

SERIES 400
SAFETY FENCES, SAFETY BARRIERS
AND PEDESTRIAN GUARDRAILS

Contents

Clause	Title	Page
401	Performance Criteria for Safety Fences and Safety Barriers	2
402	Components for Safety Fences and Safety Barriers	4
403	Installation of Safety Fences	8
404	Site Testing	10
405	Tensioned Corrugated Beam Safety Fence (TCB)	10
406	Untensioned Corrugated Beam Safety Fence (UCB)	10
407	Open Box Beam Safety Fence (OBB)	11
408	Double Rail Single Sided Open Box Beam Safety Fence (DROBB)	11
409	Wire Rope Safety Fence (WR)	11
410	Tensioned Rectangular Hollow Section Safety Fences (RHS)	11
411	Concrete Safety Barriers	12
412	Pedestrian Guardrails	12

“The user’s attention is drawn to the requirements of the Interim Advice Note 44 (IAN 44) (latest revision). This Interim Advice Note provides information and guidance on changes to the provision and procurement process in relation to Road Restraint Systems to ensure compliance with the British Standard BS EN 1317.” (11/03)

SAFETY FENCES, SAFETY BARRIERS AND PEDESTRIAN GUARDRAILS

401 Performance Criteria for Safety Fences and Safety Barriers

Safety

1 (05/01) Safety fences and barriers shall comply with the following performance criteria:

Testing Criteria

- (i) On impact a safety fence or barrier shall contain and redirect a vehicle of 'A' kg mass travelling at a velocity of 'B' km/h at an angle of incidence of 'C' degrees to the fence or barrier.

Values of 'A', 'B' and 'C' shall be as follows:

- (a) Normal level of vehicle containment:

'A' = 1500 ±75 kg

'B' = 113 ±5 km/h

'C' = 20 ±1°

- (b) Lower level of vehicle containment:

'A' = 1500 ±75 kg

'B' = 80 ±5 km/h

'C' = 20 ±1°

- (c) Intermediate level of vehicle containment:

'A' = 10000 ±300 kg

'B' = 70 km/h +7%, -0%

'C' = 15 +1.5°, -1.0°

- (d) Higher level of vehicle containment:

'A' = 30000 ± 900 kg

'B' = 65 ±3 km/h

'C' = 20 ±1°.

The centre of gravity of the 1500 kg test vehicle prior to impact shall be 500 ± 30 mm above the ground.

- (ii) After impact, defined in (i) above, the vehicle shall be contained by the fence or barrier and be redirected in a stable manner, on to a path adjacent to the line of the fence or barrier. The vehicle shall be redirected so that no part of the vehicle crosses the line

drawn parallel with and 4.0 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 with the fence or barrier, in the direction of adjacent traffic flow. The vehicle shall neither turn on its side nor roll over.

- (iii) The lateral deflection of each type of fence or barrier shall be established as part of the type approval procedure.

Durability

2 Safety fences and barriers shall comply with the following durability criteria:

- (i) All components of a safety fence shall be designed to achieve a serviceable life of not less than 20 years and for concrete barriers 50 years, except for Temporary Vertical Concrete Safety Barriers where the nominal service life shall be not less than 10 years.

Type Approval

3 Only safety fences or safety barriers which have received type approval by the Overseeing Organisation shall be incorporated into the Works. The safety fences and barriers listed in Tables 4/1 and 4/2 and described in this Series and in the HCD: Section 2, have been approved by the Overseeing Organisation and are deemed to meet the performance criteria contained in this Clause. If the Contractor proposes to use a safety fence or barrier not listed in Tables 4/1 and 4/2 then he must first obtain type approval from the Overseeing Organisation.

