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10 VEHICLE CRASH BARRIERS

10.1 GENERAL REQUIREMENTS

10.1.1 Scope

- 1 This section of the specification covers the supply, installation and foundation requirements of the following representative types of vehicle crash barriers. The definition of each type of barrier is given in the relevant section of the specification.
 - (a) steel wire rope barriers.
 - (b) tensioned corrugated beam safety fence
 - (c) untensioned corrugated beam safety fence
 - (d) open box beam safety fence
 - (e) tensioned rectangular hollow section safety fence
 - (f) permanent concrete barriers
 - (g) temporary concrete barriers
 - (h) aluminium bridge parapet.
- 2 This section of the specification does not cover the design criteria for deciding on the type of barrier to be applied in a particular situation.

3 Related Sections and Parts

This Section

Part 12..... Fencing
Section 5 Concrete

10.1.2 References

- 1 The following standards and other documents are referred to in this Part:

ASTM D 1248.....Specification for Polyethylene Plastics Moulding and Extrusion Materials US, Department of Transportation Research Report NCHRP, No. 230.

BS 4.....Structural steel sections

BS 302.....Wire ropes for cranes, excavators and general engineering purposes

BS 970.....Wrought steels for mechanical and allied engineering purposes

BS 1449: Part 2.....Stainless and heat resistant steel plate sheet and strip

BS 1474Wrought aluminium and aluminium alloys for engineering purposes

BS 1490Aluminium and aluminium ingots for engineering purposes

BS 3416Bitumen based coatings for cold application

BS 4320Metal washers for general engineering purpose

BS 4464Spring washers for general engineering and automobile purposes

BS 6579Safety fences and barriers for highways

EN 1011MIG Welding of aluminium and aluminium alloys

EN 1317"Highway parapets for bridges and other structures. Part 1. Specification for vehicle containment parapets of metal construction

EN 10025Hot rolled products of non-alloy structural steels - Technical delivery conditions.

EN 10264Round carbon steel wire for wire ropes

- EN 13411-1Specification for Thimbles for wire ropes
- EN 1317Road Restraint Systems
- ISO 1461Hot dip galvanised coatings on iron and steel articles
- ISO 2081 & ISO 2082, Electroplated coatings of cadmium and zinc on iron and steel
- ISO 3506Corrosion-resistant stainless steel fasteners
- ISO 9002Quality assurance system for production and installation

TD 19/06Requirements for Road Restraint Systems

- DTP, Manual of contract documents for highway works - volume 1 specification series 400
- DTP, Manual of contract documents for highway works - volume 3 standard details
- UK, Design Manual for Roads and Bridges

10.1.3 Performance Requirements

- 1 The vehicle crash barriers shall present a continuous smooth face to an impacting vehicle so that the vehicle is redirected without turning on its side or rolling over to a course that is nearly parallel to the barrier face and with a lateral deceleration which is tolerable to the vehicle occupant. The vehicle shall be redirected without rotation about either its horizontal axis (spinning out) or vertical axis (overturning) and the rate of lateral deceleration shall be such as to cause minimum risk of injury to the passengers.
- 2 The vehicle shall be directed so that no part of the vehicle crosses the line parallel with and 4 m from the original alignment of the traffic face of the fence or barrier within a distance of 10 m from the last point of initial impact in the direction of the adjacent traffic flow.
- 3 On impact the safety fence or barrier shall contain and redirect a vehicle of a certain mass travelling at a certain velocity at an angle of incidence of 20 degrees to the fence or barrier.
- 4 The level of vehicle containment shall be lower, normal or higher as designated, with the following value for vehicle mass and vehicle speed.

<u>Containment</u>	<u>Vehicle Mass, kg</u>	<u>Vehicle Speed, km/h</u>
Normal	1500	113
Lower	1500	80
Higher	5000	80

The centre of gravity of the test vehicle prior to impact shall be 500 mm above the ground.

- 5 All the components of a vehicle crash barrier shall be designed to achieve a serviceable life of not less than 20 years except for the use of temporary concrete barriers where the nominal service life shall not be less than 10 years.

10.1.4 Submittals

- 1 The Contractor shall submit details of previous installations of the vehicle crash barrier over a 10-year period, indicating the system, its location and the type of highway.

