAN)

401 General

- 1 Road restraint systems are defined in IS EN 1317-1 and comprise both systems to contain errant vehicles (road vehicle restraint systems) and systems to provide guidance for pedestrians (pedestrian restraint systems).
- 2 The specialist responsible for the design shall ensure that safety barriers and vehicle parapets (with the exception of bespoke vehicle parapets as described in Clause 415):
 - (i) Comply with this Series, Appendices 4/1, 4/3 and 4/7 and the requirements of standards NRA TD 19 and NRA BD 52 (as appropriate);
 - (ii) Are certified in accordance with IS EN 1317-5 to conform to the parameters of containment level, impact severity level and working width identified in Appendices 4/1 and 4/7; and
 - (iii) Are installed in accordance with the manufacturers' installation manual, attached to the relevant CE Certificate.
- 3 For transitions, terminals or temporary barriers, in the absence of CE marking, the specialist responsible for the design shall ensure compliance with all of the equivalent information that would be required to apply for certification of a safety barrier under IS EN 1317-5 for each terminal or transition type.
- 4 Pedestrian restraint systems shall comply with the requirements of this Series and Appendix 4/2.
- 5 The Contractor shall take due account of the road alignment and position of obstructions, services, etc.
- 6 Wherever practicable, all prefabricated road restraint systems installed in the Works shall be manufactured by the same manufacturer.
- 7 Posts for vehicle parapets shall be vertical and parapet rails shall follow the vertical alignment of the bridge, retaining wall or similar structure.
- 8 A check shall be undertaken by an independent Chartered Engineer who shall certify that the site testing regime is appropriate for the road restraint system installation in the specific site conditions. Such certification shall be submitted to the Employer's Representative before the start of installation.
- 9 An installed road restraint system that has not been installed in accordance with the manufacturer's installation manual for that system shall be considered a modification, which will require a departure from Standard, and the specialist responsible for the design shall ensure the modification is certified in accordance with Annex A of IS EN 1317-5. Where such a modification is considered to affect the performance of the system, the associated modification report must reference all relevant evidence and/or installation methods used, including the product specification calculations and/or test results compared to original values. The modification report shall be validated by an independent Chartered Engineer.

402 Types of Road Vehicle Restraint System

- 1 Proprietary road vehicle restraint systems, of steel, concrete (in-situ and pre-cast) or other materials, shall comply with the requirements of this specification.
- 2 Bespoke vehicle parapets shall be designed in accordance with the requirements of Clause 415 and Standard NRA BD 52.

403 Durability

- 1 All components of road restraint systems, with the exception of vehicle parapets, shall be designed to achieve a serviceable life of not less than 20 years and for concrete barriers 50 years, except for Temporary Safety Barriers where the nominal service life shall be not less than 10 years. Durability assessment shall specifically address the prevention of galvanic corrosion between dissimilar metals.
- 2 All road restraint systems shall operate over an ambient temperature range of -20°C to $+50^{\circ}\text{C}$ without any reduction in performance.
- 3 Vehicle Parapets shall conform to the following:
 - (i) All components shall be designed to achieve a serviceable life of not less than:
 - (a) 50 years for metal vehicle parapets and metal components of combined metal and concrete vehicle parapets;
 - (b) 120 years for concrete vehicle parapets and concrete components of combined metal and concrete vehicle parapets; and
 - (ii) For metal vehicle parapets and metal components of combined metal and concrete vehicle parapets the serviceable life shall be obtained without the requirement for any maintenance other than that resulting from accidental damage.
- 4 Pedestrian parapets shall conform to the following:
 - (i) All components of pedestrian parapets shall be designed to achieve a serviceable life of not less than:
 - (a) 30 years for metal pedestrian parapet and metal components of combined metal and concrete pedestrian parapets;
 - (b) 120 years for concrete pedestrian parapets and concrete components of combined metal and concrete pedestrian parapets; and
 - (ii) For metal pedestrian parapets and metal components of combined metal and concrete pedestrian parapets the serviceable life shall be obtained without the requirement for any maintenance other than that resulting from accidental damage.

404 Protection against Corrosion

- 1 Protection against corrosion shall be as described in the Manufacturer's Specification and the following:
 - (i) All steel components, except stainless steel items, reinforcing rings and reinforcing bars, shall be galvanised after shop fabrication as described in Series 1900;
 - (ii) The surface preparation and protection against corrosion of all steel parapets, and steel components of combined metal and concrete parapets shall comply with Series 1900; and
 - (iii) As an alternative to a combined galvanised and painted system, steel parapets may be protected by galvanising only, provided that the galvanising coverage rate shall be in accordance with EN ISO 1461, stainless steel bolts shall be used for holding down the parapet and for all other system fixings and the finished galvanised surface shall be smooth and free from sharp projections.