TABLE 4/1: (05/01) Performance Testing Criteria for Safety Fences

Type of Safety Fence	Ref. Code	Single/Double Sided	Post Spacing m	Vehicle Mass kg	Vehicle Impact Speed km/h	Angle of Incidence Degrees
Tensioned Corrugated Beam (TCB)	TS1	Single	3.2	1500±75	113±5	20±1
Tensioned Corrugated Beam (TCB)	TS2	Single	1.6	1500±75	113±5	20±1
Tensioned Corrugated Beam (TCB)	TD1	Double	3.2	1500±75	113±5	20±1
Tensioned Corrugated Beam (TCB)	TD2	Double	1.6	1500±75	113±5	20±1
Untensioned Corrugated Beam (UCB)	US1	Single	3.2	1500±75	80±5	20±1
Untensioned Corrugated Beam (UCB)	US2	Single	1.6	1500±75	80±5	20±1
Open Box Beam (OBB)	BS1	Single	2.4	1500±75	113±5	20±1
Open Box Beam (OBB)	BS2	Single	1.2	1500±75	113±5	20±1
Open Box Beam (OBB)	BSB	Single on brackets fixed to structure	1.2	1500±75	113±5	20±1
Open Box Beam (OBB)	BD1	Double	2.4	1500±75	113±5	20±1
Open Box Beam (OBB)	BD2	Double	1.2	1500±75	113±5	20±1
Open Box Beam (OBB)	BDS	Double with spacers and stiffeners	2.4	1500±75	113±5	20±1
Double Rail Open Box Beam (DROBB)	DR1	Single	2.4	{ 1500±75 10000±300	{ 113±5 70+7%-0%	{ 20±1 15+1.5-1
Wire Rope (WR)	WR	Single/Double	3.2	1500±75	113±5	20±1
Tensioned Rectangular Hollow Section Beam (RHS) (100 x 100mm)	RH1	Double	3.2	1500±75	113±5	20±1
Tensioned Rectangular Hollow Section Beam (RHS) (200 x 100mm)	RH2	Single or Double	3.2	1500±75	113±5	20±1

402 Components for Safety Fences and Safety Barriers

General

1 Materials and fabrication of components and fittings shall be as described below, in the HCD: Section 2, in BS 6579 : Part 8, and as particularly identified and described in Appendix 4/1.

TABLE 4/2: (05/01) Performance Testing Criteria for Safety Barriers

Type of Safety Barrier	Ref. Code	Vehicle Mass kg	Vehicle Impact Speed km/h	Angle of Incidence Degrees
Permanent Vertical Concrete Safety Barrier	VCB	1500±75	113±5	20±1
Higher Permanent Vertical Concrete Safety Barrier	HVCB	30000±900	65±3	20±1
Temporary Vertical Concrete Safety Barrier	TVCB(80)	1500±75	80±5	20±1
Temporary Vertical Concrete Safety Barrier	TVCB(110)	1500±75	113±5	20±1
Temporary Higher Vertical Concrete Safety Barrier	THVCB	30000±900	65±3	20±1

Materials

2 (05/01) Materials used shall be as given below unless otherwise shown on the Drawings.

(i) Steel Main Components

Component Type	Material
Corrugated and open box beams	BS EN 10 025 Grade S275
'S' and 'Z' posts and plates	BS EN 10 025 Grade S275
'S' and 'Z' posts and plates for Wire Rope Safety Fence	BS EN 10 025 Grade S275 Note: Grade S355 for deflection and restraining posts
Rolled hollow sections	BS EN 10 210 Grade S275JO or S355JO Note: Grade S355JO for 100 mm x 100 mm beams in Rectangular Hollow Section (RHS) Safety Fence
Angles	BS EN 10 025 Grade S275, Section BS 4848: Part 4
Channels	BS EN 10 025 Grade S275, Section BS 4: Part 1
Reinforcement Bar	BS 4449 Grade 250 BS EN 10 025 Grade S275
Wire for component and tail ropes	BS 2763, 3 mm, Grade 1370
Wire for safety check ropes	BS 2763, Grade 1770

Tolerances on stock thicknesses of steel plate shall be Class C to BS EN 10 029.

(ii) For 'S' and 'Z' posts, defects occurring during fabrication such as edge laminations and minor cracks shall be repaired by grinding, welding and dressing.

