

Structural use of steelwork in building —

Part 2: Specification for materials, fabrication and erection — Rolled and welded sections

ICS 91.080.10

Committees responsible for this British Standard

The preparation of this British Standard was entrusted to Technical Committee B/521, Execution of steel structures, upon which the following bodies were represented:

- British Constructional Steelwork Association
- Cold Rolled Sections Association
- DETR (Construction Directorate)
- DETR (Highways Agency)
- Health and Safety Executive
- Institution of Civil Engineers
- Institution of Structural Engineers
- Steel Construction Institute
- UK Steel Association
- Welding Institute

This British Standard, having been prepared under the direction of the Sector Policy and Strategy Committee for Building and Civil Engineering, was published under the authority of the Standards Policy and Strategy Committee on 24 August 2001

© BSI 24 August 2001
First published December 1985
Second edition March 1992
Third edition August 2001

The following BSI references relate to the work on this standard:
Committee reference B/521
Draft for comment 99/100269 DC

Amendments issued since publication

Amd. No.	Date	Comments

ISBN 0 580 33304 3

Contents

	Page
Committees responsible	Inside front cover
Foreword	iii
Section 1. General	1
1.1 Scope	1
1.2 Normative references	1
1.3 Definitions	3
Section 2. Materials	5
2.1 Structural steel	5
2.2 Fasteners	5
2.3 Welding consumables	7
2.4 Steel castings and forgings	7
2.5 Bedding materials	7
Section 3. Fabrication	9
3.1 General	9
3.2 Identification	9
3.3 Cutting	9
3.4 Holing	9
3.5 Contact surfaces of preloaded friction grip connections	10
3.6 Direct contact bearing of cross-sections	10
3.7 Surface imperfections	10
Section 4. Assembly	11
4.1 General	11
4.2 Welding	11
4.3 Bolting	11
4.4 Movement joints	12
4.5 Marking for erection	12
4.6 Protective treatment	12
Section 5. Erection	15
5.1 Delivery, storage and handling	15
5.2 Erection methods	15
5.3 Accuracy of construction	15
Section 6. Supports and foundations	17
6.1 Installation and positioning of foundation bolts	17
6.2 Packings	17
6.3 Bedding of structures	17
Section 7. Tolerances	19
7.1 General	19
7.2 Fabrication tolerances	19
7.3 Erection tolerances	22
Annex A (normative) Final inspection of welds	23
A.1 Visual examination	23
A.2 Non-destructive testing	23
A.3 Stud shear connectors	23
A.4 Weld acceptance criteria and corrective actions	23
A.5 Structures subjected to cyclic loading	23

	Page
Annex B (informative) General recommendations for steelwork tenders and contracts	29
B.1 General	29
B.2 Exchange of information	29
B.3 Information needed by the steelwork designer	29
B.4 Information needed by the tenderer (if not also the steelwork designer)	30
B.5 Detailing	30
B.6 Time schedule	31
B.7 Inspection and testing	31
Annex C (informative) References to the phrase “Project Specification”	32
Bibliography	33
Figure 1 — Maximum punching distortion	10
Table 1 — Structural steel products	5
Table 2 — Matching bolts, nuts and washers	6
Table 3 — Clear threads	11
Table 4 — Tolerances on shape and dimensions	20
Table A.1 — Scope of inspection — Type of joints and thicknesses requiring non-destructive testing	24
Table A.2 — Scope of inspection — Frequency of testing of joints identified in Table A.1 as requiring non-destructive testing	25
Table A.3 — Acceptance requirements for production welds in steel structures	26
Table A.4 — Characteristic defects of production welds in steel structures	28

Foreword

This part of BS 5950 is a revision of BS 5950-2:1992, which is superseded and withdrawn.

BS 5950 is a standard combining codes of practice covering the design, construction and fire protection of steel structures and specifications for materials, workmanship and erection. It comprises the following parts:

- *Part 1: Code of practice for design — Rolled and welded sections;*
- *Part 2: Specification for materials, fabrication and erection — Rolled and welded sections;*
- *Part 3: Design in composite construction;*
- *Section 3.1: Code of practice for design of simple and continuous composite beams;*
- *Part 4: Code of practice for design of composite slabs with profiled steel sheeting;*
- *Part 5: Code of practice for design of cold-formed thin gauge sections;*
- *Part 6: Code of practice for design of light gauge profiled steel sheeting;*
- *Part 7: Specification for materials and workmanship: cold-formed sections;*
- *Part 8: Code of practice for fire resistant design;*
- *Part 9: Code of practice for stressed skin design.*

Although the main purpose of this part of BS 5950 is to define the materials and workmanship needed for compatibility with the design assumptions of Part 1, its use with other design standards is not precluded.

It has been assumed in the drafting of this British Standard that the execution of its provisions is entrusted to appropriately qualified and experienced people.

