
British Standard Specification for

Weldable structural steels

Aciers de construction soudables — Spécifications

Schweißbare Baustähle

Foreword

This British Standard has been prepared under the direction of the Iron and Steel Standards Policy Committee and is identical to BS 4360 : 1986 except for the deletion of A, B, C and D and 50 DD grades for plates, sections and bars together with any references to them in the text.

This standard, together with BS EN 10 025, supersedes BS 4360 : 1986, which is withdrawn. For hollow sections a separate EN is being prepared.

The European equivalents of the B, C and D and 50 DD grades are specified in BS EN 10 025 which is the English language version of EN 10 025 and is published simultaneously with this standard.

Work is going on in Europe to prepare standards covering fine grain steels (covering the E, EE and F grades of BS 4360 : 1986), hot finished hollow sections and weathering steels.

As these projects achieve European Standard status it is anticipated that the English language versions will be published as follows.

BS EN 10 113 Hot rolled products in weldable fine grain structural steels

Part 1 General delivery conditions

Part 2 Delivery conditions for normalized steels

Part 3 Delivery conditions for thermomechanically rolled steels

BS EN 10 210 Hot finished structural hollow sections of non-alloy and fine grain structural steels

Part 1 Technical delivery conditions

Part 2 Dimensions and sectional properties

BS EN 10 155 Weathering steels

BS EN 10 137 Plates and wide flats made of weldable fine grained structural steels in the quenched and tempered condition
Part 1 Technical delivery conditions
general requirements

It is anticipated that tolerances for plates, strip, wide flats, sections and bars will be part of a separate series of European Standards.

BS 4360 will consequently become smaller and smaller until eventually it will be withdrawn.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

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Specification

Section one. General

1 Scope

This British Standard specifies requirements for weldable steels for general structural and engineering purposes in the form of hot-rolled plates, strip, wide flats, flats and bars and for structural steel sections complying with BS 4848 : Parts 2, 4 and 5 and BS 4 : Part 1. However, in the case of hollow sections formed from plate and with the seams metal arc welded, this standard covers only the requirements for the plate material.

The products are equally suitable for bolted and riveted structures.

This standard applies to material supplied ex-mill or from merchant's stock (see clause 12).

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

2 Definitions

For the purposes of this British Standard, the definitions given in BS 6562 : Part 2 apply together with the following.

2.1 parent product. The product rolled from one piece of steel.

2.2 manufacturer. The manufacturer of the steel products.

2.3 supplier. The manufacturer for material supplied ex-mill, the merchant for material supplied from a merchant's stock (see clause 1).

2.4 purchaser. The purchaser or his representative.

2.5 controlled rolling. A generic term for rolling procedures in which the temperatures and deformation during rolling are controlled to achieve desirable material properties.

2.6 temperature controlled rolling (TCR). A rolling procedure in which the final deformation is carried out in the normalizing temperature range, resulting in a material condition generally equivalent to that obtained by normalizing.

2.7 thermo-mechanical controlled rolling (TMCR).

A rolling procedure in which significant deformation takes place at temperatures below the normalizing range permitting little, if any, recrystallization of austenite and conferring beneficial properties on the material. Unlike TCR, the properties conferred by TMCR cannot be reproduced by subsequent normalizing or other heat treatments.

3 General

The steel products shall comply with the general requirements of this standard and with the specific requirements applicable to the grade concerned. Where any of the options given in appendix B are called up at the time of the enquiry and order, the steel products shall, in addition, comply with the requirements of any such options.

4 Information to be supplied by the purchaser

4.1 General

The following information shall be supplied by the purchaser at the time of enquiry and order.

- (a) Details of the product form, dimensions and quantity.
- (b) The grade of steel (see tables 12, 14, 16, 18, 20 and 22).

4.2 Options

A number of options are specified in appendix B. In the event that the purchaser does not indicate his wish to implement any of these options and specify his requirements at the time of the enquiry and order, the supplier shall supply in accordance with the basic specification.

5 Steelmaking process

5.1 Process

The steel shall be made by any process except the Bessemer process.

See also option B.1.

5.2 Rimming steel

Rimming steel shall not be supplied.

6 Supply condition

NOTE. Purchasers who intend to re-heat any of the steels detailed in this standard over and above those levels implicit in preheating and/or welding in accordance with BS 5135 are advised to discuss the application and proposed re-heat treatment of the steel with the manufacturer.

6.1 Normal

The material shall be delivered in the supply condition given in tables 12, 14, 16, 18, 20 and 22 and the mechanical properties given in tables 13, 15, 17, 19, 21 and 23 refer only to material in the specified condition or alternative condition specified in 6.2. Where the supply condition is specified as rolled or hot finished, it is permissible for the manufacturer to normalize the material provided the specified properties are obtained after normalizing.

6.2 Alternative supply condition

It is permissible for the application of TCR to take the place of normalizing, except for reversing mill plates of sub-grade EE, at the supplier's discretion. In all cases the specified properties shall be obtained.

