

Execution of steel structures —

Part 1: General rules and rules for buildings —

(together with United Kingdom
National Application Document)

ICS 91.040.01; 91.080.10

Committees responsible for this Draft for Development

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

- British Constructional Steelwork Association Ltd.
- Cold Rolled Sections Association
- Confederation of British Forgers
- Department of Transport (Highways Agency)
- Health and Safety Executive
- Institution of Civil Engineers
- Institution of Structural Engineers
- Steel Construction Institute
- UK Steel Association
- Welding Institute

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National foreword

This Draft for Development has been prepared by Technical Committee B/521 and comprises the English language version of ENV 1090-1:1996 *Execution of steel structures — Part 1: General rules and rules for buildings*, as published by the European Committee for Standardization (CEN), plus the National Application Document to be used with the ENV in the execution of buildings to be erected in the United Kingdom.

This publication is not to be regarded as a British Standard.

An ENV is made available for provisional application, but does not have the status of a European Standard. The aim is to use the experience gained to modify the ENV so that it can be adopted as a European Standard in the future.

During the ENV period of validity, reference should be made to the supporting documents listed in the National Application Document (NAD).

The purpose of the NAD is to provide essential information, particularly in relation to safety, to enable the ENV to be used for buildings erected in the UK. The NAD takes precedence over corresponding provisions in the ENV.

ENV 1090-1:1996 has been thoroughly examined over a period of several years and is considered to be a suitable alternative execution standard to BS 5950-2, when used in conjunction with this NAD.

Compliance with ENV 1090-1:1996 does not in itself confer immunity from legal obligations.

Users of this document are invited to comment on its technical content, ease of use and any ambiguities and anomalies. These comments will be taken into account when preparing the UK national response to CEN on the question of whether the ENV can be converted to an EN.

Comments should be sent in writing to BSI, 389 Chiswick High Road, London W4 4AL, quoting the document reference, the relevant item and, where possible, a proposed revision, within 2 years of the issue of this document.

A British Standard does not purport to include all the 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 xviii, the ENV title page, pages 2 to 100 and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

National Application Document

**for use in the UK with
ENV 1090-1:1996**

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Introduction

This National Application Document has been prepared by Technical Committee B/521. It has been developed from:

- a) a textual examination of ENV 1090-1:1996;
- b) a study against UK practice and supporting standards.

1 Scope

This National Application Document provides information required to enable ENV 1090-1:1996 to be used for the execution of steel structures for buildings to be erected in the UK. Its application does not extend to structures subject to significant fatigue.

The steels covered in this standard are those relevant to the design of structures conforming to DD ENV 1993-1-1:1992, using steels of grades S235, S275 and S355 conforming to the following standards:

- BS EN 10025, *Hot rolled products of non-alloy structural steels. Technical delivery conditions*;
- BS EN 10113, *Hot-rolled products in weldable fine grain structural steels*;
- BS EN 10155, *Structural steels with improved atmospheric corrosion resistance. Technical delivery conditions*;
- BS EN 10210, *Hot finished structural hollow sections of non-alloy and fine grain structural steels*;
- BS EN 10219, *Cold formed welded structural hollow sections of non-alloy and fine grain steels*¹⁾.

NOTE 1 Steels of higher strength grades are covered in DD ENV 1090-3.

NOTE 2 ENV 1090-1 should not be used for other grades, including S420 and S460.

2 References

2.1 Normative references

This National Application Document incorporates, by dated or undated reference, provisions from other publications. These normative references are made at the appropriate places in the text and the cited publications are listed on page xv. For dated references, only the edition cited applies; any subsequent amendments to or revisions of the cited publication apply to this document only when incorporated in the reference by amendment or revision. For undated references, the latest edition of the cited publication applies, together with any amendments.

2.2 Informative references

This National Application Document refers to other publications that provide information or guidance. Editions of these publications current at the time of issue of this document are listed on page xvi, but reference should be made to the latest editions.

3 Reference standards

The supporting standards to be used in place of those quoted in ENV 1090-1 are listed in Table 1. Where no equivalent British Standard is given, the standard referred to in the text shall be used.

¹⁾ In preparation.