A British Standard does not purport to include all necessary provisions of a contract. Users of British Standards are responsible for their correct application.

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

Summary of pages

This document comprises a front cover, an inside front cover, pages i to iv, pages 1 to 33 and a back cover.

Section 1. General

1.1 Scope

This part of BS 5950 specifies requirements for the materials, fabrication and erection of structural steelwork in buildings subject primarily to static loading, using rolled and welded sections.

NOTE Although the requirements of this standard can be referred to in contractual documents, they might need to be modified, within the terms of contract, to align with specific contractual obligations. Special requirements will also have to be specified in the project specification. Annex B gives general recommendations for the exchange of information in steelworks tenders and contracts. Annex C identifies references to the project specification.

1.2 Normative references

The following normative documents contain provisions, which, through reference in this text, constitute provisions of this British Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. For undated references, the latest edition of the publication referred to applies.

BS 4-1, *Structural steel sections — Part 1: Specification for hot-rolled sections.*

BS 29, *Specification for carbon steel forgings above 150 mm ruling section.*

BS 3100, *Specification for steel castings for general engineering purposes.*

BS 3923-1, *Methods for ultrasonic examination of welds — Part 1: Methods for manual examination of fusion welds in ferritic steels.*

BS 4190, *Specification for ISO metric black hexagon bolts, screws and nuts.*

BS 4320:1968, *Specification for metal washers for general engineering purposes: Metric series.*

BS 4395-1, *Specification for high strength friction grip bolts and associated nuts and washers for structural engineering — Part 1: General grade.*

BS 4395-2, *Specification for high strength friction grip bolts and associated nuts and washers for structural engineering — Part 2: Higher grade bolts and nuts and general grade washers.*

BS 4604, *Specification for the use of high strength friction grip bolts in structural steelwork — Metric series.*

BS 4933, *Specification for ISO metric black cup and countersunk head bolts and screws with hexagon nuts.*

BS 5400-6, *Steel, concrete and composite bridges — Part 6: Specification for materials and workmanship, steel.*

BS 5950-1, *Structural use of steelwork in building — Part 1: Code of practice for design — Rolled and welded sections.*

BS 5964-1, *Building setting-out and measurement — Part 1: Methods of measuring, planning and organization and acceptance criteria.*

BS 5996, *Methods for ultrasonic testing and specifying quality grades of ferritic steel plate.*

BS 6072, *Method for magnetic particle flaw detection.*

BS 7079-A.1, *Preparation of steel substrates before application of paints and related products — Visual assessment of surface cleanliness — Specification for rust grades and preparation grades of uncoated steel substrates and of steel substrates after overall removal of previous coatings.*

BS 7419, *Specification for holding down bolts.*

BS 7644, *Direct tension indicators.*

BS 7668, *Specification for weldable structural steels — Hot-finished structural hollow sections in weather resistant steels.*

BS EN 287, *Approval testing of welders for fusion welding — Steels.*

BS EN 288-1, *Specification and approval of welding procedures for metallic materials — Part 1: General rules for fusion welding.*

BS EN 288-2, *Specification and approval of welding procedures for metallic materials — Part 2: Welding procedures specification for arc welding.*

BS EN 288-3, *Specification and approval of welding procedures for metallic materials — Part 3: Welding procedure tests for the arc welding of steels.*

BS EN 440, *Welding consumables — Wire electrodes and deposits for gas shielded metal arc welding of non-alloy and fine grain steels — Classification.*

BS EN 499, *Welding consumables — Covered electrodes for manual metal arc welding of non-alloy and fine grain steels — Classification.*

BS EN 571, *Non-destructive testing — Penetrant testing — General principles.*

BS EN 756, *Welding consumables — Wire electrodes and wire-flux combinations for submerged arc welding of non-alloy and fine grain steels — Classification.*

BS EN 758, *Welding consumables — Tubular cored electrodes for metal arc welding with and without a gas shield of non-alloy and fine grain steels — Classification.*

BS EN 970, *Non-destructive examination of fusion welds — Visual examination.*

BS EN 1011-1, *Welding — Recommendations for welding of metallic materials — Part 1: General guidance for arc welding.*

BS EN 1011-2, *Welding — Recommendations for welding of metallic materials — Part 2: Arc welding of ferritic steels.*

BS EN 1668, *Welding consumables — Rods, wires and deposits for tungsten inert gas welding of non-alloy and fine grain steels — Classification.*

BS EN 10024, *Hot-rolled taper flange I sections — Tolerances on shape and dimensions.*

BS EN 10025, *Hot-rolled products of non-alloy structural steels: Technical delivery conditions.*

BS EN 10029, *Specification for tolerances on dimensions, shape and mass for hot-rolled steel plates 3 mm thick or above.*

BS EN 10034, *Structural steel I and H sections — Tolerances on shape and dimensions.*