(iii) Fittings:

- Bolts, screws and nuts shall, unless otherwise shown on the Drawings, comply with BS EN 24016, BS EN 24018 and BS EN 24034.
- Washers shall comply with Section 2 of BS 4320. The steel used for the manufacture of washers shall be cold rolled carbon steel strip CS4 complying with BS 1449 : Part 1.
- Stainless steel bolts, screws and nuts shall comply with BS 6105, Grade A4-80. The dimensions and tolerances of the bolts, screws and nuts shall comply with ISO 4016, 4018 and 4034.
- Stainless steel washers shall comply with BS 4320 and be made from stainless steel strip type 304 or 316 to BS 1449 : Part 2.
- For Wire Rope Safety Fences, component ropes and tail ropes shall be 3 x 7 (6/1) coreless construction

complying with BS 302 : Part 1. Safety check ropes shall be 6 x 19 (9/9/1) IWRC complying with BS 302 : Part 2.

(iv) Concrete:

- (a) Concrete in foundations and anchor blocks shall comply with Clause 2602 and be of the grade described therein.
- (b) Concrete and reinforcement for the Vertical Concrete Safety Barriers shall comply with the HCD: Section 2 and with Series 1700, and have a minimum characteristic strength of 50 N/mm² or 40 N/mm² if an air entraining agent is used.

Protective Finishes

3 (05/01) All components except stainless steel items, reinforcing rings and reinforcing bars shall be galvanized as described in Clause 1909 unless otherwise described below:

- (i) For Wire Rope Safety Fences, threaded terminals shall be galvanized in compliance with Clause 1909.
- (ii) For Wire Rope Safety Fences, component and tail ropes shall be Class A finally zinc coated in compliance with BS 2763. Safety check ropes shall be Class A finally zinc coated or drawn zinc coated in compliance with BS 2763.
- (iii) Coating weight on items other than in (ii) above shall comply with the following:

Items	Minimum average coating weight for any individual test area
Items of which all parts are 5.5 mm thick or over	610 g/m ²
Items of which any part is less than 5.5 mm thick	460 g/m ²
Bolts, screws, nuts, washers rigging screws, fork terminals and thimbles	305 g/m ²

- (iv) Bolts, screws, nuts and washers shall be centrifuged. Nuts shall be tapped up to 0.4 mm oversize after galvanizing and the threads shall be oiled. Small items such as connecting straps may be centrifuged but the coating weight shall comply with the minimum values specified in (iii) above.

Tolerances

- 4** (i) Fabrication tolerances shall be as shown on the Drawings. Components which are to be galvanized or metal coated shall be measured before galvanizing or metal coating.
- (ii) The tolerance on hole diameters shall be +1 mm, -0 mm.

Welding

- 5** (i) General. Arc welding of carbon manganese steels shall comply with BS 5135. Weld symbols shown on the Drawings are as described in BS 499 : Part 2. Welding shall not be used except where detailed on the Drawings. Processes other than arc welding shall be to the approval of the Overseeing Organisation.
- (ii) Procedures. Written welding procedures shall be used with testing to BS EN 288 : Parts 1, 2 and 3 and shall apply to all production and repair procedures. These shall be subject to reapproval after a period of seven years. When applying BS EN 288 : Parts 1, 2 and 3, the welding consumables and procedures used shall be such that the mechanical properties of deposited weld metal will not be less than the respective minimum specified values of the parent metal being welded. Approval shall be by an Independent Inspecting Authority using Registered Welding Engineers or Registered Welding Quality Engineers or equivalent. Testing shall be by a laboratory appropriately accredited by UKAS for weld testing.
- (iii) Welder Qualification. All welders shall be approved to BS EN 287 : Part 1. The tests shall include in addition an application test on transverse butt welds in beams. Welders carrying out fillet welds only may be approved to BS 4872 : Part 1. Approval shall be by an Independent Inspecting Authority using Registered Welding Engineers, Registered Welding Quality Engineers or Welding Inspectors certified by the Certification Scheme for Weldment Inspection Personnel (CSWIP) or equivalent. Testing shall be by a laboratory appropriately accredited by UKAS for weld testing.
- (iv) Production Inspection and Testing. The manufacturer shall provide suitable personnel to carry out inspection of

production welds as required in (a) to (c) below. Personnel conducting visual inspection shall have a nationally recognised certificate of competence appropriate to the type of welding being inspected. Personnel conducting non-destructive testing (NDT) shall be certified according to a nationally recognised certification scheme appropriate to the equipment used and the weld groups inspected. Evidence of training and qualification shall be retained and made available for examination when required. The results of all weld inspections shall be recorded.