See also options B.2 and B.3.

NOTE. TCR material may be suitable for subsequent normalizing or hot forming in the normalizing temperature range since only slight deterioration of mechanical properties will occur. (See also note to clause 6.)

7 Chemical composition

7.1 Ladle analysis

The chemical composition of the steel shall be determined by ladle analysis and shall be as given in tables 12, 14, 16, 18, 20 and 22. The manufacturer shall supply details of the ladle analysis to the purchaser.

See also options B.4, B.5 and B.6.

7.2 Product analysis

Any product analysis carried out shall be determined on a test sample used for verification of the mechanical properties or from material at the location shown in appendix C or, if this is not possible, by sampling in accordance with BS 1837.

In the event of dispute, compliance with the standard shall be decided on the basis of an independent analysis using the methods described in BS Handbook No. 19.

The permitted deviations for product analysis and purchaser's check analysis shall be as given in table 1 and are applicable to the specified chemical composition limits given in tables 12, 14, 16, 18, 20 and 22.

Table 1. Permitted deviations in product analysis from specified ladle analysis percentages

Figure in parentheses refers to the note following this table.

Grade	Deviations from specified ladle analysis				
	C	Si	Mn	P	S
	%	%	%	%	%
40DD	0.03	-0 +0.05	0.10	0.010	0.010
40E	0.03	-0 +0.05	0.10	0.010	0.010
40EE	0.03	-0 +0.05	0.10	0.010	0.010
43C	0.03	-0 +0.05	0.10	0.010	0.010
43D	0.03	-0 +0.05	0.10	0.010	0.010
43DD	0.03	-0 +0.05	0.10	0.010	0.010
43E	0.03	-0 +0.05	0.10	0.010	0.010
43EE	0.03	-0 +0.05	0.10	0.010	0.010
50C	0.03	-0 +0.05	0.10	0.010	0.010
50D	0.03	-0 +0.05	0.10	0.010	0.010
50E	0.04	-0 +0.05	0.10	0.010	0.010
50EE (1)	0.04	-0 +0.05	0.10	0.010	0.010
50F	0.04	-0 +0.05	0.10	0.010	0.010
55C (1)	0.04	-0 +0.05	0.10	0.010	0.010
55EE (1)	0.04	-0 +0.05	0.10	0.010	0.010
55F	0.04	-0 +0.05	0.10	0.010	0.010
WR 50A	0.03	-0 +0.05	0.10	-0.005 +0.010	0.005
WR 50B	0.04	-0 +0.05	0.10	0.005	0.005
WR 50C (1)	0.04	-0 +0.05	0.10	0.005	0.005

(1) For hollow sections the deviation for carbon is 0.03 %.

The deviations, other than when maxima only are given in tables 12, 14, 16, 18, 20 and 22, shall apply either above or below the specified limits of the range, but not above and below for the same element from different sample products from the same cast. When maxima only are specified, the deviations shall only be positive. As indicated in table 1, this requirement shall not apply in the case of grade WR 50A in respect of phosphorus and all grades in respect of silicon. See also option B.7.

8 Weldability

All steels complying with this standard are of weldable quality. Welding procedures and consumables appropriate for the various grades and qualities shall be used.

NOTE 1. BS 5135 specifies requirements for the process of manual, semi-automatic, automatic and mechanized arc welding of carbon and carbon manganese steels with carbon equivalents not exceeding 0.54 %. For steels with carbon equivalents above 0.54 %, BS 5135 recommends that the steelmaker, welding consumable supplier or other appropriate authoritative source be consulted. It is further pointed out that for carbon manganese steels with low carbon contents (less than about 0.10 %) additional precautions and modified procedures may be required.

NOTE 2. If weather resistant steels are to be used unpainted, it is necessary to select processes which achieve at least equivalent weathering properties of the permanently exposed surfaces.

9 Quality of finished steel

9.1 Plates, strip and wide flats

9.1.1 Surface condition. The surface condition of plates, strip and wide flats shall comply with BS EN 10163 : Part 1 : 1991 and BS EN 10163 : Part 2 : 1991. Grades 50 and 55 shall comply with BS EN 10163 : Part 2 class A subclass 2.

9.1.2 Internal soundness

9.1.2.1 Where ultrasonic testing is not specified by the purchaser at the time of ordering, reversing mill plates and wide flats shall be deemed to comply with the internal soundness of grade LC1 of BS 5996.

NOTE. Unless specified by the purchaser at the time of ordering, there is no obligation on the supplier to carry out ultrasonic testing. Where design considerations require plates to comply with a minimum ultrasonic acceptance level (including grade LC1 of BS 5996), verification by ultrasonic testing should be carried out. This requirement should be indicated at the time of ordering and option B.26 called up when ultrasonic testing is to be undertaken by the supplier.

9.1.2.2 For plates and strip produced on continuous mills, the material shall be sound and free from such internal defects as might preclude its use for the purpose for which it is intended.