- 2 For the particular crash barrier system proposed, the Contractor shall submit a detailed report giving the results of vehicle impact tests, and may include photographs and video recordings. The report shall be from a laboratory approved by the Engineer. The report shall describe in detail the arrangements for the test including vehicle weight, speed, impact area, full details of the test vehicle guidance and measuring systems and speed measurements. The report shall include photographs showing the results of the test. The report shall give full details of the actual vehicle speed, approach angle, vehicle interaction and fence movement of vehicle and roll, yawl and pitch of the vehicle movement after exit from safety fence. The report shall include details of the safety fence damage and the vehicle damage.
- 3 Crash cushions and terminals. The Contractor shall make a detailed technical submission that will include drawings indicating the layout for the system at different locations. The Contractor shall also submit design calculations for the system for head on impact and side impact. These calculations shall indicate the reduction in G force or all vehicles of specified weight and speed. The submission shall contain the precise specification of the individual elements of the system, installation procedures, fixing details and fully dimensioned scale layout drawings. The Contractor shall submit reports from the highway authority where the particular barrier system has been used showing details of vehicle collisions and the results of such collisions.
- 4 The Contractor shall submit calculations to show that post foundations can withstand an overturning moment of 6.0 kNm.
- 5 The Contractor shall submit full technical details of the safety fence system proposed including post to beam connection details of beam joints and post to beam connection details of posts, and details of tensioning assembly.
- 6 The Contractor shall submit calculations showing the required size and details of the lifting eyes for permanent and temporary concrete barriers for the designated barrier details.

10.1.5 Quality Assurance

- 1 Vehicle crash barriers shall have been tested by an approved Testing establishment. The Engineer shall decide what is an approved Testing establishment.
- 2 The manufacturer shall operate an approved quality assurance system complying with ISO 9001 for the fabrication and supply of components used in the vehicle safety barriers. Only components complying with the manufacturer's specifications may be used.
- 3 The supplier shall submit certification showing that tensioned rectangular hollow section safety fence systems have been tested in accordance with the requirements approved by the Engineer and mentioned in the contract's documents.
- 4 Crash cushion and terminal systems shall have been satisfactory tested following the procedures set down in the US Department of Transportation Research Report NCHRP, No. 230, or any other reference approved by the Engineer. The installation of the system shall be supervised by a representative of the manufacturer.

10.1.6 Maintenance

- 1 For vehicle crash barriers, crash cushion and terminal systems the Contractor shall supply:
 - (a) four copies of the installation and maintenance manual
 - (b) a relevant spare parts list for the system showing the recommended set of spare parts needed to restore one system to its original condition after a head on impact
 - (c) if specified elsewhere in the Contract the Contractor shall supply spare parts for the system

- (d) current prices of spare parts
- (e) profile of a local agent

10.2 STEEL WIRE ROPE BARRIERS

10.2.1 General

- 1 Steel wire rope safety fence barriers shall be supplied and installed in accordance with the designated dimensions and details shown on the contract drawings. The post details, spacing, anchorage, size shapes and general layout shall be as per the details shown on the contract drawings.
- 2 Wire rope barriers shall consist of either two or four, tensioned, galvanised, steel-wire ropes. The type of system to be specified shall be as shown on the contract drawings.
- 3 Four wire rope barriers shall consist of two upper ropes located in a slot at the top of the steel posts and two lower ropes interwoven along the fence between each pair of ropes. The ropes shall be joined and tensioned by means of screws at the designated intervals.
- 4 The ends of the ropes shall be attached to anchor blocks and embedded in the ground. Steel posts may be located in the ground either as driven posts or in concrete footings. In the case of any obstruction, the Contractor shall propose an alternative steel post, surface mounted to the equivalent of strain. Steel posts shall be removable and replaceable.
- 5 The supply and installation of steel wire safety fence barriers is to be carried out in accordance with BS 6579, except as modified herein.