(a) Visual Inspection. All welded joints, except those on driven posts, shall be subject to visual inspection in accordance with BS 5289 prior to any NDT and galvanizing. Welded joints on driven posts shall be visually inspected at a rate of 1 post per 20. Weld surfaces shall be free of slag residues and sharp edges. All surfaces shall be free of traces of weld spatter, arc strikes and contaminants. The apparent throat dimensions of butt welds and the apparent leg length and apparent throat dimensions of fillet welds, as measured by a welding gauge, taking into account any known lack of fit, shall not be less than those specified, except that local shortfalls up to 1 mm may be accepted, provided the average over any 50 mm length is not less than the specified dimension. The toe angle shall not be less than 90°. The surface of all welds shall be free from cracks, lack of fusion including overlap, and slag. Isolated discontinuous porosity may be accepted provided it is not detrimental to the galvanizing process. Undercut shall not result in a section loss of more than 5% over any 50 mm length of joint, nor shall its depth exceed 0.5 mm or 10% of the thickness, whichever is the less.

(b) Magnetic Particle Inspection (MPI) and Liquid Penetrant Inspection. MPI shall be applied in accordance with BS 6072 to joints selected in accordance with (d) below, where any of the material thickness exceeds 20 mm. Notwithstanding the requirements of (d) below, MPI or liquid penetrant inspection in accordance with BS 6443, shall be applied as appropriate where on

visual inspection the presence of cracking or lack of fusion may be suspected. To aid inspection, the profile of the weld may be dressed by burr grinding provided that the specified throat size and leg length is still maintained. The surface of the weld shall be free of cracks, lack of fusion and slag.

(c) Ultrasonic Testing. All butt joints in material 8 mm thick or greater selected in accordance with (d) below shall be ultrasonically tested in accordance with BS 3923. The weld shall be free of cracks. The height of buried slag, lack of fusion or lack of penetration shall not exceed 3 mm and within 6 mm of the outer surface their individual lengths shall not exceed 10 mm. The resulting net throat area loss over any 50 mm length of weld shall not exceed 5% of the specified throat area.

(d) Frequency of NDT. Joints shall be selected as follows:

All joints of each type up to a batch size of 10 components and 10% of additional components thereafter. If non-conformances are found the scope of NDT shall be doubled. If further non-conformances are found, the whole batch shall be tested.

(e) Reporting. Inspection records for production welds shall be retained by the manufacturer for three years and those covering the production periods relating to the components supplied shall be made available for examination.

(v) Destructive Testing. Copies of certified reports of destructive tests on components supplied under earlier contracts with the Overseeing Organisation shall be provided on request.

The Contractor shall supply components, or sample joints cut from components, for destructive testing. The basis of selection shall be as follows:

(a) For batches of less than 100 beam assemblies with transverse butt welds, 1 sample joint shall be supplied unless an identical sample joint from the same works has been destructively tested within the previous four weeks. For

batches exceeding 100 or more,
1 sample joint shall be supplied for each
subsequent sampling lot not exceeding
100.

- (b) Welded adjuster brackets shall be supplied at the rate of 1 for each sampling lot not exceeding 300.
- (c) Each type of driven post shall be supplied at the rate of 1 post for each sampling lot not exceeding 1000.
- (d) Each type of surface mounted post shall be supplied at the rate of 1 post for each sampling lot not exceeding 100.
- (e) Each type of anchor frame, parapet connection and connection piece shall be supplied at an interval not exceeding 6 months for each manufacturer's works.
- (f) Other welded components shall be supplied at an interval not exceeding 12 months for each manufacturer's works.

The acceptance criteria shall be as specified in (iv) above, except that in (iv) (a) above the throat and leg dimension of the weld shall apply to the true rather than the apparent dimension.