Table 1 — References in ENV 1090-1 to other standards

Standard referred to in ENV 1090	Title	Equivalent British Standard
prEN 780	<i>Hexagon nuts for high-strength structural bolting with large width across flats — Product grade B — Property classes 8 and 10</i>	BS 4395
prEN 781	<i>Hexagon bolts for high-strength structural bolting with large width across flats (thread lengths according to ISO 8.8) — Product grade C — Property classes 8.8 and 10.9</i>	BS 4395
prEN 782	<i>Hexagon bolts for high-strength structural bolting with large width across flats (short thread lengths). Product grade C — Property classes 8.8 and 10.9</i>	BS 4395
prEN 783	<i>Hexagon nuts for structural bolting with large width across flats, style 1. Product grade B — Property class 10</i>	BS 4395
prEN 784	<i>Plain washers for high-strength structural bolting, hardened and tempered</i>	BS 4395
prEN 785	<i>Plain washers, chamfered, hardened and tempered for high-strength structural bolting</i>	BS 4395
prEN 970	<i>Welding — Visual examination for fusion welded joints</i>	BS 5289
prEN 1011	<i>Recommendation for arc welding of ferritic steels</i>	BS 5135
prEN 1029	<i>Hot dip galvanized coatings on fabricated ferrous products — Specification</i>	BS 729
prEN 1418	<i>Welding personnel — Approval testing of welding personnel for fully mechanised and automatic welding of metallic materials</i>	BS 4871
prEN 10219-1	<i>Cold formed structural sections of structural steel — Part 1: Technical delivery requirements</i>	BS EN 10219-1
prEN 10219-2	<i>Cold formed structural sections of structural steel — Part 2: Dimension, tolerances and geometrical properties</i>	BS EN 10219-2
ISO 1459	<i>Metallic coatings — Protection against corrosion by hot dip galvanizing guiding principles</i>	BS 729
ISO 1460	<i>Metallic coatings — Hot dip galvanized coatings on ferrous metals — Gravimetric determination of the mass per unit area</i>	BS 729
ISO 1461	<i>Metallic coatings — Hot dip galvanized coatings on fabricated products — Requirements</i>	BS 729
ISO 1518	<i>Paints and varnishes — Scratch test</i>	BS 3900-E2
ISO 1803	<i>Building construction — Expression of dimensional accuracy — Vocabulary</i>	BS 6100-1.5
ISO 1891	<i>Bolts, screws, nuts and accessories — Terminology and nomenclature — Trilingual edition</i>	BS 6040
ISO 2808	<i>Paints and varnishes — Cross cut test</i>	BS 3900-C5
ISO 3443-1	<i>Tolerances for buildings — Part 1: Basic principles for evaluation and specification</i>	BS 6954-1
ISO 3443-2	<i>Tolerances for buildings — Part 2: Statistical basis for predicting fit between components having a normal distribution of sizes</i>	BS 6954-2
ISO 3443-3	<i>Tolerances for building — Procedures for selecting target size and predicting fit</i>	BS 6954-3
ISO 4463-1	<i>Measurement methods for building — Setting-out and measurement — Part 1: Planning and organization, measuring procedures, acceptance criteria</i>	BS 5964-1

Table 1 — References in ENV 1090-1 to other standards

Standard referred to in ENV 1090	Title	Equivalent British Standard
ISO 6507-1	<i>Metallic materials — Hardness test — Vickers test — Part 1: HV 5 to HV 100</i>	BS 427
ISO 7089	<i>Plain washers — Normal series — Product grade A</i>	BS 4320
ISO 7090	<i>Plain washers, chamfered — Normal series — Product grade A</i>	BS 4320
ISO 7091	<i>Plain washers — Normal series — Product grade C</i>	BS 4320
ISO 7976-1	<i>Tolerances for building — Method of measurement of building and building products — Part 1: Methods and instruments</i>	BS 7307-1
ISO 7976-2	<i>Tolerances for building — Method of measurement of building and building products — Part 2: Position of measuring points</i>	BS 7307-2
ISO 8322-1	<i>Building construction — Measuring instruments — Procedure for determining accuracy in use — Part 1: Theory (Introduction to additional parts)</i>	BS 7334-1
ISO 8501-1	<i>Preparation of steel substrates before application of paints and related products — Visual assessment of surface cleanliness — Part 1: Rust grades and preparation grades of uncoated steel substrates after overall removal of previous coatings</i>	BS 7079-A1
ISO 8502-2	<i>Preparation of steel substrates before application of paints and related products — Test for the assessment of surface cleanliness — Part 2: Laboratory determination of chloride on cleaned surfaces</i>	BS 7079-2
ISO 8502-3	<i>Preparation of steel substrates before application of paints and related products — Assessment of dust on steel surfaces prepared for painting (pressure-sensitive tape method)</i>	BS 7079-B3
ISO 8503-2	<i>Preparation of steel substrates before application of paints and related products — Surface roughness characteristics of blast-cleaned steel substrates — Part 2: Method for the grading of surface profile of abrasive blast-cleaned steel — Comparator procedure</i>	BS EN ISO 8503-2
ISO 8504-1	<i>Preparation of steel substrates before application of paints and related products — Surface preparation method — Part 1: General principles</i>	BS 7079-D1
ISO 8504-2	<i>Preparation of steel substrates before application of paints and related products — Surface preparation method — Part 2: Abrasive blast cleaning</i>	BS 7079-D2
ISO 8504-3	<i>Preparation of steel substrates before application of paints and related products — Surface preparation method — Part 3: Hand and power tool cleaning</i>	BS 7079-D3

4 Additional requirements

4.1 Subclause 4.1 2)

In preparing the project specification due account shall be taken of the requirements for temporary bracing covered in subclause 9.3 and Table C.1.

4.2 Subclause 5.1 5)

Replace this subclause with the following:

“Structural steels for use in building structures shall conform to the project specification and the relevant product standard by being supplied with specific inspection and testing and with an inspection certificate type 3.1B in accordance with BS EN 10204.

Materials supplied with a certificate of conformity or a test report in accordance with 2.2 of BS EN 10204 are not acceptable unless permitted by the project specification.

Material conformity shall be checked in accordance with 12.2.1.”