10.2.2 Component Ropes

- 1 Component ropes shall consist of steel wire ropes fitted with end terminals.
- 2 The rope shall be 19 mm diameter, 3 x 7 (fill) galvanised wire rope generally to BS 302: Part 1 with a minimum breaking force of 173.6 kN. All wire used in the rope shall be to EN 10264 galvanised normal duty. Various galvanised wire finishes may be used by agreement with the Engineer.
- 3 The rope shall be prestressed by applying a cyclic loading until all initial extension has been removed. After prestressing the rope will exhibit a minimum modulus of elasticity of 8300 kg/mm² based on an area of 283 mm².
- 4 The complete component rope shall have terminals, one end right-hand thread and the other left-hand thread.
- 5 The fittings shall be attached to the rope whose length measured over the extreme ends of the threaded portion of the fittings shall be 153.35 m, -0/+25 mm. Other special lengths of rope with identical construction may be detailed as necessary for specific applications.
- 6 All threaded terminals shall be made from steel to BS 970: Part I Grade 65SM13 and either cadmium plated to ISO 2081 & ISO 2082 class B or alternatively galvanised to ISO 1461.
- 7 A test will be carried out to destruction on a threaded terminal test piece consisting of a terminal and a length of rope such that the minimum test length is 600 mm. This assembly shall have a minimum breaking force of 164.6 kN.

10.2.3 Tail Rope

- 1 Tail ropes shall be short lengths of rope fitted with threaded terminals at both ends that are used to connect component ropes to anchors. Tail ropes shall be supplied to the site prefabricated.

- 2 Tail ropes are of identical construction and specification to the component ropes but of different overall length. These ropes must also be prestressed.
- 3 The length of the fitted rope measured over the extremities of the threaded portions of the screwed terminals shall be 6 m ± 10 mm.
- 4 Tail ropes shall be terminated in one of two ways using identical terminals to those specified for component ropes: with right-hand terminations on both ends, or with a right-hand at one end and a left-hand termination at the other.

10.2.4 Safety Check Rope

- 1 Safety Check Ropes are steel wire ropes fitted with end terminations. The rope itself shall be 8 mm diameter 6 x 19 (9/9/1) IWRC galvanised wire rope to BS 302 with a minimum breaking force of 40.3 kN. All wires used in the rope shall be to EN 10264 grade normal duty, galvanised to class 'A' finish.
- 2 The rope shall have a galvanised heart-shaped thimble to EN 13411-1 capable of accepting a 38 mm diameter pin fitted by using a pressed ferrule on one end and a forked terminal on the other end.
- 3 The length of the rope between the centre of the 38 mm pin hole and the 9 mm pin hole shall be 1.8 m –0/+20 mm.

10.2.5 Posts

- 1 There are three types of posts with variations for embedded style or surface mounting: line, deflection and surface.
- 2 All posts shall be manufactured from 6 mm section cold rolled mild steel plate to EN 10025 grade Fe 50A, having a minimum yield strength of 355 N/mm². All posts shall be galvanised to ISO 1461. Dimensions and tolerances of the types of posts shall be as designated.
- 3 Post foundations and anchor blocks shall be as per the dimensions and details designated by the supplier.

10.2.6 Anchorage Frames

- 1 A range of anchorage frames must be available for various locations and applications. These are: on the median, verge and for end/intermediate and embedded/surface mounted fixings. The anchorage frames shall comply with the requirements of clause 4.3 of BS 6579.
- 2 End anchorage frames shall be constructed from weldable structural steel as defined in EN 10025 Grade Fe 430A with steel plate to section 4, and steel bar to section 6. Rolled steel channel to BS 4. All materials shall be galvanised to ISO 1461.
- 3 Intermediate anchorage frames are double sided frames. All materials and finishes shall be as defined above.
- 4 The intermediate anchor frames may be surface mounted.

10.2.7 Other Components

- 1 Sockets for post foundation shall be constructed from 3 mm steel to EN 10025 Grade Fe 430A. Galvanised to ISO 1461.
- 2 Excluders shall be produced from high-density polyethylene type iii class C Cat 4, ASTM D 1248

- 3 Rigging screws shall be used to connect component ropes together and component to tail ropes. The rigging screws shall be the body of a rigging screw manufactured to BS 4429. Except for the threads which are to be right and left hand M24 x 3-7H. Each rigging screw shall be hot dipped galvanised to ISO 1461.
- 4 Steel pins used in the fork terminal on the safety check rope shall be made from BS 970 Grade 045M10.
- 5 Split cotter pins shall be in stainless steel 2.5 mm x 16 mm to BS 4320 and shall have a retaining pin.
- 6 Nuts used to secure the threaded rope terminal to an anchor frame shall be M24 thread in zinc electroplated condition. Steel washers shall be M 24 to BS 4320 and fitted over the threaded terminal and between the nut and anchor frame.
- 7 Locating hooks shall be made in stainless steel to BS 970 Part I. Nuts (for hooks) shall be M6 to BS 3692 Grade A2.
- 8 Caps for posts shall be high-density polyethylene Type III class c cat 4, ASTM D 1248
- 9 Ordinary thimbles shall be size 9, fitted to safety check rope made to EN 13411-1.
- 10 The fork terminal shall be fitted to the safety check rope shall be made to BS 970 Grade 45 M10.
- 11 All ropes, terminals, rigging screws, posts and anchor frames are to be clearly marked with the manufacturers identification and the date of manufacture and the standard of construction.