In the event that there is a non-conformance arising from a serious deviation in materials, preparation, assembly or welding procedure, the batch concerned shall be rejected and further production of the components affected stopped until such time as the fault has been corrected. A minor non-compliance shall only be accepted on the basis that further sampling and testing shows that the fault is not repetitive and will not in that instance impair structural integrity.

If the problem can be traced to a particular manufacturing period, operator, piece of equipment or batch of materials and if proper traceability to individual batches of components can be assured, only those batches affected may be subject to rejection.

The destructive test reports shall be retained by the manufacturer and recorded in a register for a period of three years. The destructive test samples shall be retained for a period of 18 months. These shall be made available for examination on future contracts with the Overseeing Organisation.

- (vi) Remedial Work. Welds which do not comply with the Specification may be repaired to an approved procedure, as described in (ii) above.

Marking

- 6 (i) (05/01) All components, including rope terminals and rigging screws but excluding fasteners, reinforcing rings and bars, shall be clearly and durably marked with the manufacturer's identification mark and digits indicating month and year of manufacture.
- (ii) In addition to the marking requirements of BS EN 20898, fasteners, except Items F18 and F19, shall be clearly marked with the following:
 - (a) safety fence manufacturer's identification mark;
 - (b) fastener number.

Workmanship and Testing

- 7 (i) All components shall be manufactured so as to permit the construction of safety fences or barriers within the tolerances described in sub-Clauses 403.2, 403.5 and 408.4. During fabrication of components any necessary straightening or forming shall be carried out so as not to deface or weaken the material and they shall be assembled in such a manner that they are not bent, twisted or otherwise damaged.
- (ii) All fabrication of components except wire ropes and threaded terminals for Wire Rope Safety Fences shall be completed before galvanizing or metal coating.
- (iii) The Contractor shall provide the Overseeing Organisation with evidence that the manufacturer of wire rope terminals has arranged for tensile tests to destruction to be carried out by a testing laboratory annually and whenever the production technique is changed. The test shall be carried out on a test piece of a Wire Rope Safety Fence consisting of a threaded terminal and a length of rope such that the minimum test length is 600 mm. The method of measuring the breaking load shall comply with BS 302 : Part 1. The minimum breaking load of component and tail ropes shall be 17.7 tonnes. The minimum breaking load of the rope fitted with the threaded terminal shall be 16.7 tonnes. For safety check ropes the minimum breaking loads shall be 4.1 tonnes and 3.9 tonnes respectively.
- (iv) The component ropes and tail ropes of Wire Rope Safety Fences shall be prestressed in the factory by applying a cyclic loading

which shall be continued until all initial extension has been removed, eg. the lower limit of cyclic loading may be 1.7 tonnes and the upper limit 8.9 tonnes. The rope shall exhibit a minimum modulus of elasticity of 8,300 kg/mm² (based on an area of 283 mm²) after prestressing.

Handling and Storage

8 (05/01) 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. Means shall be provided to avoid damage to galvanized coatings and any damage that does occur shall be made good in accordance with BS EN ISO 1461. Component ropes and tail ropes for Wire Rope Safety Fences shall be supplied on reels with a barrel diameter of not less than 450 mm. Ropes shall not be twisted or kinked.

403 Installation of Safety Fences

Overall Requirements

General

1 Installation shall be as described in this Series, in the HCD: Section 2, in BS 7669 : Part 3 and as particularly described in Appendix 4/1.

Layout

- 2 (i) The overall layout of safety fences and barriers shall be as described in Appendix 4/1.
- (ii) All safety fences and barriers shall be erected to present a flowing alignment and in accordance with the following:
 - (a) The overall alignment on plan of safety fences shall not depart from the prescribed alignment by more than ± 30 mm, nor deviate in any 10 m length from the straight or required radius by more than ± 15 mm.
 - (b) Beams and wire ropes shall be at the heights shown on drawings included in the HCD: Section 2.

Excavation for Concrete Foundations and Anchor Blocks

- 3 (i) Excavations for concrete foundations and anchor blocks shall have vertical sides.