9.2 Sections, hollow sections, flats and round and square bars

9.2.1 Defects. The material shall be sound and free from such internal and external defects or surface flaws as might preclude its use for the purpose for which it is intended.

9.2.2 Correction of minor defects

9.2.2.1 Sections (other than hollow sections), flat and round and square bars

9.2.2.1.1 Sections (other than hollow sections). The surface condition shall comply with BS EN 10163 : Part 1 : 1991 and BS EN 10163 : Part 3 : 1991.

9.2.2.1.2 Flats and round and square bars. It is permissible for the supplier to remove minor defects by grinding. In all cases the thickness shall not be reduced locally by more than 4 % below the minimum otherwise allowed for ordered thickness by 17.1 of this standard and BS 4 : Part 1 (with a maximum removal of 3 mm) (see also 9.2.3).

9.2.2.2 Hollow sections. It is permissible for the supplier to remove minor surface defects by grinding to a remaining thickness of 12.5 % below the ordered thickness. In all cases the reduction below ordered thickness shall not exceed 3 mm. In no case shall the final outside dimension after grinding and, if appropriate, repair by welding in accordance with 9.2.4, be below the minimum allowed by BS 4848 : Part 2.

NOTE. Round and square bars intended for applications such as painting or cold heading may require a higher degree of freedom from surface imperfections which should be agreed between the purchaser and the supplier.

9.2.3 Additional procedure for flats. When the local reduction in thickness would be greater than 4 % or 3 mm, it is permissible for the supplier to remove surface defects by grinding. In all cases the thickness shall not be reduced locally by more than 7 % below the minimum otherwise allowed by BS 4 : Part 1 and BS 4848 : Parts 4 and 5.

See also option B.10.

9.2.4 Repair of flats and hollow sections by welding. It is permissible for the supplier to remove surface defects that cannot be corrected in accordance with 9.2.2 and 9.2.3 by grinding or chipping followed by welding subject to the following conditions.

(a) After complete removal of the defect and before welding, the thickness shall not have been reduced to less than 80 % of its nominal dimension.

(b) The welding shall be carried out in accordance with BS 5135 by competent operators approved to BS 4872 : Part 1 and the weld shall be ground smooth and flush with the adjacent surface of the product. The supplier shall follow documented welding procedures established in accordance with BS 4870 : Part 1 which are appropriate for the material being welded.

See also options B.8 and B.9.

NOTE. In certain applications repair by welding may not be appropriate or may require special inspection after completion. An example would be otherwise unwelded components of structures for which the choice of steel grade with respect to notch ductility would be determined by the presence or absence of welding or in which permissible stresses are limited by considerations of fatigue.

10 Identification of cast

The manufacturer shall identify the ingots, billets, slabs, plates, steel sections, bars, etc., in such a way as to enable the finished steel to be traced to the cast from which it was made or, for hollow sections rolled by the continuous process, the casts from which they were made.

11 Marking

Each piece or parcel of steel shall be legibly marked with the manufacturer's name or trade mark, and with cast number or identification marks by which the steel can be traced to the cast or casts from which it was made. In addition, the material shall be legibly marked with the grade number ringed with paint. When parcels of material are securely bundled, a tab attached to each bundle and marked as above shall be sufficient marking.

NOTE. It is recommended that in the case of weather resistant steels, the purchaser should consult the supplier concerning agreement to the method of marking to be used.

See also option B.11.

12 Test certificates

12.1 Manufacturer's supply

The manufacturer shall supply the purchaser with a test certificate endorsed by the manufacturer stating the process

of manufacture and giving the steel grade, ladle analysis and the results of each of the mechanical tests applicable to the material purchased. The certificate shall indicate the numbers or identification marks of the casts to which it applies, corresponding with the numbers to be found on the material supplied. In the case of sections with tapered flanges, the certificate shall indicate whether the sample for test purposes is taken from the web or flange.

12.2 Merchant supply

If any steel is supplied from a merchant's stock, the merchant shall satisfy the purchaser by means of numbers or identification marks on the steel or tab when parcels of steel are bundled, combined with a manufacturer's test certificate, that such steel has been tested and complies with all the requirements of this standard applicable to the material specified. If the merchant has altered the condition or dimensions of the steel in any way, it is his responsibility to ensure that the material he supplies still complies with this standard.

13 Mass of steel

The mass of steel shall be calculated on the basis that the steel has a density of 7850 kg/m³.

Section two. Specific requirements for dimensional and shape tolerances

14 Tolerances for plates and strip

Tolerances for plates and strip produced on continuous mills shall comply with BS 1449 : Section 1.6

Tolerances for plates produced on non-continuous mills shall comply with BS EN 10029. For thickness, class A tolerances as specified in BS EN 10029 shall apply unless otherwise specified at the time of the enquiry and order.