10.2.8 Installation

- 1 Steel wire ropes safety fences shall not be used where
 - (a) the length of fence at full height would be less than 37.5 m
 - (b) on horizontal kerb at radius less than 600 m
 - (c) on vertical sag curves of radius less than 300 m
 - (d) on medians having a width of less than 3.14 m
 - (e) where the height of any kerb at the edge of the adjacent surface exceeds 100 mm
 - (f) where high mast lighting columns are situated within 10m of the edge of the paved surface
 - (g) where the fence has to be connected to any other fence or building
- 2 All components shall be suitably protected and supplied in packaging that prevents any permanent damage particularly to threaded components. Damage to metallic coating shall be prevented by appropriate means. Any damage found on inspection prior to installation shall be made good to the satisfaction of the Engineer.
- 3 Component ropes and tail ropes shall be supplied on reels with a bar of diameter not less than 450 mm.
- 4 Ropes shall not be twisted or kinked.
- 5 Driven line posts shall be installed to the alignment and level shown on the drawing without damage to the slot on the top of the post.
- 6 The top of the post shall be capped with a black polypropylene excluder.

- 7 The length of the line rope between any two adjacent anchors shall be not greater than 627m.
- 8 Tensioning between any two limits shall not proceed until the Engineer is satisfied that each limit is anchored sufficiently securely to resist the load effects due to tensioning.
- 9 The tension shall be measured using a device approved by the Engineer.
- 10 The ambient air temperature shall be noted at the time of tensioning and adjusted as follows;

<u>ROPE TENSION kN</u>	<u>AMBIENT TEMPERATURE °C</u>
14.00	45
16.75	40
19.50	35
22.25	30
25.00	25
27.75	20
30.50	15
33.25	10
36.00	5

10.3 TENSIONED CORRUGATED BEAM SAFETY FENCE

- 1 Except as modified herein, tension corrugated beam safety fences shall comply with the DTP Manual of Contract Documents for Highway Works Specification - Volume 1, specification series 400.
- 2 Tensioned corrugated beam safety fences are for use on high speed roads at the road edge or on the central median in one of the following forms:
 - (a) Single sided for road edges.
 - (b) Double sided for medians.
 - (c) Dual single sides for medians .
- 3 In the event of an accident, the support post shall give away while the safety fence remains in tension absorbing the impact energy while protecting the traffic on the opposite carriageway. The angle of deflection shall be reduced and as the vehicle decelerates it shall be redirected towards the carriageway.
- 4 The barrier shall consist of a strong corrugated steel beam section mounted and tensioned on steel universal posts. End posts shall be set in concrete and intermediate posts can be driven, pre-augered or set in concrete.
- 5 Surface mounted posts may be used where there are obstructions. In all cases the end posts which are attached to barriers must be set in concrete.
- 6 The layout and the positioning of the barrier shall be as shown on the contract drawings. The details and sizes and spacing of the various components shall be as shown on the contract drawings.
- 7 The height of the centreline of the barrier shall be 610 mm above the edge of the carriageway unless shown otherwise on the contract drawings.
- 8 There is no maximum length for installation. Where the line of the barrier is interrupted for an obstacle or gap, additional end anchorages shall be provided.