- (ii) Where the side 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 mix ST1 concrete. Where such concrete is placed the outside face of the temporary casing shall be coated with a release agent in accordance with Clause 1708 and the casing either rotated or slightly moved to break the bond with the overbreak concrete 24 hours after its placing. Temporary casings shall be withdrawn carefully to minimise disturbance to the surrounding material. The maximum taper on temporary casings to facilitate withdrawal shall be 2°.
- (iii) Impermeable plastic sheeting 125 microns thick shall be laid at the base of in situ concrete post foundations located in filter drains.
- (iv) Precast concrete post foundations shall be installed on a firm and level base. Any lateral overbreak of the excavation shall be filled with mix ST1 concrete.

Concrete in Foundations and Anchor Blocks

4 In addition to the requirements of Clause 2602 concrete shall be compacted by internal vibration, and the curing period shall be not less than 4 days.

In the case of tensioned safety fences, the Contractor must ensure that the concrete has reached the specified 28 day characteristic compressive strength prior to any tensioning taking place.

Beams

5 Notwithstanding the manufacturing tolerances permitted for individual beams, the cumulative length tolerance shall be such that beams and posts can be positioned within 30 mm of their prescribed location and the requirements of sub-Clause 403.2 can be met. With the exception of any special closure pieces necessary to complete lengths of fencing, beam lengths shall not differ from those described in the HCD: Section 2.

Posts

6 Posts and foundations shall be of the types described in the HCD: Section 2, and as particularly described in Appendix 4/1 and shown on the Drawings. The radiused edge of all 'S' and 'Z' posts shall be presented to the adjacent traffic flow. Where posts are mounted in cast-in post sockets these shall be filled

where described in Appendix 4/1, after erection, with a non-setting passive filler to prevent the collection of water.

Cutting of Components

- 7 (i) (05/01) No drilling, cutting (including flame cutting) or welding of beams and posts will be permitted after galvanizing.
- (ii) Special closure pieces shall be fabricated before galvanizing.
- (iii) Damaged galvanizing and any areas of bare steel shall be made good in compliance with BS EN ISO 1461.

Assembly

8 Direct contact between dissimilar metals shall be avoided by interposing non-metallic sleeves, washers or coatings to prevent galvanic corrosion.

Anchorage and Attachment Systems for Surface Mounted Posts

- 9 (i) Unless otherwise described in Appendix 4/1, at least 4 weeks before installation, the Contractor shall submit to the Overseeing Organisation well attested and documented evidence that proposed anchorages and attachment systems in drilled holes, are capable of resisting the ultimate design tensile loads given in Table 4/3. Anchorages of an expanding type, other than undercut anchorages, shall not be used.

TABLE 4/3: Design and Test Loads for Safety Fence Anchorage and Attachment Systems in Drilled Holes

Nominated Post Section mm	Ultimate Design Tensile Load		Anchorage Tensile Test Load kN
	Anchorage kN	Attachment System kN	
100 x 32 x 6 (100 x 32 x 5) 110 x 49 x 5	65	55	40
125 x 90 x 6	125	100	75

Note: Loads are per bolt/stud.

- (ii) Steel anchorages and attachment systems shall be used for securing surface mounted posts to a concrete or steel base. Attachment systems shall use M20 bolts or studs as appropriate.

- (iii) For anchorages in drilled holes, the hole location shall be checked to ensure that the hole will be clear of reinforcement before drilling is carried out.
- (iv) Before installation of anchorages in drilled holes, the hole shall be sound, clean and dry and the tolerance of the hole shall be within the values given by the anchorage manufacturer.
- (v) Where surface mounted posts are to be installed on bridge decks, the anchorages shall include an internally threaded component to receive the attachment system ie. holding down bolt or stud. All parts of anchorages on bridge decks (where the anchorage is within 80 mm 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 316 S 31 or 316 S 33 to BS 970 : Part 1. Holding down bolts, studs and nuts on bridge decks shall be stainless steel grade A4-80 to BS 6105. Washers on bridge decks shall comply with BS 4320 and be made from stainless steel strip grade 316 S 31 or 316 S 33 to BS 1449 : Part 2.
- (vi) The threads of steel anchorages shall be lined with grease having a high resistance to creep and being suitable for hot or cold smearing. The grease shall provide protection to the threads for a minimum of either 18 months under cover or 6 months exposed on Site.
- (vii) Attachment systems shall be tightened to the appropriate torque and have the minimum thread engagement specified by the manufacturer of the system.
- (viii) Except where surface mounted posts are attached to a steel base they shall be bedded on mortar complying with Clause 2601. The bedding mortar shall have a minimum thickness of 10 mm and a maximum thickness of 30 mm.
- (ix) All voids in anchorages, attachment systems and base plates shall be filled with a non-setting passive filler to prevent the collection of water.