Table 2. *Table deleted*

Table 3. *Table deleted*

Figure 1. *Figure deleted*

Table 4. *Table deleted*

Table 5. *Table deleted*

15 Tolerances for wide flats

15.1 Length tolerances for wide flats

The length tolerances on ordered length for wide flats shall be $-0, +50$ mm.

The length of a wide flat shall be taken as the length of the largest rectangle contained within the wide flat.

See also option B.16.

15.2 Width tolerance for wide flats

The width tolerance on ordered width for wide flats shall be ± 2 % of the ordered width but shall not exceed ± 5 mm.

Width shall be measured at a distance not less than 150 mm from the end of the wide flat.

15.3 Thickness tolerances for wide flats

15.3.1 The thickness tolerances on ordered thickness for wide flats shall be as given in table 6.

Thickness shall be measured at a distance of not less than 15 mm from the longitudinal edges and not less than 100 mm from the ends of the wide flat.

The difference in thickness across the width of one transverse cross section shall be measured on a line running at right angles to the longitudinal edges.

See also options B.17, B.18 and B.19.

15.3.2 Additionally, the difference in thickness between dimensions a and d (see figure 2) in a transverse cross section shall not exceed the values given in table 7.

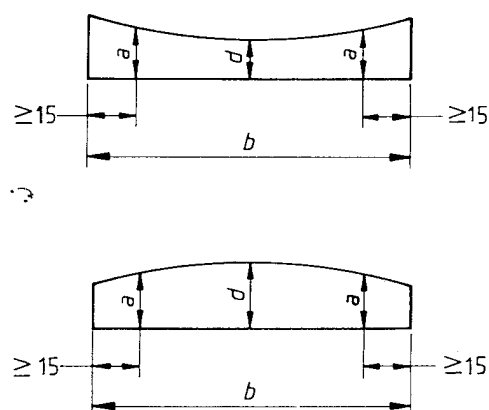
15.4 Edge camber tolerances for wide flats

The edge camber tolerances for wide flats shall be a normal straightness edge camber not exceeding 0.25 % of the length of the wide flat.

The edge camber value, C , shall be taken as the maximum deviation between one longitudinal edge and the straight line joining the two ends of this edge. It shall be measured on the concave edges of the wide flat (see figure 3).

The measuring points shall be at least 50 mm from the ends of the wide flat.

See also option B.20.



All dimensions are in millimetres.

Figure 2. Thickness across a transverse cross section of a wide flat

Table 6. Thickness tolerances for wide flats

Ordered thickness	Tolerances
mm	mm
4 to less than 10	± 0.5
10 to less than 20	± 0.6
20 to less than 25	± 0.7
25 to less than 30	± 0.8
30 to less than 40	± 0.9
40 to less than 50	± 1.0
50 to less than 60	± 1.1
60 to less than 80	± 1.3
80 and over	± 2.0

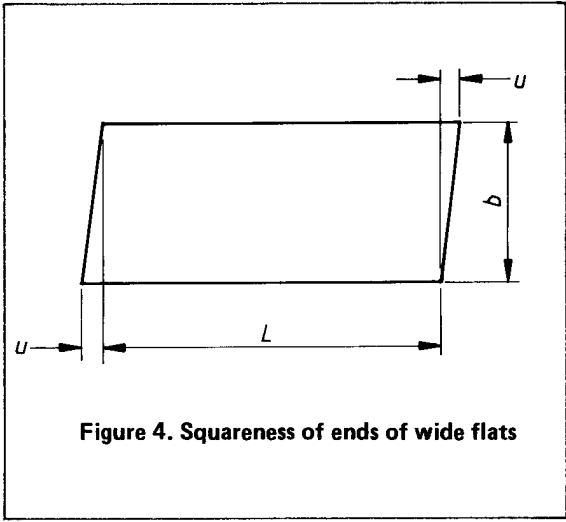
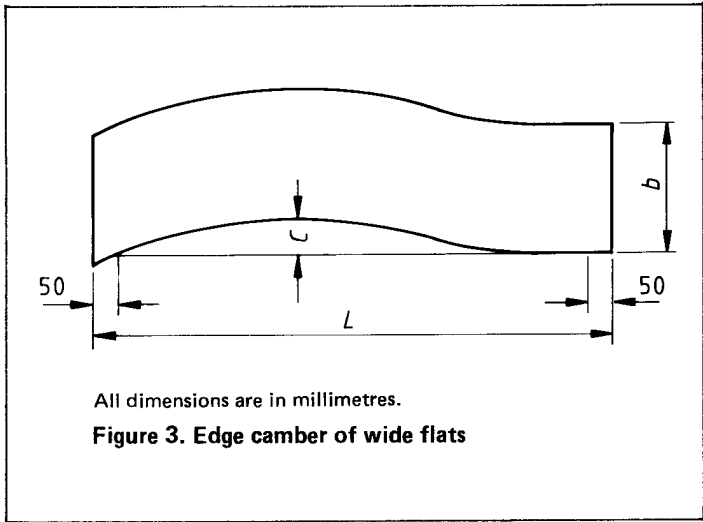
Table 7. Maximum difference in thickness in one transverse cross section for wide flats

Ordered width	Maximum difference in thickness between a and d
mm	mm
Over 150 up to and including 500	0.5
Over 500 up to and including 1 000	0.6
Over 1 000 up to and including 1 250	0.7

15.5 Squareness of ends of wide flats

The out-of-square value, u , shall be equal to or less than 1 % of the actual width of the wide flat, but shall not exceed 5 mm.