4.3 Subclause 5.2.3 3)

In the event of the material not having a manufacturer's certificate then either it shall be rejected or tests shall be carried out to determine the grade and properties of the material. If the CEV is not given in the manufacturers type 3.1B certificate then it may be calculated from the chemical composition in the certificate specified in 4.2 or by test.

4.4 Subclause 5.4.1.3

This subclause shall also be read in conjunction with subclause 8.5 which sets out the situations where washers are to be used.

4.5 Table 3

Pre-loaded bolts shall conform to the requirements of BS 4395.

4.6 Subclause 5.4.3 1)

Fasteners conforming to British Standards need not be considered as special fasteners. Unless required otherwise by the project specification, countersunk bolts should conform to BS 4933.

NOTE Countersunk bolts conforming to other national or international standards may be formed with different head dimensions, particularly in relation to the angle of the seating face.

4.7 Subclause 6.6

All matching holes for fasteners or pins shall register with each other so that fasteners can be inserted freely through the assembled members in a direction at right angles to the faces in contact.

4.8 Subclause 6.6 3)

Punched holes shall also conform to the following:

- a) there shall be no serious material distortion and the burrs shall not exceed that shown in Figure 1;
- b) holes shall not be punched full size in any of the following conditions:
 - 1) in tension flanges at locations where plastic hinges have been assumed;
 - 2) in elements of rigid connections in which local yield lines have been assumed;
 - 3) where repetition of loading makes fatigue critical in the member design;
 - 4) punching holes full size is not permitted for pre-loaded bolts;
- c) at splices, the holes in mating surfaces shall be punched in one direction in all members;
- d) burrs shall also be removed from punched holes.

These positions shall be indicated in the project drawings (see Figure 1).

Providing the above requirements are conformed to, the 25 mm limitation shall be waived.

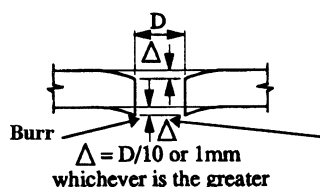


Figure 1 — Distortion limit for punched holes

4.9 Subclause 7.4.1 2)

The following Parts of EN 288 should not be used:

- Part 5: *Approval by using approved welding consumables for arc welding;*
- Part 6: *Approval related to previous experience;*
- Part 7: *Approval by a standard welding procedure for arc welding.*

4.10 Subclause 7.5.7 1)

Replace this subclause with the following:

“Tack welds shall be made using the same procedures as for the root runs of main welds. The minimum length of the tack shall be the lesser of four times the thickness of the thicker part or 50 mm, unless a shorter length can be demonstrated as satisfactory by test.”

4.11 Subclause 8.5

Tapered washers shall always be used when the surface of the material is at an angle of more than 3° to a plane perpendicular to the bolt axis.

4.12 Table 7

The following values have been assumed in ENV 1993-1-1 for the design of slip resistant connections:

$\mu = 0,50$ for class A surfaces;

$\mu = 0,40$ for class B surfaces;

$\mu = 0,30$ for class C surfaces;

$\mu = 0,20$ for class D surfaces.

4.13 Subclause 8.10.1

If countersunk holes are required, the angle of the countersinking should be 90° corresponding to that of standard countersunk bolts conforming to BS 4933, unless other countersunk bolts are used.

4.14 Subclause 9.1

The planning and erection of the steelwork should conform to BS 5531.

4.15 Subclause 9.4.4 2) a)

For ordinary Portland cement the minimum temperature limits for grouting shall be 8 °C on a falling thermometer and 5 °C on a rising thermometer, unless protection is provided.

4.16 Subclause 9.4.4 4)

Replace this clause with the following:

“Vent holes shall be provided in the baseplate not further than 250 mm from the nearest edge unless otherwise stated in the project specification.”

4.17 Table 9 and Table 10

Delete these tables and replace with Table A.1 and Table A.2.

4.18 Subclause 12.6.2 2)

Amend the acceptance level from 80 % to 75 %.

Add the following additional note:

“NOTE Variation of film thickness is inevitable and although a minimum thickness can be specified, it is often preferable to specify a nominal thickness. If a relevant British Standard exists (e.g. BS 2569) it should be quoted. In other cases it should be specified that over any square metre of a scheduled area the average of the readings taken should equal or exceed the nominal thickness and in no case should any reading be less than 75 % of the nominal thickness. In the project specification a specifier may feel justified in using a different percentage but it is essential to use figures that are based on practical requirements for the systems being used and surfaces being coated. The use of unrealistic figures can result in extra costs and these will not be justified by the results obtained.”

4.19 Subclause 12.7.4.4

In this subclause the “imposed load” should be taken as all the loads, whether permanent or variable, applied after the steel has been erected.

4.20 Subclause D.2.1

The note should be taken to read:

“NOTE Structures made from steel grades S235 and S275 may be assumed to be basic class, providing that there is no welding on material greater than 30 mm thick or fatigue loading on main components. Components where high stresses in the connections occur during handling, identified as such in the project specification, should be considered as higher class.”

4.21 Subclause D.4 1)

Ensuring the mechanical resistance and stability of the structure requires that it is properly designed. This should normally be achieved by design in accordance with the relevant parts of the structural Eurocodes. Alternatively the design may conform to BS 5950.