404 Site Testing

Anchorage in Drilled Holes

1 The Contractor shall carry out loading tests on anchorages in drilled holes. For the purpose of this sub-Clause the types of fixing referred to in Clause 1 of BS 5080 : Part 1 : 1993 shall include “anchorages”. Where anchorages are tested they shall be loaded incrementally in tension in accordance with BS 5080 : Part 1 : 1993 except that they shall be capable of resisting the test load given in Table 4/3 in lieu of testing to failure. 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 1.0 mm 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. A test rig deemed to be equivalent to that shown in BS 5080 : Part 1 : 1993 Figure 3 is contained in the HCD: Section 2, Series ATR 53.

3 The testing frequency shall be in accordance with Appendix 1/5. In addition, testing shall comply with any special requirements given in Appendix 4/1.

Post Foundations

- 4 (i) Where stated in Appendix 4/1, the Contractor shall provide the test equipment and carry out loading tests on post foundations. Testing shall be carried out as described in the HCD: Section 2 on Drawing Number PTE 09 (for TCB, OBB, WR and RHS post foundations) or Drawing Number PTE 10 (for UCB and DROBB post foundations). Details of test equipment are given on Drawing Numbers PTE 01 to PTE 08. The tests shall be carried out and the results submitted to the Overseeing Organisation on Form PTE (Revision A) at least one week prior to installation of the relevant lengths of fence, unless otherwise stated in Appendix 4/1.
- (ii) Where stated in Appendix 4/1, the Overseeing Organisation will provide the test equipment and carry out loading tests on post foundations installed by the Contractor for that purpose. The Contractor shall make available a vehicle of not less than 5 tonnes for the Overseeing Organisation's use while carrying out the tests.

- (iii) The Contractor shall install test posts and foundations after completion of the finished ground.
- (iv) On completion of loading tests the Contractor shall remove the test posts and foundations and make good the finished ground.
- (v) Where appropriate, the Contractor shall establish and maintain traffic safety and management measures complying with Clause 117 during installation, loading and removal of the test posts and foundations.

405 Tensioned Corrugated Beam Safety Fence (TCB)

Assembly and Tensioning

1 Tensioned Corrugated Beam Safety Fence shall be assembled and tensioned in accordance with BS 7669 : Part 3, Section 2.1.

2 Beams shall be connected by lap joints using M16 screws, nuts and washers as described in the HCD: Section 2, Drawing Numbers GA/11 to GA/13 and SF/00.

3 Tensioning between any two limits shall not proceed until each limit is anchored sufficiently securely to resist the load effects due to tensioning.

4 Tensioning shall be undertaken only when the ambient temperature is between 25°C and -5°C.

5 Adjuster assemblies shall be located not more than 70.5 m apart and each installation shall incorporate at least one adjuster assembly.

6 On completion of tensioning, the centre of each screw securing beams to posts shall be not closer than 25 mm $\pm$ 2 mm to the end of the slotted hole in the beam.

406 Untensioned Corrugated Beam Safety Fence (UCB)

Assembly

1 Untensioned Corrugated Beam Safety Fence shall be assembled in accordance with BS 7669 : Part 3, Section 2.2.

2 Beams shall be connected by lap joints using M16 screws, nuts and washers as described in the HCD: Section 2, Drawing Numbers GA/18, GA/19 and SF/00.