The value of u shall be taken as the orthogonal projection of one transverse edge over one longitudinal edge (see figure 4).



15.6 Angular accuracy tolerances for wide flats

The deviation for angular accuracy, w , (see figure 5) shall not exceed the value given in table 8.

Table 8. Angular accuracy tolerances for wide flats	
Ordered thickness	Tolerances
mm	mm
Up to and including 13	2.0
Over 13 up to and including 18	3.0
Over 18	3.5

15.7 Flatness tolerances for wide flats

Wide flats shall be supplied to a normal flatness tolerance. The deviation in the transverse direction shall not exceed 0.3 % of the width of the wide flat. The deviation in the longitudinal direction referred to a straightedge length of 1000 mm shall not exceed 7 mm.

In the case of a shorter measuring length of 500 mm up to but not including 1000 mm, the deviation shall not exceed 1 % of the measuring length.

To measure flatness, the wide flat, resting under its own weight, shall be placed on a flat horizontal surface. Deviations with respect to flatness shall be determined by measuring the distance between the wide flat and a straightedge which may be placed in the longitudinal or transverse directions. Only the portion situated between two points of contact shall be taken into consideration. Deviations shall be measured at a point a minimum of 200 mm from the ends.

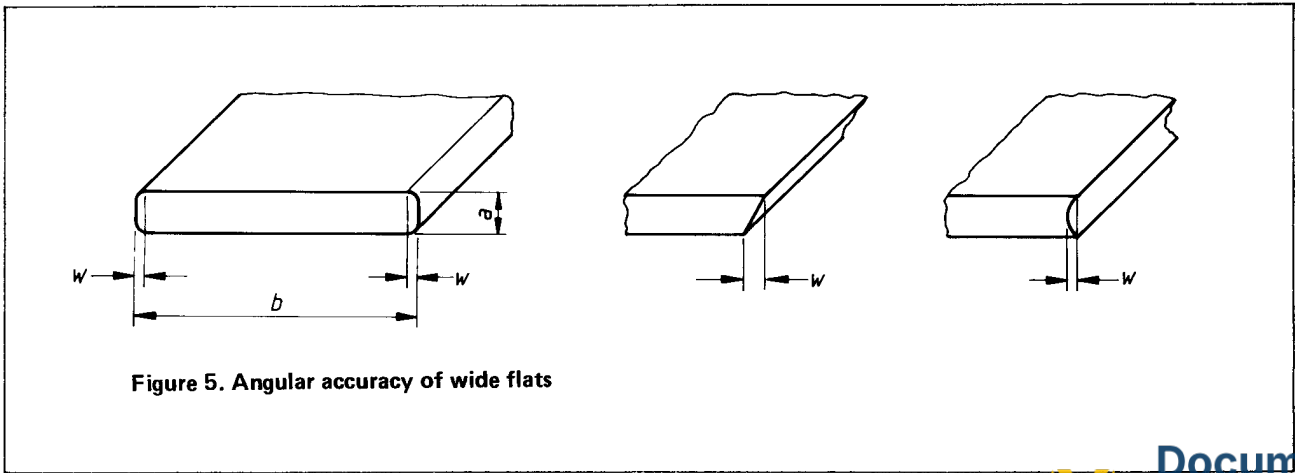
See also option **B.20**.

16 Tolerances for flats

16.1 Length tolerances for flats

The length tolerances on ordered length for flats shall be -0, +300 mm.

See also options **B.16** and **B.21**.



16.2 Width tolerances for flats

The width tolerances on ordered width for flats shall be as given in table 9.

Table 9. Width tolerances for flats	
Ordered width	Tolerances
mm	mm
Up to and including 35	± 0.5
Over 35 up to and including 75	± 0.8
Over 75 up to and including 100	± 1.0
Over 100 up to and including 125	± 1.3
Over 125 up to and including 150	± 1.5

16.3 Thickness tolerances for flats

The thickness tolerances on ordered thickness for flats shall be as given in table 10.

See also options B.22 and B.23.

Table 10. Thickness tolerances for flats	
Ordered thickness	Tolerances
mm	mm
Up to and including 10	± 0.4
Over 10 up to and including 20	± 0.5
Over 20 up to and including 40	± 0.6
Over 40 up to and including 60	± 0.8
Over 60	± 1.0

17 Tolerances for round and square bars

17.1 Size tolerances for round and square bars

17.1.1 The size (diameter in the case of round bars and width across flats in the case of square bars) tolerances on ordered size shall be as given in table 11.