4.22 Subclause F.8 3)

Before the application of resin the joints should be dry throughout. This should be achieved by heating, if required. During the installation of the resin the steel should be maintained at a minimum temperature of 10 °C.

Annex A (normative)

Modified tables

The requirements of Table A.1 shall not preclude the use of non-destructive testing outside the limits shown should the results of visual inspection or NDT indicate that a lapse in quality may have occurred in specific joints.

Table A.1 — Welds — Scope of inspection

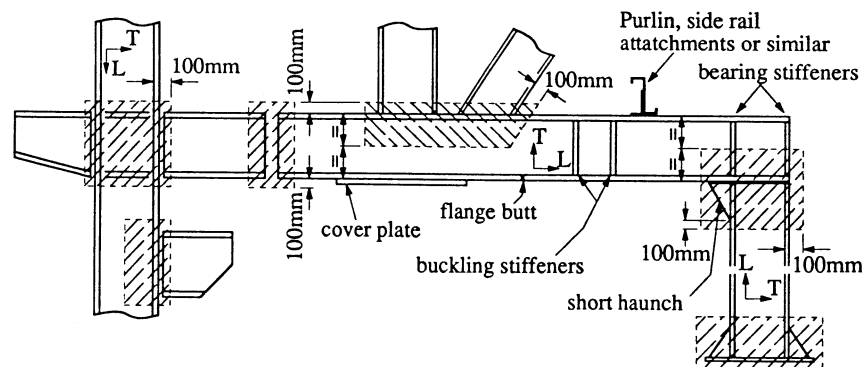
Part A	Visual inspection. Prior to non-destructive testing all welds shall be visually inspected by a suitably qualified person				
Part B	Minimum thickness when non-destructive testing becomes mandatory (all dimensions in millimetres)				
Weld type	Butt (full penetration and reinforcing fillets)				
Joint type	In line		TEE and cruciform		Corner
Procedures	Single-sided	Double-sided and single-sided plus backing	Single-sided	Double-sided and single-sided plus backing	All
	Examples				
MPI	$t_{\max} < 10$	$t_{\max} < 12$	$t_{\max} \geq 20$	$t_{\max} \geq 20$	$t_{\max} \geq 20$
U/S	$t_{\max} \geq 10$	$t_{\max} \geq 12$	$t_{\max} \geq 12$	$t_{\max} \geq 30$	$t_{\max} \geq 30$
Weld type	Fillet				
Joint type	Lap		Tee and cruciform		
Procedures	All		All		
	Examples				
MPI	$t_{\max} \geq 20$		$t_{\max} \geq 20$		
U/S	Not mandatory		$l_{f\max} \geq 20$		

NOTE Abbreviations:
 MPI Magnetic Particle Inspection;
 U/S Ultrasonic Inspection;
 < less than;
 ≥ greater than or equal to.

Table A.1 — Welds — Scope of inspection

Part C	Frequency of testing of joints identified in Part B		
Connection zones	Shop welds	First five identified joints of each type having the same basic dimensions, material grades and weld geometry and welded to the same procedures. Thereafter, one in five joints of each type	
	Site welds	All identified joints	
Member zones	Built up members	Transverse butts to web and flange plates before assembly	As for shop welds in connection zones
		Transverse fillet welds at ends of cover plates	
		Longitudinal welds	0,5 m in each 10 m or part thereof
	Secondary attachment welds	e.g. for fixing purlins, side rails, buckling stiffeners, etc.	One in 20 attachments

NOTE Where only partial inspection is required the joints for testing should be selected on a random basis, but ensuring the sampling covers the following variables as far as possible: joint type, material grade and welding equipment.



Definition of zones and weld orientations

 Connection zones — all welds transverse

 Member zones — welds transverse or longitudinal

T = Transverse to member axis

L = Longitudinal to member axis

Table A.2 — Weld quality acceptance criteria and corrective actions

	Parameter	Weld type	Particular condition	Acceptance requirements (all dimensions in mm) (see notes 1 and 5)	Figure	Remedial action for non-conforming welds
Weld geometry	Location	All	—	As specified on drawings	—	Repair
	Weld type	All	—	As specified on drawings	—	Refer to engineer
	Length	All	—	$\geq$ As specified on drawings	—	Repair
Profile	Throat thickness	Butt	—	$l_b \geq$ As drawing (Av. 50)	b, c	Repair
		Fillet	—	$t_f \geq$ As drawing (Av. 50) $\leq$ As drawing + 5	a	Repair or grind and MPI after grinding
	Leg length	Fillet	—	$I_f \geq$ As drawing	a	Repair
	Toe angle	All	—	$\theta < 90^\circ$	a	Grind and MPI after grinding
	Cap/root bead (height or concavity)	Butt	Butt joint	$-1 \leq C_b \leq 4$	b	Repair or grind
	Misalignment	Butt	Butt joint	$m \leq$ As drawing + 0,25t $\leq$ As drawing + 3.0	d	Refer to engineer
		All	Cruciform joint	$m \leq$ As drawing + 0,5t and $\leq$ As drawing + 6	e	—
Surface discontinuities	Undercut	All	Longitudinal weld	$U_1 + U_2 \leq 0.1t$ (Av. 100) and ≤ 2	d, e	Repair
		All	Transverse weld	$U_1 + U_2 \leq 0.5t$ (Av. 100) and ≤ 1	d, e	—
	Root preparation (lack of)	Single-sided	Longitudinal weld	$r_p \leq$ drawing + 0,1t (Av. 100) and $\leq$ As drawing + 3	c	Repair and double scope of U/S inspection if root is inaccessible
		Butt	Transverse weld	$r_p \leq$ As drawing + 0,15t (Av. 100) and $\leq$ As drawing + 2	c	—
	Porosity	All	All welds	$d \leq 3$	f	Repair
			Longitudinal weld	$\Sigma d \leq 20$ in 100 (length)	f	Repair
			Transverse weld	$\Sigma d \leq 10$ in length	f	Repair
	Lack of fusion and cracks	All	—	Not permitted	—	Repair and increase MPI to 100 % (see note 4)

