



**BS 1139 : Part 1 : 1982**

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# Metal scaffolding

## Part 1. Specification for tubes for use in scaffolding

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Echafaudages métalliques

Partie 1. Tubes pour échafaudages — Spécification

Metallgerüste

Teil 1. Spezifikation für Gerüstrohre

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## Foreword

This Part of BS 1139 is one of a series specifying requirements for the design, construction and testing of equipment for use in scaffolding and other temporary structures. It specifies requirements for steel and aluminium tubing of the type traditionally used in tubular scaffolding. Recommendations for the design of tubular scaffolding structures in aluminium and steel are given in BS 5973 and BS 5974.

This standard was previously published as sections two and five of BS 1139 : 1964. However, open jointed steel scaffold tube is not included in this revision. BS 1139 is now being published in separate Parts as follows and, on

publication of Parts 1 to 4, BS 1139 : 1964 will be withdrawn.

Part 1 Specification for tubes for use in scaffolding

Part 2\* Specification for couplers, fittings and accessories for use in tubular scaffolding

Part 3\* Specification for prefabricated access and working towers

Part 4 Specification for prefabricated steel splitheads and trestles

Further Parts will be added as the need arises.

British Standard

# Metal scaffolding

## Part 1. Specification for tubes for use in scaffolding

### Section one. General

#### 1. Scope

This British Standard specifies requirements for the material, dimensions and method of manufacture of welded and seamless steel tubes and extruded aluminium tubes for use in scaffolding. It specifies one grade of material and one range of dimensions for each.

Appendix A describes a bending test for steel scaffold tubes. Appendix B describes a method for assessing the continuity of the zinc coating on hot-dip galvanized steel scaffold tubes. Appendix C describes a drift expanding test for extruded aluminium scaffold tubes.

#### 2. References

The titles of the standards publications referred to in this standard are listed on the inside back cover.

### Section two. Steel scaffold tubes

#### 3. Method of manufacture

Steel scaffold tubes shall be manufactured by a seamless or welded process. When tested in accordance with appendix A, a tube in its finished state shall show no sign of fracture or failure.

NOTE. This test procedure should be considered as being part of a quality control programme and the frequency of testing should be such as to ensure adequate quality control.

#### 4. Materials

**4.1 General.** The tube shall be manufactured from steel complying with the requirements of 4.2 and 4.3.

**4.2 Chemical composition (ladle analysis).** The chemical composition of the steel shall be as follows:

- C 0.20 % max.
- Si 0.30 % max.
- P 0.060 % max.
- S 0.060 % max.

**4.3 Mechanical properties of the tube.** The mechanical properties of the tubes shall be as follows:

- tensile strength ( $R_m$ ) 340 N/mm<sup>2</sup> to 460 N/mm<sup>2</sup>
- yield strength ( $R_e$ ) 210 N/mm<sup>2</sup> min.
- elongation (A) on a gauge length,  $L_o$ , of  $5.65 \sqrt{S_o}^*$  22 % min.

#### 5. Dimensions and tolerances

The dimensions and tolerances for welded and seamless steel tubes shall be as given in table 1.

**Table 1. Dimensions and tolerances for welded and seamless steel tubes**

| Dimensions and mass                                     | Tolerance                                                              |
|---------------------------------------------------------|------------------------------------------------------------------------|
| Outside diameter 48.3 mm                                | ± 0.5 mm                                                               |
| Thickness 4.0 mm                                        | Welded tube + 0.8 mm<br>- 0.4 mm<br>Seamless tube ± 0.5 mm             |
| Nominal mass per unit length 4.37 kg/m (48.3 mm × 4 mm) | Single tube max. reduction 7.5 %<br>Quantities of 150 m and over ± 4 % |
| Length if specified exact                               | ± 6.0 mm                                                               |

NOTE. The following values for the properties of steel scaffolding tubes of the dimensions specified in table 1 are given for information purposes only. Details of the maximum permissible stresses are given in BS 5973.

|                                           | Symbol | Value                |
|-------------------------------------------|--------|----------------------|
| Cross-sectional area                      | A      | 5.57 cm <sup>2</sup> |
| Second moment of area (moment of inertia) | I      | 13.8 cm <sup>4</sup> |
| Elastic modulus                           | Z      | 5.70 cm <sup>3</sup> |
| Radius of gyration                        | r      | 1.57 cm              |

#### 6. Workmanship

A tube shall not deviate from a straight line by more than 1/600 of its length, measured at the centre of the length.