Diameter or width across flats shall be measured at a distance not less than 150 mm from the end of the bars when delivery is made in lengths and at any point when delivery is made with restricted length tolerances in accordance with options B.16 and B.21.

See also options B.24 and B.25.

17.1.2 The out-of-section tolerances shall be as given in table 11.

Out-of-section shall be measured as the difference between the maximum and minimum diameters on the same cross section, for round bars, and the difference of the distance between parallel faces on the same cross section, for square bars.

17.2 Length tolerances for round and square bars

The length tolerance on ordered length for round and square bars shall be $-0, +600$ mm.

See also options B.16 and B.21.

18 Tolerances for sections

The dimensional and mass tolerances for sections shall comply with the following.

- (a) Sections (other than hollow sections): BS 4 : Part 1; BS 4848 : Parts 4 and 5.
- (b) Hollow sections: BS 4848 : Part 2.

Table 11. Size tolerances for round and square bars		
Ordered size	Tolerances on diameter or width	Tolerances on out-of-section
mm	mm	mm
Up to and including 15	± 0.2	0.3
Over 15 up to and including 25	± 0.3	0.5
Over 25 up to and including 35	± 0.4	0.6
Over 35 up to and including 50	± 0.5	0.8
Over 50 up to and including 65	± 0.6	0.9
Over 65 up to and including 80	± 0.7	1.1
Over 80 up to and including 100	± 0.9	1.4
Over 100 up to and including 120	± 1.1	1.7
Over 120 up to and including 160	± 2.0	3.0
Over 160 up to and including 200	± 2.5	3.8
Over 200	± 3.0	4.5

Section three. Specific requirements for testing

19 Selection and identification of test samples

NOTE. Ultrasonic testing and through-thickness testing of plates (other than continuous mill products) and wide flats may be incorporated in the specification (see options B.26 and B.27).

19.1 Selection of samples

The manufacturer shall randomly select and identify test samples in accordance with clauses 20, 21, 24 and 25.

See also options B.28, B.29, B.30 and B.31.

19.2 Condition of samples

The test samples shall be in the heat treatment condition specified in clause 6.

20 Number of tensile tests

20.1 Plates, strip (coil), wide flats, flats, sections and bars

One tensile test shall be made on the finished steel for each 40 t or part thereof of the same product form (e.g. plates or types of sections), of the same thickness or diameter range (see tables 13, 15, 17, 19, 21 and 23) from the same cast, and showing a thickness or diameter variation of not more than 5 mm above and below the thickness or diameter of the product sampled (or not more than 25 mm in the case of plates above 75 mm thick).

20.2 Hollow sections

One tensile test shall be made on the finished section for each 40 t or part thereof from the same cast, except for hollow sections made by a continuous process, for which two tensile tests shall be made for each 40 t or less of any section.

See also option B.32.

21 Direction and position of tensile test samples

21.1 Direction of samples

21.1.1 Plates and strip (coil). Tensile test samples shall be cut in the transverse direction.

21.1.2 Wide flats. Tensile test samples shall be cut in the longitudinal direction for widths up to 400 mm and longitudinal or transverse for widths over 400 mm, at the manufacturer's discretion.

21.1.3 Flats, sections (other than hollow sections) and bars. Tensile test samples shall be cut in the longitudinal direction.

21.1.4 Hollow sections. Tensile test samples shall be cut in the longitudinal direction.

21.2 Position of samples

21.2.1 Plates, wide flats and flats. Samples shall be taken from one end midway between the centre and one edge. (See appendices C and D.)

21.2.2 Strip (coil). Samples shall be taken at an adequate distance from the outer end midway between the centre and one edge for wide strip and at one-third of the width for narrow strip (less than 600 mm wide).

21.2.3 Sections. Samples shall be taken from the relevant flange positions shown in appendix C. In the case of sections with tapered flanges, it is permissible for the test samples to be taken from the web or flange, at the manufacturer's discretion, as shown in appendix C.

21.2.4 Hollow sections. It is permissible to test small hollow sections in full section. Where this is not done, samples from rectangular (including square) hollow sections shall be taken from any side midway between and excluding the corners as shown in appendix C.

Samples shall be cut clear of any welds.

21.2.5 Round and square bars. It is permissible to test small bars in full section. Where this is not done, samples shall be taken from the positions shown in appendix D.

22 Tensile test pieces

22.1 Preparation of test pieces

Tensile test pieces shall be prepared in accordance with BS EN 10002 : Part 1, as appropriate, from the test samples obtained in accordance with clause 21, so that, wherever practicable, the rolled surface of the steel is retained on two opposite sides of the test piece. Where this is not practicable, round or rectangular test pieces having a thickness or diameter of not less than 12.5 mm shall be taken from the relevant positions shown in appendix D.

22.2 Straightening of test pieces

Any straightening of test pieces which is required shall be done cold. Test pieces cut from circular hollow sections shall be tested in the curved condition, but it is permissible for the ends to be flattened cold for gripping.