- 9 Where a barrier protects an individual short obstacle the barrier should extend from at least 30 m in front of the obstacle to at least 7.5 m or more beyond it. A minimum clearance behind the barrier shall be allowed for deflection based on requirements of EN 1317.
- 10 Circular installations shall be at a radius of not less than 120 m. Tighter radii than this shall not be used without the written approval of the Engineer.
- 11 Tensioners shall consist of two longitudinal bulbs installed in brackets and shall be positioned in intervals along the barrier and bolted to the corrugated beam.
- 12 Beams shall be connected by lap joints using screws nuts and washers. Beams shall be spliced by lapping with the edge facing away from the direction of traffic. Longitudinal clearance between screws and slotted holes in the beams shall be removed by prising apart the beams. The nuts shall be tightened to a torque approved by the supplier.
- 13 Tensioning between any two limits shall not proceed until the Engineer is satisfied that each limit is anchored sufficiently securely to resist the load effects due to tensioning. Tensioning shall be carried out strictly in accordance with the system manufacturer's recommendations. Adjustments to the tensioning shall be made for the ambient temperature at the time of tensioning strictly in accordance with the system manufacturer's recommendations.
- 14 The beam shall be completely formed, punched with holes for mounting and splicing and ready for assembly when delivered. It shall be uniform corrugated section straight or curved sections, galvanising shall be carried out after fabrication and each element and end sections shall be marked at the point of fabrication with the manufacturer's name or trade mark, gauge and heat (steel batch) number and with the coating lot referenced.
- 15 The barrier system shall be supplied with all required terminals and approach flares for the particular installation situation.
- 16 Safety barriers shall be erected to present a flowing alignment, with the alignment in plan not more than ± 30 mm from the prescribed alignment and no deviations in a 10 m length by more than ± 15 mm from the prescribed alignment. The height of the beam shall not depart from the prescribed height by more than ± 30 mm nor deviate in any 10 m length from the prescribed height by more than ± 10 mm.

10.4 UNTENSIONED CORRUGATED SAFETY FENCE

- 1 Untensioned corrugated safety fences shall meet the requirements of the tensioned corrugated safety fence except as modified herein and the fence shall not be tensioned.
- 2 Untensioned corrugated safety fences can be used in low-speed situations to prevent vehicles crossing median and for protection at the verge.
- 3 Beams shall be shaped so that there are no sharp edges protruding into traffic. Beams shall be connected by lap joints made in the direction of the traffic flow. The beams shall be formed from a 3 mm steel strip to give a corrugated cross-section. On curves less than 45 m radius, the beam shall be provided in preformed curves, internal or external, without any reduction in strength.
- 4 At terminations, the end rails shall be sloped down at a slope of approximately 1 in 6 to terminate just above ground level. Anchorage shall be provided by an end post set in concrete. Unless otherwise designated the centreline of the beam shall be 610 mm above the edge of the carriageway or hard shoulder.

10.5 OPEN-BOX BEAM SAFETY FENCE

- 1 Open box beam safety fences shall meet the requirements of the DTP - Manual of contract documents for highway works - volume 1 specification series 400 except as modified herein.
- 2 The open-box beam barrier shall be used on high-speed roads where a stiffer barrier than the tensioned corrugated beam is required. The open-box barrier can be used for a double sided installation in a median.
- 3 The layout, positioning, post spacing and all dimensions of the system shall be as designated.
- 4 The systems shall comprise a main traffic section rail element with a traffic face 150 mm wide. This shall be ground mounted on relatively weak Z-section posts or with hexagonal energy absorbing brackets bolted to a reinforced concrete wall or bridge pier. The traffic face shall be set to a height of 610 mm at the centreline of the rail.
- 5 There is no limit to the length of the installation, but end rails shall be taken down to ground level and bolted to end posts to form anchors which are set in concrete.
- 6 Where the installed barrier exceeds 100 m in length, expansion joints are to be inserted in the main rail.
- 7 The standard section length shall be 4.8 m unless otherwise designated, and this value shall be used on curves of radii down to 335 m.
- 8 For radii between 335 m and 107 m special fish plates shall be used.
- 9 For radii between 107 m and 50 m, 2.4 m rail lengths shall be used with special fish plates.
- 10 Z-section intermediate posts shall be connected to the main rail by shear bolts and clamp plates into the back of the rail section.
- 11 Rail sections shall be butt jointed together connected by fish plates and bolted in connection.
- 12 Where a non-standard situation arises in the use of the crash barrier, the supplier shall obtain recommendations from the UK Transport Research Laboratory.
- 13 In particularly hazardous locations where vehicles with a high centre of gravity are in use, the open box barrier may be installed to a double height with two protective rails. The horizontal centreline of the second rail shall be positioned 1 m above the adjacent carriageway. The two box section rails shall be connected together with vertical straps or a single shear bolt in the centre of each connection of the rails to longer intermediate posts.