BS EN 10051, *Specification for continuously hot-rolled uncoated plate, sheet and strip of non-alloy and alloy steels — Tolerances on dimensions and shape.*

BS EN 10055, *Hot-rolled steel equal flange tees with radiused root and toes — Dimensions and tolerances on shape and dimensions.*

BS EN 10056-1, *Specification for structural steel equal and unequal angles — Part 1: Dimensions.*

BS EN 10056-2, *Specification for structural steel equal and unequal angles — Part 2: Tolerances on shape and dimensions.*

BS EN 10113, *Hot-rolled products in weldable fine grain structural steels.*

BS EN 10137-2, *Plates and wide flats made of high yield strength structural steels in the quenched and tempered or precipitation hardened conditions — Part 2: Delivery conditions for quenched and tempered steels.*

BS EN 10155, *Structural steels with improved atmospheric corrosion resistance — Technical delivery conditions.*

BS EN 10163, *Specification for delivery requirements for surface conditions of hot-rolled steel plates, wide flats and sections.*

BS EN 10164, *Steel products with improved deformation properties perpendicular to the surface of the product — Technical delivery conditions.*

BS EN 10204, *Metallic products — Types of inspection documents.*

BS EN 10210-1, *Hot-finished structural hollow sections of non-alloy and fine grain structural steels — Part 1: Technical delivery requirements.*

BS EN 10210-2, *Hot-finished structural hollow sections of non-alloy and fine grain structural steels — Part 2: Tolerances, dimensions and sectional properties.*

BS EN 10219-1, *Cold-formed welded structural sections of non-alloy and fine grain steels — Part 1: Technical delivery requirements.*

BS EN 10219-2, *Cold-formed welded structural sections of non-alloy and fine grain steels — Part 2: Tolerances, dimensions and sectional properties.*

BS EN 10279, *Hot-rolled steel channels — Tolerances on shape, dimension and mass.*

BS EN ISO 4014, *Hexagon head bolts — Product grades A and B.*

BS EN ISO 4016, *Hexagon head bolts — Product grade C.*

BS EN ISO 4017, *Hexagon head screws — Product grades A and B.*

BS EN ISO 4018, *Hexagon head screws — Product grade C.*

BS EN ISO 4032, *Hexagon nuts, style 1 — Product grades A and B.*

BS EN ISO 4033, *Hexagon nuts, style 2 — Product grades A and B.*

BS EN ISO 4034, *Hexagon nuts — Product grade C.*

BS EN ISO 7091, *Plain washers — Normal series — Product grade C.*

BS EN ISO 8503-1, *Preparation of steel substrates before application of paints and related products. Surface roughness characteristics of blast-cleaned steel substrates. Specifications and definitions for ISO surface profile comparators for the assessment of abrasive blast.*

BS EN ISO 12944-4, *Paints and varnishes. Corrosion protection of steel structures by protective paint systems — Part 4: Types of surface and surface preparation.*

BS EN ISO 12944-7, *Paints and varnishes — Corrosion protection of steel structures by protective paint systems — Part 7: Execution and supervision of paintwork.*

ISO 10721-2, *Steel structures — Part 2: Fabrication and erection.*

EU 91, *Hot-rolled wide flats — Tolerances on dimensions, shape and mass.*

1.3 Definitions

For the purposes of this part of BS 5950, the following definitions shall apply.

1.3.1

project specification

documentation covering technical data and requirements for a particular project that need to be specified to supplement and qualify the requirements of this British Standard

NOTE This includes all documentation that specifies requirements for execution including fabrication and erection drawings.

1.3.2

thermal cutting

flame cutting, plasma cutting and or laser cutting

1.3.3

fastener

threaded bolt (possibly with a nut and/or one or more washers) or an alternative mechanical device capable of serving the same purpose

Section 2. Materials

2.1 Structural steel

2.1.1 General

Unless stated otherwise in the project specification all structural steel products shall conform to the relevant British Standards in Table 1.

Table 1 — Structural steel products

Product	Technical delivery requirements ^a				Dimensions	Tolerances
	Non-alloy steels	Fine grain steels	Quenched and tempered steels	Weathering steels		
Universal beams and columns	BS EN 10025 ^b	BS EN 10113	BS EN 10137-2 ^c	BS EN 10155	BS 4-1	BS EN 10034
Joists					BS 4-1	BS EN 10024
Channels					BS 4-1	BS EN 10279
Angles					BS EN 10056-1	BS EN 10056-2
Rolled T sections					BS EN 10055	BS EN 10055
Split T sections					BS 4-1	—
Plates (reversing mill)					—	BS EN 10029
Plates (cut from coil)					—	BS EN 10051
Wide flats					—	EU 91
Hot finished hollow sections					BS EN 10210-1	
Cold-formed hollow sections	BS EN 10219-1		—	—	BS EN 10219-2	BS EN 10219-2
^a Certain product grades do not have a specified maximum manganese content or are not supplied with carbon equivalent value (CEV) options. Additional requirements might therefore need to be specified and agreed at the time of order.						
^b Grades S235, S275 and S355 only, excluding rimming steel grades S235JR and S235JRG1.						
^c Only plates and wide flats grade S460.						