23 Tensile test

23.1 General

The tensile test shall be carried out in accordance with BS EN 10002 : Part 1, as appropriate. The tensile strength, R_m , the yield strength, R_e , and the elongation, A , shall be determined, and the results obtained shall comply with the values given in tables 13, 15, 17, 19, 21, and 23 for the appropriate grade. For the yield strength, it is permissible for the manufacturer to determine either the upper yield stress, R_{eH} , or the 0.5 % proof stress (total extension), $R_{t0.5}$.

23.2 Dispute

If the result is in doubt or dispute, the yield strength shall be deemed not to be reached until the total extension under load as determined by the extensometer or dividers, is observed to be 0.5 % of the gauge length ($R_{t0.5}$).

23.3 Elongation

The specified elongation values relate to an 80 mm or 200 mm gauge length or a proportional gauge length of $5.65 \sqrt{S_0}$ where S_0 is the original cross-sectional area of the test piece as shown in tables 13, 15, 17, 19, 21 and 23 and if other gauge lengths are used, the corresponding elongation on gauge length of 80 mm or 200 mm or $5.65 \sqrt{S_0}$ shall be obtained as described in BS 3894 : Part 1.

24 Number of impact tests

24.1 Plates and strip

24.1.1 For steel sub-grades EE and F, three adjacent Charpy V-notch test pieces shall be taken from each parent plate or strip (coil).

24.1.2 For other sub-grades, three adjacent test pieces shall be taken from one of the thickest plates or strips (coils) of each 40 t or part thereof of the same thickness range (see tables 13 and 21) from the same cast.

24.2 Wide flats, flats, sections, hollow sections and bars

24.2.1 For steel sub-grades DD, E, EE and F, where applicable (see tables 13, 15, 17 and 19), three adjacent Charpy V-notch test pieces shall be taken from one of the thickest products for every 5 t or from each parent product if its mass exceeds 5 t.

24.2.2 For other sub-grades, three adjacent test pieces shall be taken from one of the thickest products of each 40 t or

part thereof of the same thickness range (see tables 13, 15, 17, 19, 21 and 23) from the same cast.

25 Position of impact test samples

The impact test samples shall be taken from the positions shown in appendix E. Impact test samples taken from welded hollow sections shall be cut clear of the weld. For other sections, the impact test samples shall be taken from within 25 mm of the centres of the position shown in appendix E.

26 Impact test pieces

NOTE 1. Impact tests for material less than 6 mm thick are not normally carried out but may be agreed between the purchaser and the manufacturer at the time of the enquiry and order.

NOTE 2. Test piece size is dependent on the actual thickness of the test sample and for circular products allowance also needs to be made for the radius of curvature of the surface.

26.1 General

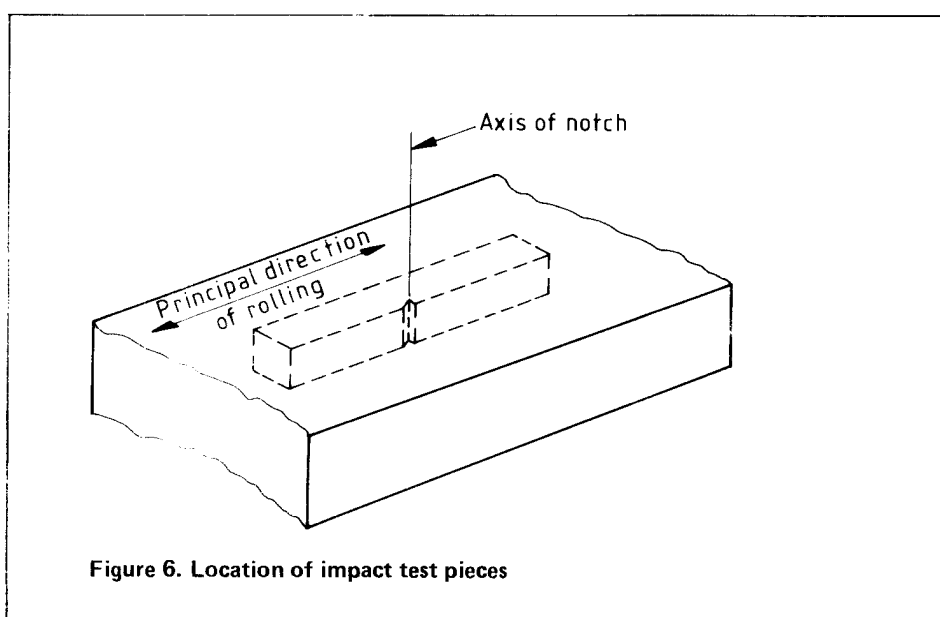
The test pieces shall be cut parallel to the principal direction of rolling and the axis of the notch shall be perpendicular to the rolled surface of the product (see figure 6). The test pieces shall be prepared in accordance with BS EN 10045 : Part 1 and 26.2 to 26.4.