Table A.2 — Weld quality acceptance criteria and corrective actions

	Parameter	Weld type	Particular condition	Acceptance requirements (all dimensions in mm) (see notes 1 and 5)	Figure	Remedial action for non-conforming welds
Sub-surface discontinuities	Slag lines and lack of fusion/root penetration	All	All welds	$h \leq 3 + \text{As drawing}$	e, g	Repair and double scope of US inspection
			—	$l \leq 10$ and $r \geq 10$ if $h' < 6$	g	
			Longitudinal weld	$\Sigma l \leq 6t$ in 200 (length)	g	
	Root gap	Fillet or partial pen. butt	Transverse weld	$\Sigma l \leq 3t$ in 200 (length)	g	Repair and double scope of U/S inspection
			Tee, cruciform corner and lap joints	$r_g \leq 2/(\text{Av. } 100)$ and ≤ 3	a, e	
	Cracks	All	—	Not permitted	—	Repair and increase U/S inspection to 100 %
	Lamellar tears	All	—	Not permitted (see note 5)	—	Refer to engineer and increase U/S inspection to 100 %

Table A.2 — Weld quality acceptance criteria and corrective actions

Dimensional symbols

Definitions of measurements

(a) Symbols for weld throat thickness (l_r), face width (l_f), face thickness (t_f), and face radius (r_s).

(b) Symbols for weld crown thickness (C_v), crown width (C_h), crown radius (r_p), and crown angle (θ).

(c) Symbols for weld crown thickness (C_v), crown width (C_h), crown radius (r_p), and crown angle (θ).

(d) Symbols for weld crown thickness (C_v), crown width (C_h), crown radius (r_p), and crown angle (θ).

(e) Symbols for weld crown thickness (C_v), crown width (C_h), crown radius (r_p), and crown angle (θ).

(f) Symbols for weld crown thickness (C_v), crown width (C_h), crown radius (r_p), and crown angle (θ).

(g) Symbols for weld crown thickness (C_v), crown width (C_h), crown radius (r_p), and crown angle (θ).

(h) Symbols for weld crown thickness (C_v), crown width (C_h), crown radius (r_p), and crown angle (θ).

View on surface of weld

Typical Discontinuities

Typical section through sub-surface defects.

NOTE 1 Where there are two limits for one dimension both apply.

NOTE 2 All limits are peak values unless indicated as average.

NOTE 3 Where a repair is necessary an approved procedure should be used. If on increasing the scope of inspection, further non-conformities are found, the scope should be increased to 100 % for the joint type in question.

NOTE 4 May be accepted up to the limits for slag lines if the joint is subjected to longitudinal shear only.

NOTE 5 All welds to the same procedure.

NOTE 6 Abbreviations:

Av. 100 or Av. 50 indicates the average value over 100 mm or 50 mm length

≥ Not less than

≤ Not greater than

Σ Sum of.

List of references (see clause 2)

Normative references

BSI publications

BRITISH STANDARDS INSTITUTION, London

- BS 427:1990, *Method for Vickers hardness test and for verification of Vickers hardness testing machines.*
- BS 729:1971, *Specification for hot dip galvanized coatings on iron and steel articles.*
- BS 3900, *Methods of test for paints.*
- BS 3900-C5:1992, *Determination of film thickness.*
- BS 3900-E2:1992, *Scratch test.*
- BS 4320:1968, *Specification for metal washers for general engineering purposes. Metric series.*
- BS 4395, *Specification for high strength friction grip bolts and associated nuts and washers for structural engineering.*
- BS 4871, *Specification for approval testing of welders working to approved welding procedures.*
- BS 4933:1973, *Specification for ISO metric black cup and countersunk head bolts and screws with hexagon nuts.*
- BS 5135:1984, *Specification for arc welding of carbon and carbon manganese steels.*
- BS 5289:1976, *Code of practice. Visual inspection of fusion welded joints.*
- BS 5531:1988, *Code of practice for safety in erecting structural frames.*
- BS 5964, *Building setting out and measurement.*
- BS 5964-1:1990, *Methods of measuring, planning and organization and acceptance criteria.*
- BS 6040:1981, *Nomenclature for bolts, screws, nuts and accessories.*
- BS 6100, *Glossary of building and civil engineering terms.*
- BS 6100, *General and miscellaneous.*
- BS 6100-1.5, *Operations; associated plant and equipment.*
- BS 6363:1983, *Specification for welded cold formed steel structural hollow sections.*
- BS 6954, *Tolerances for building.*
- BS 6954-1:1988, *Recommendations for basic principles for evaluation and specification.*
- BS 6954-2:1988, *Recommendations for statistical basis for predicting fit between components having a normal distribution of sizes.*
- BS 6964-3:1988, *Recommendations for selecting target size and predicting fit.*
- BS 7079, *Preparation of steel substrates before application of paints and related products.*
- BS 7079:Group A, *Visual assessment of surface cleanliness.*
- BS 7079-A1:1989, *Specification for rust grades and preparation grades of uncoated steel substrates and of steel substrates after overall removal of previous coatings.*
- BS 7079:Group B, *Methods for the assessment of surface cleanliness.*
- BS 7079-B2:1992, *Method for determination of chlorides on cleaned surfaces.*
- BS 7079-B3:1993, *Assessment of dust on steel surfaces prepared for painting (pressure-sensitive tape method).*
- BS 7079:Group C, *Surface roughness characteristics of blast-cleaned steel substrates.*
- BS 7079:Group D, *Methods for surface preparation.*
- BS 7079-D1:1993, *General principles.*
- BS 7079-D2:1993, *Abrasive blast-cleaning.*
- BS 7079-D3:1993, *Hand- and power-tool cleaning.*
- BS 7307, *Building tolerances. Measurement of buildings and building products.*
- BS 7307-1:1990, *Methods and instruments.*
- BS 7307-2:1990, *Position of measuring points.*