10.6 TENSIONED RECTANGULAR HOLLOW SECTION SAFETY FENCE

- 1 Tensioned rectangular hollow section safety fences shall be installed as designated. The position, layout dimensions and details shall be as designated.
- 2 The barriers shall be used where protection is required for bridge piers lighting columns and other obstructions.
- 3 The size of the rectangular hollow section shall be 100 mm wide x 100 mm high or 100 mm wide x 200 mm high.
- 4 The minimum recommended curve for the barrier shall be 120 m radius. Tensioners shall be fitted at a maximum spacing of 70.5 m and the first tensioner shall be within 50 m of the anchorage.

- 5 When supplied the system shall include a detailed packing list with each component referenced and clearly marked to the standard of manufacture and the manufacturer's name and date of manufacture.

10.7 MARKERS FOR BARRIERS

- 1 To ensure that the vehicle crash barriers are clearly delineated, reflectorized markers shall be fixed to the barriers. The work shall consist of the fabrication supplied and fixing of reflectorized markers to vehicle crash barriers and other road side obstructions.
- 2 Reflectorized markers shall consist of two retro-reflective faces of minimum area 4000 mm² on a weather proof durable backing capable of being fixed to the barrier. All metal fixings and fittings shall be galvanised or stainless steel and approved by the Engineer.
- 3 Reflectorized faces shall consist of a minimum of 210 glass beads set in a 3 mm thick tough durable plastic backing. The two faces of the marker shall be of the colour specified in the Qatar Traffic Manual unless shown otherwise in the drawing or instructed otherwise by the Engineer.
- 4 Reflectors shall be fixed to safety barriers and other structures where designated. Stainless steel fixings complying with ISO 3506 grade A4 shall be used to attach markers to concrete. Plastic isolation washers shall be used if the marker is galvanised.

10.8 CRASH CUSHIONS AND TERMINALS

- 1 Where designated, permanent or portable energy absorbing terminal systems shall be provided for protection of traffic as shown on the drawings.
- 2 Proposed systems shall have a proven record of satisfactory performance of at least five years in a number of locations.
- 3 The system shall be able to withstand head on and side impacts within the specified design criteria. The system shall have the performance characteristics of a conventional metal beam guard rail for strength durability and redirectional properties.
- 4 All of the components and materials of the system shall be suitable for use in the climatic conditions of Qatar and shall not be liable to damage or deterioration in high temperatures or by prolonged exposure to direct sunlight.
- 5 The system shall be such that most major components can be reused after a typical impact.
- 6 All metal work used in the system shall be galvanised or stainless steel.
- 7 All concrete used in the system shall meet the requirements of Section 5.
- 8 No work or fabrication of the system or ordering of the materials shall be carried out until the Engineer has given formal approval in writing to the Contractor's detailed submission.

10.9 VEHICLE BARRIER UNITS (VBU)

- 1 Vehicle barrier units and their foundations shall be as per the details and dimensions shown on the drawings.
- 2 Vehicle barrier units shall be mass concrete of grade C25
- 3 The barriers shall be cast in-situ in nominal 6 m length units unless designated otherwise.
- 4 All the concrete materials and procedures including any steel reinforcement for the barriers shall comply with Section 5.
- 5 Forms shall be smooth and tight-fitting which can be held rigidly to the line and grade during the placing of concrete.

- 6 At the option of the Contractor, the barriers may be precast in sections not exceeding 6 m in length. In such cases the barrier shall be reinforced to ensure that information technology can be safely handled and have 2 no. lifting eyes of galvanised steel cast in at the top. The method of casting, handling and placing of barrier sections shall be proposed by the Contractor for approval by the Engineer.
- 7 The joints between the barriers shall be as per the details shown on the drawings.
- 8 Vehicle barrier units shall be cast onto blinding concrete laid onto compacted subgrade

10.10 TEMPORARY CONCRETE BARRIERS

- 1 Temporary concrete barriers shall be used for traffic management at road diversions or detours where there is slow moving traffic.
- 2 Temporary concrete barriers shall be as per the designated detailed dimensions. The barriers shall be either double or single sided.
- 3 The barriers shall be cast in nominal 6 m length units unless otherwise designated.
- 4 Each barrier shall have cast in at the top two lifting eyes of galvanised steel.
- 5 Where adjacent barriers are put together two galvanised steel wire eyes shall be cast in to the ends to allow a steel pin to be placed through the eyes and into the road surface to secure the barrier laterally.
- 6 The Contractor shall propose the reinforcement in the precast barriers which shall be adequate to resist the forces and moments induced during lifting and handling.
- 7 All the concrete work including any steel reinforcement for the barriers shall comply with Section 5 of this specification.
- 8 The method of casting, handling and placing of barrier sections shall be proposed by the Contractor for approval by the Engineer.