26.2 Thick material

For thicknesses of 20 mm and over, standard 10 mm x 10 mm test pieces shall be so machined that they do not include material nearer to the surface than 3 mm.

26.3 Thin material

For material equal to or greater than 12 mm up to but excluding 20 mm thick, standard 10 mm x 10 mm test pieces shall be so machined that they do not include material nearer to the surface than 1 mm.



26.4 Material less than 12 mm thick

For material equal to or greater than 6 mm thick up to but not including 12 mm thick, one of the following sizes of test pieces shall be prepared using the full thickness where necessary:

- standard test piece 10 mm × 10 mm;
- subsidiary standard test piece 10 mm × 7.5 mm;
- subsidiary standard test piece 10 mm × 5 mm.

27 Impact tests

NOTE 1. The specified impact properties are for quality control purposes during the manufacture of the steel and the fact that low temperatures are used for these tests does not necessarily imply that the steels are completely satisfactory for use at these temperatures.

NOTE 2. The steels specified in this standard may be used in many applications for which design and construction codes may differ in requirements in respect of impact testing, e.g. orientation of test samples, frequency of testing or minimum energy values. The purchaser is advised to consult the manufacturer when this is the case. For information, appendix F gives indicative energy values for products other than round and square bars at temperatures other than those specified in this standard.

27.1 Method of testing

The impact test shall be carried out in accordance with BS EN 10045 : Part 1 at the temperature given in tables 13, 15, 17, 19, 21 and 23 for the grade ordered.

27.2 Values for standard test pieces

The average impact value obtained from the three standard 10 mm × 10 mm test pieces shall be not less than the appropriate value given in tables 13, 15, 17, 19, 21 and 23 (see 27.4) for the grade ordered.

27.3 Values for subsidiary standard test pieces

The average impact values obtained from three subsidiary standard test pieces shall be not less than 22 J for 10 mm × 7.5 mm test pieces or 19 J for 10 mm × 5 mm test pieces (see 27.4).

27.4 Individual value

For standard and subsidiary standard test pieces, it is permissible for one individual value to be below the average value specified, but it shall not be less than 70 % of that value.

28 Flattening test

A flattening test shall be carried out for hollow sections manufactured by a welding process. A test specimen shall be selected for each 40 t or part thereof of the same size of section which is presented for inspection. The test shall be carried out on circular hollow sections and, where practicable, on rectangular hollow sections in the round form before shaping.

A ring not less than 40 mm in length cut from one end of each selected section shall be flattened cold between two parallel flat surfaces. Burrs shall be removed before testing and the weld shall be placed at 90° to the direction of flattening. No opening of the weld shall take place until the distance between platens is less than 85 % of the original outside diameter of the section. The test shall then be continued until the weld opens and the weld shall show no signs of incomplete fusion.

No cracks or breaks in the metal, elsewhere than in the weld, shall occur until the distance between the platens is less than two-thirds of the original outside diameter of the section.

29 Bend tests

Bend tests shall not be carried out.

See also option B.33.

30 Retests

30.1 Tensile and flattening tests

Should a test result not comply with clause 23 or 28, two further test pieces shall be made on samples taken from the product from which the original test piece was prepared.

In the case of sections with tapered flanges, it is permissible for the retests to be made on test pieces taken from the flange, at the manufacturer's discretion.

Provided the results of both these further tests comply with clauses 23 or 28, all the material represented shall be deemed to comply with this standard.

If the results of either of these additional tests does not comply with clauses 23 or 28, the product from which the samples were cut shall be deemed not to comply with this standard, but the remaining material represented shall be deemed to comply with this standard provided that test pieces from two of the remaining products selected and prepared in accordance with clauses 20, 21 and 22 or 28 are tested and comply with clause 23 or 28.

30.2 Impact tests

30.2.1 General. If the average value of the three impact tests is less than the minimum average specified in clause 27 or if one individual value is less than 70 % of the specified minimum, three additional test pieces from the same sample shall be tested and the results added to those previously obtained and a new average calculated. The new average value shall be not less than the specified minimum average. Not more than two of the individual values shall be less than the specified value. Not more than one individual value shall be less than 70 % of the specified value.

30.2.2 Products tested on a thickness range basis (see 24.1.2 and 24.2.2). For products tested on a thickness range basis, if the average impact test value of the selected test from the

thickest product fails to comply with 30.2.1, the product from which the samples were cut shall be deemed not to comply with this standard but the remaining material represented shall be deemed to comply with this standard provided test pieces from two of the remaining products selected and prepared in accordance with clauses 24, 25 and 26 are tested and comply with clause 27 and, where applicable, 30.2.

30.3 Re-heat treatment

Notwithstanding the requirements of 30.1 and 30.2, the manufacturer shall have the right to heat treat or re-heat treat any material, including material already found not to comply with clauses 23, 27 and 28, and re-submit it for testing.