BS 7334, *Measuring instruments for building construction.*

BS 7334-1:1990, *Methods for determining accuracy in use: theory.*

DD ENV 1993, *Eurocode 3. Design of steel structures.*

DD ENV 1993-1-1:1992, *General rules and rules for buildings (together with United Kingdom National Application Document).*

BS EN 10025:1993, *Hot rolled products of non-alloy structural steels. Technical delivery conditions.*

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

BS EN 10155:1993, *Structural steels with improved atmospheric corrosion resistance. Technical delivery conditions.*

BS EN 10204:1991, *Metallic products. Types of inspection documents.*

BS EN 10210, *Hot finished structural hollow sections of non-alloy and fine grain structural steels.*

BS EN ISO 8503, *Preparation of steel substrates before application of paints and related products. Surface roughness characteristics of blast-cleaned steel substrates.*

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ICS 91.040.00; 91.080.10

Descriptors: Buildings, steel construction, steel frames, structural steels, materials, manufacturing, setting-up conditions, joining, welding, fastenings, assembling, geometrical tolerances, protection, inspection, tests

English version

Execution of steel structures — Part 1: General rules and rules for buildings

Exécution des structures en acier —
Partie 1: Règles générales et règles pour les
bâtiments

Ausführung von Tragwerken aus Stahl —
Teil 1: Allgemeine Regeln und Regeln für
Hochbauten

This European Prestandard (ENV) was approved by CEN on 1995-02-28 as a prospective standard for provisional application. The period of validity of this ENV is limited initially to three years. After two years the members of CEN will be requested to submit their comments, particularly on the question whether the ENV can be converted into an European Standard (EN).

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CEN

European Committee for Standardization
Comité Européen de Normalisation
Europäisches Komitee für Normung

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Foreword

This European Prestandard has been prepared by Technical Committee CEN/TC 135 “Execution of steel structures”, the secretariat of which is held by NSF.

No European Standard for execution of structures has previously been issued. Certain rules for execution have been included in product standards, certain rules have also been included in the design rules for structures, such as ENV 1992-1-1 (Eurocode 2), ENV 1993-1-1 (Eurocode 3) and ENV 1994-1-1 (Eurocode 4). The intention of including rules for execution in the design standards has been to define minimum requirements which shall be met in order to ensure consistency with the assumptions made in the design thus ensuring that the structure achieves its intended reliability.

During some years from 1990, discussions have led to a common understanding of the advantages of having European Standards for execution of structures. Such standards will complete the set of standards necessary to design, execute and purchase construction works. Many countries have national standards for execution. The reason for developing European Standards for execution has, however, been debated within some of CEN's committees. It is thus convenient to summarize here the main reasons for developing a European Standard for execution of steel structures:

- To transfer the requirements set during design from the designer to the constructor, i.e. to be a link between design and execution.
- To give instructions to the constructor on how to execute the physical work (fabrication, welding, bolting, erection, protective treatment) as well as to give requirements for accuracy of the work. The standard on execution will thus serve as a document which gives standardized technical requirements when ordering a steel structure.
- To inform and serve as the check list for the designer with respect to information which needs to be specified in the project specification for the particular project. It is foreseen and required that each project shall have a project specification which defines the technical requirements for that particular project. Such a project specification could be a single drawing for a minor project or a comprehensive package of documents for a complicated steel structure.

A standard for execution of structures is basically a type A standard which give rules for fulfillment of the essential requirement of mechanical resistance and stability. The execution standard is a direct parallel to ENV 1993-1-1 in this respect.

However, some clauses give specific measurable performance criteria for fabricated steel products manufactured for inclusion in construction works (e.g. tolerances for fabrication and welding). Whether these products are produced in batches, non-series production or as one-off items (to a purchaser's special requirements) the same criteria will apply when products are manufactured to this standard.