405 Not Used

406 Installation

Handling and Storage

- 1 All components shall be protected from damage and handled and stacked in such a way that permanent damage is not caused, particularly to threaded components. Transport and storage arrangements shall comply with the recommendations of the system manufacturer and IS EN ISO 1461, IS EN 10346 and IS EN 13369 as appropriate. In particular means shall be provided to avoid damage to galvanised coatings and any damage that does occur shall be made good in accordance with the recommendations of IS EN ISO 1461. Component ropes and tail ropes shall be supplied on reels with a barrel diameter that will avoid twisting and kinking of the ropes.

Layout

- 2 The overall layout and location of road restraint systems shall be as indicated in the **Works Requirements** [Contractor's Documents] including Appendices 4/1, 4/2, 4/3 and 4/7.
- 3 The Contractor shall ascertain and install the minimum overall length of road vehicle restraint system which is required in order that the system will perform as designed including where this length is more than the overall length determined in accordance with Standard NRA TD 19, NRA BD 52 or the **Works Requirements** [Contractor's Documents] incorporating Appendices 4/1, 4/2, 4/3 and 4/7.
- 4 All safety barriers shall be erected to present a flowing alignment and in accordance with the following:
 - (i) The overall alignment on plan of safety barriers shall not depart from the prescribed overall layout by more than $\pm 30\text{mm}$, nor deviate in any 10m length from the straight or required radius by more than $\pm 15\text{mm}$;
 - (ii) Barriers shall be at the height shown in the barrier manufacturer's details for the barrier installation. The height of the barrier shall be measured from the edge of the road pavement if the set-back is less than 1.5m. Elsewhere, the height shall be measured from the adjacent ground; and
 - (iii) The ground within the set-back and working width dimensions shall be generally level and free from obstructions.
- 5 Vehicle and pedestrian parapets shall be set true to line and level, within the tolerances set for bedding, (see Clause 408.8), where applicable, throughout their length to give a smooth flowing line to the finished parapet.

Excavation for Concrete Foundations and Anchor Blocks

- 6 Where the sides of excavations cannot be maintained vertical until concrete is placed, suitable permanent or temporary casings shall be used. The casings shall be installed immediately after excavation and any lateral overbreak of the excavation shall be filled with concrete.
- 7 Impermeable plastic sheeting 125 microns thick shall be laid at the base of an in-situ concrete foundation located in a filter drain

Concrete in Foundations and Anchor Blocks

- 8 Concrete in foundations and anchor blocks shall be in accordance with the relevant Clauses of the 1700 and 2600 Series of this specification and the system manufacturer's requirements.
- 9 The Contractor shall ensure that any concrete which constitutes part of the restraint system has reached the specified strength stated by the system manufacturer prior to any tensioning taking place.

Posts

- 10 Where posts are mounted in cast-in post sockets these shall be protected to prevent the collection of detritus in the socket voids.
- 11 When steel posts are driven into the ground this shall be carried out without damage to the post and any protective coating. Any minor damage to galvanising shall be treated in accordance with IS EN ISO 1461.

Cutting of components

- 12 No drilling, cutting (including flame cutting) or welding of beams and posts shall be permitted after application of any protective coating.
- 13 Special closure pieces shall be fabricated before application of any protective coating.

Assembly

- 14 Direct contact between dissimilar metals shall be avoided by interposing non-metallic sleeves, washers or coatings as detailed by the road restraint system manufacturer.

Installation

- 15 At least 4 weeks prior to the incorporation of any road restraint system into the Works, the Contractor shall provide suitable evidence to the Employers Representative that those installing the system have been provided with adequate training in the system installation by the road restraint system manufacturer.

407 Site Testing

Anchorage in Drilled Holes

- 1 Where the impact characteristics of the road vehicle restraint system may be affected by the performance of anchorages in drilled holes, the Contractor shall carry out on-site tensile load tests as detailed in this Clause. For the avoidance of doubt, the requirements of this Clause apply to all vehicle parapets. For the purpose of this sub-Clause, the phrase “types of fixings” referred to in clause 1 of BS 5080 Part 1 shall include “anchorages”. Where anchorages are tested they shall be loaded incrementally in tension in accordance with BS 5080 : Part 1 except that they shall be capable of resisting a test load equal to 10 per cent above the nominal tensile load applied to the anchor at failure of the road vehicle restraint system in lieu of testing to failure.
The nominal tensile load shall be determined by the restraint system manufacturer. Where the failure of the attachment system (e.g. the holding down bolt) is the prescribed failure mode of the road vehicle restraint system, the test load shall be 90 per cent of the yield load of the attachment system. Incremental loads shall be held for not less than half a minute and the test load for not less than five minutes. Readings shall be taken immediately after applying load and at the end of the time intervals stated above.
- 2 The total movement of the anchorage shall not exceed 1.0mm during the test. Any evidence of slip during loading up to the test load, as demonstrated by a significant change in the slope of the load/extension curve, shall constitute failure.
- 3 The Contractor shall test the anchorages selected by the Employer’s Representative and the testing frequency shall be in accordance with Appendix 1/5. In addition, testing shall comply with any special requirements given in Appendices 4/1 and 4/7.