10.11 ALUMINIUM BRIDGE PARAPET

- 1 The aluminium alloy parapets for installation on the bridges and retaining walls shall be designed to the requirements of EN 1317 "Highway parapets for bridges and other structures. Part 1. Specification for vehicle containment parapets of metal construction".
- 2 The parapet shall be designed for normal level of containment as defined by the standard i.e. that required to resist penetration from the following vehicle's impact characteristics:

Vehicle	Saloon Car
Mass	1500 kg
Height of centre of gravity	600 mm
Angle of impact	2 degrees
Speed	113 km/h

- 3 The parapet proposed for use shall be a three rail system of an established design the prototypes of which have been subjected to full scale dynamic testing. The parapet design which shall therefore be considered exempt from further dynamic testing shall be taken from the list in Appendix G of EN 1317.
- 4 The parapets supplied to the project shall be certified by the supplier as a normal containment system complying with one of the following.

- 5 That it complies in all respects with the design of parapet that successfully met the requirements of Clause 26.1 or 26.5 (concerning dynamic testing) of EN 1317 as appropriate.
- 6 That any modifications that have been made to the tested design comply with Clause 26.6 or 26.7 of EN 1317 as appropriate.
- 7 The parapet construction materials shall be as follows:
- | | |
|-------------------|------------------------------------|
| Extruded sections | Aluminium alloy 6082-T6 to BS 1474 |
| Castings | Aluminium alloy LM6M to BS 1490 |
- 8 The finish of the parapets shall be high quality defect free mill finish and as cast finish for extrusions and castings respectively.
- 9 All aluminium welds shall confirm to EN 1011 and the requirements of EN 1317.
- 10 All setscrews and nuts are to be stainless steel to ISO 3506 material grade A4. Setscrews are to be strength class 80. Washer material is to be stainless steel to BS 1449: Part 2 conforming to grade A4 or A2 as defined in ISO 3506.
- 11 Rail attachment and rail joint screws are to be M12 x 30 long hexagon head each complete with one spring washer to BS 4464 type B, and one plain washer to BS 4320 form A.
- 12 Holding down bolts are to be M20 hexagon head bolts of sufficient length to give the engagement required in EN 1317.
- 13 Bottom mesh fixing screws if required, are to be to the M8 long hexagon head set screws each complete with one spring washer, two plain washers and one M8 nut where appropriate.
- 14 The holding down arrangement shall be in accordance with the requirements of EN 1317.
- 15 Loctite grade 270 (or similar approved) to be applied on erection to all rail joint and rail attachment setscrews. At the holding down bolts, contact between the stainless steel and aluminium baseplate shall be avoided by the use of a suitable "top-hat" insert manufactured from an inert material.
- 16 Underside of baseplates are to be given at least two coats of an alkali resistant bitumastic paint or pitch complying with BS 3416.
- 17 Mesh, if required, shall be 10 gauge welded steel wire in accordance with EN 1317, where appropriate. It may be galvanised, or any other finish as directed by the Engineer.
- 18 Rivets shall consist of Avdel drive rivets, code 5141 or 06 37 or similar approved. Where there is no substantial backing Avdel chrobert rivets, code 1125 06 13 with sealing pins code 1182 06 07 or similar approved, shall be used.
- 19 Full details of the proposed supplier with his technical specification in English covering materials, main dimensions and sizes shall be submitted to the Engineer for approval before the Contractor places an order.
- 20 Two copies of detailed shop drawings shall be submitted and the Engineer's approval obtained before manufacture is commenced.
- 21 During erection, parapets shall be securely held in their correct position until all connections and fastenings are complete and the post fixings have attained adequate strength to the Engineer's approval.
- 22 The finished parapets shall be true to line and level throughout their length.
- 23 Panels and members shall be free from twist, and posts shall be truly vertical.

END OF PART

ARAB ENGINEERING BUREAU