Because of the close connection between design rules and rules for execution, TC 135 cooperates closely with CEN/TC 250/SC 3 — *Eurocode 3: Design of Steel Structures*. This applies to the framework for the standards, including the subdivision into a series of standards for various types of structures, as well as the technical rules themselves. CEN/TC 135 has not yet concluded whether it will be necessary for the execution standards to have the same number of parts as for the design standards. However, Part 1 of the execution document covers the same scope as ENV 1993-1-1, with the exception that structures susceptible to fatigue are excluded from the execution part.

The present program for further parts is the following:

Execution of steel structures — Part 2: Rules for cold formed thin gauge members and sheeting;

Execution of steel structures — Part 3: Supplementary rules for high strength steels;

Execution of steel structures — Part 4: Supplementary rules for hollow section lattice structures;

Execution of steel structures — Part 5: Supplementary rules for bridges and plated structures.

(This numbering system is different from the numbering system of ENV 1993).

According to the CEN/CENELEC Internal Regulations, the national standards organisations of the following countries are bound to announce this European Prestandard: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

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Introduction

- 1) This European Prestandard gives requirements for execution of steel structures in order to ensure adequate levels of mechanical resistance and stability, serviceability and durability.
- 2) This European Prestandard specifies requirements for execution of steel structures in particular those which are designed according to ENV 1993-1-1 and for the steel parts of composite structures designed according to ENV 1994-1-1.
- 3) This European Prestandard presupposes that the work is carried out with the necessary skill and adequate equipment and resources to perform the work in accordance with the requirements of the project specification and the requirements of this European Prestandard.

NOTE This European Prestandard does not state requirements for quality assurance which shall follow relevant national regulations.

1 Scope

- 1) This European Prestandard specifies general requirements for execution of structural steelwork produced from hot rolled, hot finished, welded and cold formed steel products. This European Prestandard does not cover cold formed thin gauge members and sheeting. The definition of steel products is given in EN 10079.
- 2) In addition, Part 1 gives detailed requirements for structures which are not significantly susceptible to fatigue. The definition of structures which are not significantly susceptible to fatigue is given in ENV 1993-1-1.
- 3) The standard also gives the method for specifying to match the requirements of the standard to project specific requirements.
- 4) The standard is also applicable to steel components in composite steel and concrete structures as defined in ENV 1994-1-1.
- 5) The standard is also applicable to temporary steel structures.

2 Normative references

This European Prestandard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Prestandard, only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

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ISO/DIS 12944-5, *Paints and varnishes — Corrosion protection of steel structures by protective paint systems — Part 5: Protective paint system.*

ISO/DIS 12944-6, *Paints and varnishes — Corrosion protection of steel structures by protective paint systems — Part 6: Laboratory performance test methods.*

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

ISO/DIS 12944-8, *Paints and varnishes — Corrosion protection of steel structures by protective paint systems — Part 8: Development of specifications for new work and maintenance.*

3 Definitions

For the purposes of this standard, the following definitions apply:

3.01

cold formed component

see EN 10079 and EN 10131

3.02

construction works

everything that is constructed or results from construction operations. This term covers both building and civil engineering works. It refers to the complete construction comprising both structural and non-structural elements

3.03

constructor

the person or organization executing the works (the supplier in EN 29002)

3.04

deviation

see ISO 1803

3.05

design basis method of erection

the outline of a method of erection upon which the design of the structure is based

3.06

erection method statement

documentation describing the procedures to be used to erect a steel structure

3.07

execution

all activities performed for the physical completion of the works, i.e. procurement, fabrication, welding, mechanical fastening, transportation, erection, protective treatment and the inspection and documentation thereof

3.08

normal tolerances

the basic limits for dimensional deviations necessary:

- a) to satisfy the design assumptions for statically loaded structures;
- b) to define acceptable tolerances for building structures in the absence of any other rules.

3.09

permitted deviation

see ISO 1803

3.10

position point

see ISO 4463-1

3.11

project specification

documents covering technical data and requirements for a particular project that need to be specified to supplement and qualify the rules of this European Prestandard

3.12

safety plan

a document that sets out arrangements which will reasonably ensure the safety of persons affected by execution of work on site

3.13

secondary system

the lines and levels that comprise the secondary setting out system defined in ISO 4463-1

3.14

special tolerances

more stringent tolerances necessary to satisfy the design assumptions for safety or other functional requirements

NOTE Special tolerances in this European Prestandard cover special tolerances as well as particular tolerances defined in ENV 1993-1-1.

3.15

tolerance

see ISO 1803

3.16

welding coordinator

see EN 719

3.17

works

those parts of the construction works that are structural steelwork and are described in the project specification

4 Documentation

4.1 Project specification

1) All necessary information and technical requirements for execution of the works shall be set out in the project specification.

NOTE Annex C lists the information that should be considered for inclusion in the project specification, as appropriate.

2) The project specification shall specify requirements for the safety plan for execution of the works which shall comply with the safety plan for the construction works.

3) Before commencement of execution of any part of the works the information required within the project specification that is relevant to that part of the works shall be complete.

4) The project specification shall include procedures for making alterations to previously agreed information within the project specification.

4.2 Constructor's documentation

4.2.1 Quality plan

1) The project specification shall state whether it is required that the constructor present a quality plan for execution of the works.