Alternative anchorage systems

- 4 Where the road restraint system manufacturer proposes a form of anchorage system other than anchorages in drilled holes the Contractor shall implement a suitable site testing regime to demonstrate satisfactory performance in an equivalent manner to that described in sub clauses 1 to 3 above. The Contractor shall submit details of the proposed testing regime to the Employer's Representative at least four weeks prior to the installation of each anchorage type.

Road Restraint System

- 5 The Contractor shall undertake any testing that the road restraint system manufacturer may require on the installed system.

Ground Conditions

- 6 The Contractor shall ensure that the finished ground conditions are suitable for the correct performance of the road restraint system selected, and shall:
- (i) Demonstrate that the finished ground provides sufficient resistance to comply with the requirements identified in the road restraint system manufacturer's IS EN 1317-5 compliant installation manual; and
 - (ii) Where posts are mounted in post sockets, demonstrate by on-site testing that the post sockets remain serviceable and in their correct original position following the collapse of the post.
- 7 Where the above requires in-situ testing these tests shall be undertaken at 50m centres with a minimum of two test locations per restraint system length. On completion of loading tests the Contractor shall replace any damaged elements of the restraint system and reinstate the finished ground to meet the requirements of the Contract.

If the site tests fail to demonstrate that the ground conditions are suitable, the Contractor shall:

- (i) Provide an alternative road restraint system; and/or
- (ii) Improve the ground conditions such that they are suitable.

408 Anchorages and Attachment Systems for Surface Mounted Posts

- 1 The design, fabrication and installation of the anchorage and attachment system shall conform to the manufacturer's drawings and specifications, the requirements of IS EN 1317-1, IS EN 1317-2 and Standards NRA TD 19 and NRA BD 52. At least 4 weeks before installation, the Contractor shall submit to the Employer's Representative well attested and documented evidence that the proposed attachment systems and anchorages in drilled holes are capable of resisting the ultimate tensile loads resulting from failure of the proposed road restraint system. Where the ultimate capacity of a road restraint system is governed by the failure of the attachment system, the evidence shall demonstrate that the anchorages in drilled holes are capable of resisting the ultimate tensile loads resulting from the failure of the attachment systems. Anchorages of an expanding type shall not be permitted.
- 2 Intermediate anchors shall be provided to all tensioned safety barrier systems that are over 1000m long. They shall be spaced approximately at equal distances between end anchors so that the maximum length of unanchored barrier does not exceed 1000m. The means of terminating tensioned elements shall ensure that there is at least 50 per cent of the normal containment capacity provided at any point within the termination sections.

The minimum overlap distance between anchor blocks within the intermediate termination sections shall be 30m and the maximum distance 60m. These requirements shall be stated within the barrier manufacturer's details.

- 3 For anchorages in drilled holes, each hole location shall be checked to ensure that the hole will be clear of reinforcement before drilling is carried out. Where it is not possible to locate drilled holes without encountering reinforcement, the Contractor shall submit a report to the Employer's Representative on the consequences of drilling through or cutting the reinforcement from the Specialist responsible for the design or assessment of the affected reinforcement. No drilling or cutting shall take place without the prior written acceptance of the Employer's Representative.
- 4 Before installation of anchorages in drilled holes, each hole shall be sound, clean and dry and the tolerance of the hole shall be within the values given by the anchorage manufacturer.
- 5 Where surface mounted posts are to be installed on bridge decks and other structures, the anchorages shall include an internally threaded component to receive the attachment system i.e. holding down nut and bolt or stud. Anchorage systems shall incorporate anti-theft devices. All parts of anchorages on bridge decks and other structures (where the anchorage is within 80mm of the upper surface of the supporting concrete or where the anchorage parts are threaded to receive the holding down bolt) shall be of stainless steel grade designation 1.4401 or 1.4436 to IS EN 10088-1. Holding down bolts, studs and nuts shall be stainless steel grade 14-80 to IS EN ISO 3506-1 and IS EN 3506-2. Metal to metal contact between dissimilar materials within the attachment system and anchorage shall be prevented by the use of non-conductive sleeves, washers or coatings to prevent bimetallic corrosion.
- 6 The threads of steel anchorages shall be lined with grease having a high resistance to creep and being suitable for hot or cold smearing.
- 7 Attachment systems shall be tightened to the specified torque and have not less than the minimum thread engagement specified by manufacturer of the system.
- 8 Except where surface mounted posts are attached to a steel base they shall be bedded on mortar complying with Clause 2601 and Appendix 26/2. The bedding mortar shall have a minimum thickness of 10mm and a maximum thickness of 30mm. An additional allowance may be made for longitudinal falls.
- 9 All voids in anchorages, attachment systems and base plates shall be filled with a non-setting passive filler.
- 10 Stainless steel bolts, studs, screws and nuts shall conform to IS EN ISO 3506-1 and IS EN ISO 3506-2, Grade A4-80. The dimensions and tolerances of the bolts, studs, screws and nuts shall conform to IS EN ISO 4016, IS EN ISO 4018 and IS EN ISO 4034.
- 11 Washers on bridge decks and other structures shall conform to BS 4320 and be made from stainless steel strip designation 1.4401 or 1.4436 to IS EN 10029, IS EN 10048, IS EN 10051 and IS EN ISO 9445.