407 Open Box Beam Safety Fence (OBB)

Assembly

- 1 Open Box Beam Safety Fence shall be assembled in accordance with BS 7669 : Part 3, Section 2.3.
- 2 Beams shall be connected by butt joints using fish plates and M16 bolts, nuts and washers as described in the HCD: Section 2, Drawing Numbers SF/22 and SF/00. Fences shall be as described in the HCD: Section 2, Drawing Numbers GA/20 to GA/28.
- 3 An expansion assembly (detailed on Drawing Number SF/35) shall be provided at not more than 100 m spacing on all continuous lengths of open box beam fence exceeding 100 m overall length.

408 Double Rail Single Sided Open Box Beam Safety Fence (DROBB)

Assembly

- 1 Double Rail Single Sided Open Box Beam Safety Fence shall be assembled in accordance with BS 7669 : Part 3, Section 2.3.3.
- 2 Beams shall be connected by butt joints using fish plates and M16 bolts, nuts and washers as described in Appendix 4/1.
- 3 An expansion assembly (detailed on Drawing Number SF/35) shall be provided on each rail at not more than 100 m spacing on all continuous lengths of double rail single sided open box beam fence exceeding 100 m overall length.
- 4 Notwithstanding the manufacturing tolerance permitted for individual beams, and the tolerances described in sub-Clause 403.2, the cumulative length tolerance shall be such that the position of the upper beam joint is within ± 40 mm longitudinally of the lower beam joint.

409 Wire Rope Safety Fence (WR)

Assembly

- 1 Wire Rope Safety Fence shall be installed in accordance with BS 7669 : Part 3, Section 2.5.
- 2 Driven line posts shall be installed to the prescribed levels without damage to the slot in the top of the post.

Ropes

- 3 The ropes shall be installed to the layouts as shown in Appendix 4/1.

Tensioning

- 4 Tensioning between any two limits shall not proceed until each limit is anchored sufficiently securely to resist the load effects due to tensioning.
- 5 Tensioning shall be undertaken only when the ambient temperature is between 30°C and -10°C .
- 6 Before tensioning the ropes the ambient temperature shall be agreed with the Overseeing Organisation. The tension shall be measured using a tension indicating device approved by the Overseeing Organisation.
- 7 Before putting the safety fence into service the tension in each rope shall be checked and it shall be retensioned if necessary.

410 Tensioned Rectangular Hollow Section Safety Fences (RHS)

Beams

- 1 Beams shall be either 200 mm x 100 mm section mounted either on top of posts or on the side of posts or 100 mm x 100 mm section mounted on top of posts, as detailed on the Drawings. They shall be connected using internal steel plates, bolts and washers as detailed in the HCD: Section 2.

Assembly and Tensioning

- 2 Assembly and tensioning shall be carried out in accordance with BS 7669 : Part 3, Section 2.4.
- 3
 - (i) The installation shall be as detailed in the HCD: Section 2, Series RHS 47 and RHS 48.
 - (ii) Tensioning between any two limits shall not proceed until each limit is anchored sufficiently securely to resist the load effects due to tensioning and that the safety fence has been completely assembled and connected to the anchorages.
 - (iii) Tensioning shall be undertaken only when the ambient temperature is between 10°C and 20°C .
 - (iv) Tensioner assemblies shall be located not more than 70.5 m apart and each installation shall incorporate at least one tensioner assembly.

411 Concrete Safety Barriers

1 (05/01) The Permanent Vertical Concrete Safety Barrier (VCB) shall comply with the details in the HCD: Section 2.

2 (05/01) The Temporary Vertical Concrete Safety Barrier (TVCB) shall comply with the details in the HCD: Section 2.

Where required in Appendix 4/1, the Contractor shall provide Temporary Vertical Concrete Safety Barrier units, and on completion of the Works, remove to the location stated therein.

Where Temporary Vertical Concrete Safety Barrier units are to be provided by the Overseeing Organisation, the Contractor shall remove the barrier units from, and return on completion of the Works to, the location stated in Appendix 4/1.

412 Pedestrian Guardrails

1 Pedestrian guardrails shall comply with BS 7818 and with any other requirements described in Appendix 4/2.