Tubes shall be free from cracks, surface flaws, laminations and other detrimental defects. The ends shall be cut cleanly and square with the axis of the tube.

#### 7. Finish

This standard does not specify that scaffold tubes need to have a particular surface finish but if galvanized tubes are specified, the galvanizing shall comply with the requirements of clause 8.

NOTE. It is recommended that, if no other finish is specified, scaffold tubes should be varnished externally throughout their length with the manufacturer's normal mill varnish.

\* $S_o$  is the original cross-sectional area of the gauge length.

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**8. Galvanizing**

**8.1 Quality of the zinc.** The zinc used for galvanizing the tubes shall comply with the requirements for grade Zn 4 as specified in BS 3436.

NOTE. BS 3436 specifies the following maximum percentages of impurities for grade Zn 4: lead 1.35 %, cadmium 0.15 %, tin 0.02 %, iron 0.04 %. The permissible maximum total of lead, cadmium, tin, iron and copper is 1.5 %.

**8.2 Appearance.** When assessed visually, the coating shall be uniform, adherent and without gaps in the layer of zinc. When tested in accordance with appendix B, the coating shall appear continuous and steel shall not be exposed at any point.

NOTE. The mass of zinc per unit area should be not less than 300 g/m<sup>2</sup>; this value applies to both the internal and external coatings.

The mass of zinc per unit area is not the subject of a check. It is accepted that because the hot-dip galvanizing process is used, and because of the dimensions of the tube, the mass per square metre is not normally less than the recommended minimum.

**9. Identification**

Any method of identification used shall not impair the performance of the tube.

**Section three. Aluminium scaffold tubes****10. Method of manufacture**

Aluminium scaffold tubes shall be produced by extrusion, e.g. by means of a process using a mandrel, a bridge die or a porthole. When tested in accordance with appendix C, a tube in its finished state shall show no sign of an unsound weld.

NOTE. A tube with faulty welding will tend to exhibit a straight line, rather than jagged, fracture at the position of the weld.

This test procedure should be considered as being a part of a quality control programme and the frequency of testing should be such as to ensure adequate quality control.

**11. Materials**

**11.1 General.** The tube shall be manufactured from aluminium complying with the requirements of 11.2 and 11.3.

**11.2 Chemical composition.** Tubes shall be extruded aluminium tubes complying with the requirements for alloy 6082-TF (formerly HE30-TF) as specified in BS 1474.

NOTE. As these tubes are heat-treated, heat should not be applied to them by welding, flame cutting, etc., unless this is carried out under the controlled conditions recommended in CP 118.

**11.3 Mechanical properties.** The mechanical properties of the tubes shall be as follows:

|                                                        |                            |
|--------------------------------------------------------|----------------------------|
| tensile strength ( $R_m$ )                             | 295 N/mm <sup>2</sup> min. |
| yield strength ( $R_e$ )                               |                            |
| (0.2 % proof stress)                                   | 255 N/mm <sup>2</sup> min. |
| elongation ( $A$ ) on a gauge length, $L_0$ , of 50 mm | 7 % min.                   |

**12. Dimensions and tolerances**

The dimensions and tolerances for aluminium tubes shall be as given in table 2.

**Table 2. Dimensions and tolerances for aluminium tubes**

| Dimensions and mass                                          | Tolerance                                                              |
|--------------------------------------------------------------|------------------------------------------------------------------------|
| Outside diameter 48.30 mm                                    | ± 0.5 mm                                                               |
| Thickness 4.47 mm                                            | ± 0.56 mm                                                              |
| Nominal mass per unit length 1.667 kg/m (48.30 mm × 4.47 mm) | Single tube max. reduction 7.5 %<br>Quantities of 150 m and over ± 5 % |
| Length if specified exact                                    | ± 6.0 mm                                                               |

NOTE. The following nominal values for the properties of aluminium scaffolding tubes of the dimensions specified in table 2 are given for information purposes only. Details of maximum permissible stresses are given in BS 5973.

|                       | Symbol | Value                |
|-----------------------|--------|----------------------|
| Cross-sectional area  | $A$    | 6.15 cm <sup>2</sup> |
| Second moment of area | $I$    | 14.9 cm <sup>4</sup> |
| Elastic modulus       | $E$    | 6.18 cm <sup>3</sup> |
| Radius of gyration    | $r$    | 1.56 cm              |

**13. Workmanship**

A tube shall not deviate from a straight line by more than 1/600 of its length, measured at the centre of the length.