409 In-Situ Concrete Barrier

- 1 In-situ concrete barriers shall be CE marked on the basis of the Standard EN 1317-5: 2007+A2:2002 and their manufacturers must issue a Declaration of Performance in line with Regulation (EU) 305/2011.
- 2 Slots are to be provided in all concrete barriers at a maximum of 50m centres where the carriageway has normal crossfall and spacing is to be decreased to a maximum 10m centres where the carriageway is in superelevation. Slots shall be either rectangular (150mm wide by 100mm high) or circular (150mm diameter) with an invert level of slots 30mm above the pavement level. Slots are only to be provided at the base of vertical saw cuts.
- 3 In cases where a bifurcation of an in-situ concrete barrier is required, the length of the bifurcation shall be dependent on the rate of change of the barrier alignment applied on each side of the bifurcation,

relative to the centreline of the in-situ concrete barrier. This rate of change shall be less than or equal to a maximum rate of 1 in 20.

4 In-situ concrete barriers shall comply with the requirements of RCD/400/7.

410 Temporary Safety Barriers

1 Where required in order to comply with the requirements of Appendix 1/17 or as particularly required in Appendix 4/1 the Contractor shall provide, install and maintain temporary safety barriers, terminals and transitions, and on completion of the Works remove to the location stated therein. Any such temporary barriers shall comply with the requirements of this specification as for permanent barriers.

411 Terminals and Transitions

1 All full height terminals shall comply with the requirements of IS ENV 1317-4 for the performance criteria as described in Appendix 4/3.

2 All transitions shall comply with NRA TD 19 or NRA BD 52, as appropriate and the requirements of the impact assessment test criteria and the critical impact requirements specified in IS EN 1317-2 for road restraint systems.

3 In the case of a terminal for an in-situ concrete barrier:

(i) The length of the downstream terminal shall be dependent on the rate of decrease of the barrier height applied over the terminal, relative to the top of the in-situ concrete barrier. This rate of change shall be less than or equal to a maximum rate of 1 in 4.

(ii) The upstream end shall either transition to a suitable full height terminal or be ramped in accordance with item 3(i) above and the ramped terminal protected by a suitable overlapping barrier.

4 In all other respects, terminals and transitions shall comply with the requirements of this specification for safety barriers.

412 Provision of Information, Training, Materials and Equipment

1 The Contractor shall provide to the Employer the types and quantities of information, training, materials and equipment stated in Appendix 4/4. He shall deliver them to the location(s) specified in Appendix 4/4.

2 The Contractor shall submit to the Employer's Representative a statement from the safety barrier supplier of the anticipated delivery period for all components of the safety barrier systems listed in Appendix 4/1. Period(s) shall be stated for the delivery of 50 to 100 metres of barrier, terminals, transitions and all other components.

413 Pedestrian Restraint Systems

1 Pedestrian Restraint Systems shall comply with BS 7818 and with any other requirements described in Appendix 4/2, the durability requirements of Clause 403 of this Specification and the corrosion protection requirements of Clause 404 of this Specification.

414 Anti-Glare Screens

1 Anti-glare screen systems shall conform to IS EN 12676-1 and IS EN 12676-2 and the requirements of Appendix 4/5.

415 Bespoke Vehicle Parapets

- 1 Bespoke vehicle parapets shall include in-situ or precast concrete parapets, masonry parapets or metal parapets for use in particular circumstances and which have not been tested and certified in accordance with IS EN 1317.
- 2 Bespoke vehicle parapets shall be designed, fabricated, installed and tested in accordance with the following requirements except where these conflict with relevant requirements:
 - (i) NRA BD 52;
 - (ii) BS 6779-1:1998 (Amd. No. 14290, 21 March 2003) and BS 6779-2:1991 both as amended by NRA BD 52, BS 6779-3:1994 and BS 6779-4:1999;
 - (iii) This Specification.
- 3 The Performance Class Requirements (Containment level, Impact Severity Level, Working Width Class) and the parapet height for bespoke vehicle parapets shall be as described in Appendix 4/7.



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