In the areas shown on the project drawings, the material shall be tested for laminations to the specified acceptance level in accordance with BS 5996.

2.1.2 Through thickness properties

In the areas shown on the project drawings, the material shall be tested for through thickness properties to the specified quality class in accordance with BS EN 10164.

2.1.3 Inspection and testing

Structural steels for use in design conforming to BS 5950-1 shall receive specific inspection and testing in accordance with the relevant product standard.

A manufacturer's certificate of test and inspection shall be issued conforming to BS EN 10204, stating the process of manufacture and giving the product grade, the ladle analysis and the results of each of the mechanical tests applicable to the material supplied. The certificate shall indicate the numbers or identification marks of the product to which it applies, corresponding to those on the material supplied. In the case of sections with flanges, the certificate shall indicate whether the sample for test purposes was taken from the web or the flange.

NOTE Specific inspection and testing of certain grades of steel needs to be requested at the time of the enquiry and order.

2.2 Fasteners

Assemblies of bolts, nuts and washers shall correspond to one of the matching combinations in Table 2.

Preloaded fasteners shall generally be HSFG bolts, with associated nuts and washers. Direct tension indicators shall conform to BS 7644.

Other types of preloaded fasteners may be used provided that they can be reliably tightened to at least the minimum shank tensions specified in BS 4604.

Table 2 — Matching bolts, nuts and washers

Type of bolts		Nuts		Washers	
Grade	Standard	Class or grade ^c	Standard	Class	Standard
<i>Non-preloaded bolts</i>					
4.6	BS EN ISO 4016	Class 4 ^d	BS EN ISO 4034	100 HV	BS EN ISO 7091
	BS EN ISO 4018				
	BS 4190	Grade 4	BS 4190	—	BS 4320 ⁱ
8.8	BS 4933 ^a				
	BS EN ISO 4014 ^b	Class 8 ^e	BS EN ISO 4032 ^b	100 HV	BS EN ISO 7091
	BS EN ISO 4017 ^b				
10.9	BS 4190	Grade 8 ^f	BS 4190	—	BS 4320 ⁱ
	BS EN ISO 4014 ^b	Class 10 ^g	BS EN ISO 4032 ^b	100 HV	BS EN ISO 7091
	BS EN ISO 4017 ^b				
	BS 4190	Grade 10 ^h	BS 4190	—	BS 4320 ⁱ
<i>Non-preloaded HSFG bolts</i>					
General grade	BS 4395-1	General grade	BS 4395-1	—	BS 4320 ^j
Higher grade	BS 4395-2	Higher grade	BS 4395-2	—	BS 4320 ^j
<i>Preloaded HSFG bolts</i>					
General grade	BS 4395-1	General grade	BS 4395-1	—	BS 4395-1 ^k
Higher grade	BS 4395-2	Higher grade	BS 4395-2	—	BS 4395-2 ^k
<i>Holding down bolts</i>					
4.6	BS 7419	Grade 4	BS 4190	—	BS 4320 ⁱ
8.8	BS 7419	Grade 8 ^f	BS 4190	—	BS 4320 ⁱ
8.8 preloaded	BS 7419	General grade	BS 4395-1	—	BS 4395-1 ^k
^a BS 4933 has been declared obsolescent, but should still be used for 90° countersunk head bolts and cup head bolts until corresponding BS EN standards are available. ^b Grade 8.8 and 10.9 bolts to the strength grades of BS EN ISO 4014 or BS EN ISO 4017 but with the dimensions and tolerances specified in BS EN ISO 4016 or BS EN ISO 4018 may also be used, with matching nuts to the strength classes of BS EN ISO 4032 but the dimensions and tolerances of BS EN ISO 4034. ^c Nuts of a higher class or grade may also be used. ^d Class 5 nuts for size M 16 and smaller. ^e Nuts for galvanized or sherardized 8.8 bolts shall be class 10. ^f Nuts for galvanized or sherardized 8.8 bolts shall be grade 10 to BS 4190. ^g Nuts for galvanized or sherardized 10.9 bolts shall be class 12 to BS EN ISO 4033. ^h Nuts for galvanized or sherardized 10.9 bolts shall be grade 12 to BS 4190. ⁱ Black steel washers to section 2 of BS 4320, normal diameter series. ^j Black steel washers to BS 4320:1968, Section 2, large diameter series. ^k Direct tension indicators to BS 7644 may also be used with preloaded HSFG bolts.					