Tubes shall be clean and free from detrimental defects.

The ends shall be cut cleanly and square with the axis of the tube.

**14. Finish**

Tubes shall be mill finished, i.e. without any surface treatment.

NOTE. For all normal purposes no painting or other surface treatment is required. Tubes likely to remain in contact with wet acid or alkaline materials, e.g. damp cement or lime renderings, need protection. Advice on suitable coatings can be obtained from the Aluminium Federation\*.

**15. Identification**

The method of identification used shall not impair the performance of the tube.

\*Aluminium Federation Ltd., Broadway House, Calthorpe Road, Five Ways, Birmingham, B15 1TN.

## Appendix A

### Bend test for steel scaffold tubes

The tests shall be carried out by using a tube bending machine and bending round a grooved former of the specified radius. Welded tubes shall be bent with the weld at 90° to the position of maximum bend. The tubes shall not be filled for this test.

(a) *Ungalvanized tubes.* When cold, bend the tube through an angle of 180° round a former having a radius at the bottom of the groove equal to six times the outside diameter of the tube. When the tube is at red heat, bend it through an angle of 180° round a former having a radius equal to three times the outside diameter of the tube. Check that no cracking has occurred.

(b) *Galvanized tubes.* When cold, bend the tube through an angle of 90° round a former having a radius at the bottom of the groove equal to eight times the outside diameter of the tube. Check that no cracking has occurred.

## Appendix B

### Method of assessing the continuity of the zinc coating

**B.1 Principle.** The continuity of the zinc coating is checked by immersing a test piece in a standard copper sulphate solution.

**NOTE.** This test only allows the continuity of the coating to be checked, and indications of its thickness or anti-corrosive qualities should not be assumed from it.

#### B.2 Reagent

**B.2.1 Copper sulphate pentahydrate solution** ( $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ ), fresh, pure and with a density not exceeding 1.17 g/ml at 20°C.

Prepare the solution by dissolving pure crystalline copper sulphate pentahydrate in the proportion of approximately 330 g to 1 litre of distilled water. Shake the solution with an excess of copper carbonate or copper hydroxide (about 1 g/l of solution) and filter or allow to stand before use. Use a minimum volume of 1200 ml for each series of four immersions.

#### B.3 Apparatus

**B.3.1 Container,** of a material that does not react with copper sulphate solution and with internal dimensions allowing a clearance of at least 25 mm between the container and the test piece.

**B.4 Test pieces.** Test pieces shall be selected from freshly galvanized new tubes and taken from current manufacture. They shall be 180 mm long and cut at least 25 mm from the end of the tube. A single test piece shall be used for each series of four immersions.

**B.5 Procedure.** Degrease the test piece using benzene, trichlorethylene or other suitable organic solvent, then rinse with distilled water and wipe clean with cotton wool or a clean cloth.

Subject each test piece to four successive total immersions in the copper sulphate solution, each immersion lasting for

1 min. After each immersion, wash and scrub the test piece under running water to remove the deposited copper, then dry it. Carry out the immersion and washing operations without interruption. Keep the solution at a temperature of  $20 \pm 2^\circ\text{C}$  during the test and use a fresh solution for each series of four immersions.

**B.6 Analysis of results.** After the final washing, the test piece shall not show, at any point more than 25 mm from either tube end, any adherent deposit of salmon-red coloured copper, indicating exposure of the steel.

When the zinc coating of the test piece is considerably oxidized, a copper deposit that cannot be removed by scrubbing may be apparent. A drop of hydrochloric acid solution (prepared by diluting 10 ml of hydrochloric acid ( $d = 1.14$ ) with 90 ml of distilled water) should be put on each of these areas. If no effervescence occurs, the deposit of copper is on exposed steel and the test piece shall be deemed not to comply with the requirements of this standard. If, however, strong effervescence occurs, it is due to the attack of the acid on the zinc which indicates that the steel has not been exposed.

## Appendix C

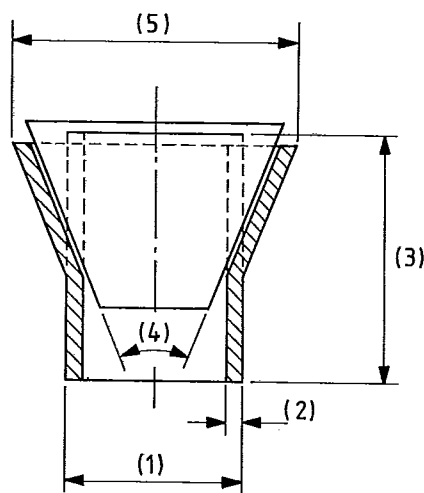
### Drift expanding test for extruded aluminium scaffold tubes

**C.1 Principle.** The end of a tube or test piece is expanded using a conical mandrel until it tears or splits.

The test is carried out at ambient temperature unless otherwise specified.

#### C.2 Apparatus

**C.2.1 Polished steel conical mandrel,** of adequate hardness and having a conical included angle of 30°, 45° or 60°.



#### Key

1. Outside diameter of tube or test piece
2. Thickness of wall of tube or test piece
3. Length of test piece
4. Conical angle of mandrel
5. Maximum external diameter of end of expanded tube

Figure 1. Arrangement of drift expanding test

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**C.3 Test piece.** The test piece shall consist of a piece of tube having a length equal to at least twice the external diameter of the tube. Both ends of the test piece shall be plane and perpendicular to the axis of the tube. The test piece shall be cleaned to remove any loose chips or dirt from the inside surface.

**NOTE.** The end to be tested is normally rounded by filing. However, a test piece with edges that have not been rounded is acceptable provided that the test result is satisfactory.

**C.4 Procedure.** Lubricate the mandrel so that it does not rotate in relation to the tube during the test. Force the conical mandrel under pressure into the open end of the test piece, so that the axis of the cone coincides with the axis of the test piece. Continue applying pressure until the tube tears or splits.

### Standards publications referred to

- |         |                                                                                                                   |
|---------|-------------------------------------------------------------------------------------------------------------------|
| BS 1474 | Wrought aluminium and aluminium alloys for general engineering purposes — bars, extruded round tubes and sections |
| BS 3436 | Ingot zinc                                                                                                        |
| BS 5973 | Code of practice for access and working scaffolds and special scaffold structures in steel                        |
| BS 5974 | *Code of practice for temporarily installed suspended scaffolds and access equipment                              |
| CP 118  | The structural use of aluminium                                                                                   |

\*Referred to in the foreword only.

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The following BSI references relate to the work on this standard: Committee reference CSB/46 Draft for comment 81/12458 DC

### Cooperating organizations

The Civil Engineering and Building Structures Standards Committee, under whose direction this British Standard was prepared, consists of representatives from the following:

- \*Aluminium Federation
  - Association of Consulting Engineers
  - Brick Development Association
  - British Precast Concrete Federation Ltd.
  - British Steel Corporation
- \*British Steel Industry
  - Cement and Concrete Association
- \*Concrete Society Limited
  - Consumer Standards Advisory Committee of BSI
  - Convention of Scottish Local Authorities
  - County Surveyor's Society
- \*Department of the Environment (Building Research Establishment)
- Department of the Environment (Housing and Construction)
- \*Department of the Environment (PSA)
  - Department of the Environment (Water Engineering Division including Water Data Unit)
- Department of Transport
- \*Federation of Civil Engineering Contractors
- \*Health and Safety Executive
- \*Institution of Civil Engineers

- \*Institution of Municipal Engineers
- Institution of Public Health Engineers
- \*Institution of Structural Engineers
- Institution of Water Engineers and Scientists
- London Transport Executive
- Ministry of Agriculture, Fisheries and Food
- \*National Federation of Building Trades Employers
- National Water Council
- Royal Institute of British Architects
- Scottish Development Department
- Timber Research and Development Association
- Trades Union Congress

The organizations marked with an asterisk in the above list, together with the following, were directly represented on the Technical Committee entrusted with the preparation of this British Standard:

- Association of Consulting Scientists
- Confederation of British Industry
- Construction Health and Safety Group
- Construction Industry Training Board
- Electricity Supply Industry in England and Wales
- Incorporated Association of Architects and Surveyors
- National Association of Scaffolding Contractors
- Prefabricated Aluminium Scaffolding Manufacturers' Association

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