NOTE If no quality plan is required, the project specification should ensure that any relevant points from those in paragraph 2) below are specified.

2) If a quality plan is required, it shall set out the specific quality practices, resources and sequence of activities for the works.

NOTE A quality plan should consider the inclusion of the following:

- a) a review of specification requirements against process capabilities;
- b) the specific allocation of tasks and authority during the various phases of the project;
- c) the specific procedures, methods and work instructions to be applied;
- d) procedures for implementing any quality requirements for welding including selection of prEN 729-2, prEN 729-3, prEN 729-4;
- e) an inspection and test plan specific to the works;
- f) a procedure for handling of changes and modifications;
- g) a procedure for handling of non-conformities, requests for concessions and quality disputes;
- h) any second or third party approval hold points or requirement to witness inspections or tests, and any consequent access requirements.

4.2.2 Safety plan

1) Method statements giving detailed work instructions shall comply with the safety plan for execution of the works.

4.2.3 Execution documentation

1) Sufficient documentation shall be prepared during execution and with respect to the as-built structure to demonstrate that the works have been carried out according to project specification.

NOTE 1 Such documentation may consist of:

- a) material test certificates or suppliers' declaration of conformity;
- b) applications for concessions and responses;
- c) as-built drawings or sufficient information to allow for the preparation of as-built drawings;
- d) records of dimensional checks at handover.

NOTE 2 Control of conformity may be performed according to Annex D. In such cases the project specification shall identify which procedure from Annex D applies.

5 Materials

5.1 General

1) The project specification shall specify all steel material to be used in the works in terms of the relevant product standard from Table 1. The steel products selected shall be of grades up to and including S 355.

NOTE 1 For both main material and connection material, grade and grade suffixes designated in accordance with EN 10027-1 or EN 10027-2 should be given and any options allowed by the product standard should be specified.

Table 1 — Product standards for steel materials

Products	Technical delivery requirements	Dimensions	Tolerances
I and H sections	EN 10025 EN 10113 EN 10155	Not available	EN 10034
Joists		Not available	prEN 10024
Channels		Not available	Not available
Equal and unequal leg angles		prEN 10056-1	EN 10056-2
T Sections		Not available	prEN 10055
Plates		Not applicable	EN 10029 EN 10051
Flats, wide flats	EN 10210-1	Not applicable	EU 91
Hot finished hollow sections		prEN 10210-2	prEN 10210-2
Cold formed hollow sections		prEN 10219-2	prEN 10219-2
Steel with improved deformation properties	EN 10164	Not applicable	Not applicable
NOTE 1 EN 10020 gives definitions and classifications of grades of steel. Steel designations by name and number are given in EN 10027-1 and EN 10027-2 respectively. EN 10021 gives general technical delivery requirements. NOTE 2 EN 10025 refers to non-alloy steels, EN 10113 to fine grain steels and EN 10155 to weather resistant grades. NOTE 3 EN 10210-1 and prEN 10219-1 cover both non-alloy and fine grain steels. NOTE 4 EN 10051 covers plates cut from wide strip produced on continuous mills. NOTE 5 Delivery requirements for surface condition of hot rolled plates, wide flats and sections are given in EN 10163-1, EN 10163-2 and EN 10163-3. NOTE 6 EU 91 is a Euronorm that has not yet been converted into a European Standard.			

2) For plates according to EN 10029 tolerance class A and EN 10051 category A, shall be used unless otherwise stated in the project specification.

3) If material is to be processed before commencement of fabrication, the project specification shall define the requirements for this processing.

NOTE Heat treatment, cambering or bending are examples of such processes.

4) Fasteners shall be selected in accordance with 5.4.

NOTE Care should be taken to ensure that suitable bolt and nut combinations are used.

5) The properties of supplied materials shall be documented in a way that enables the properties to be compared to the requirements of the project specification. Their conformity with the relevant product standard shall be checked in accordance with 12.2.

NOTE For metallic products, inspection documents in accordance with 2.2 of EN 10204 should normally be requested as material test certificates for this purpose.

5.2 Use of materials

5.2.1 Identification

1) Materials shall be identifiable at all stages from receipt to handover after incorporation in the works.

NOTE This identification may be based on documentary records for batches of product allocated to a common production process, unless the project specification specifies unique traceability.

2) If differing grades of material are in circulation together, each item of material shall be designated with a mark that identifies its grade. Unmarked material shall be treated as nonconforming product.

3) Methods of marking material shall be in accordance with that for components given in 6.2.

5.2.2 Handling and storage

1) If materials have been stored in a way or for a length of time that may have led to significant deterioration, they shall be checked before use to ensure that they still comply with the relevant product standard.

NOTE Weather resistant steel products may require light blasting before use to provide a uniform basis for weathering.

2) Material shall not be used where it is beyond its shelf life where this is specified by its manufacturer.

3) Material shall be stored in conditions that are in accordance with its manufacturer's instructions, where these are given.

5.2.3 Steel for welded components

1) For steel to be incorporated in welded components, the chemical composition given in the material certificate shall be checked for compliance with the welding process to be used. The CEV shall be calculated from the ladle analysis in accordance with the formula given in EN 10025.

NOTE In accordance with option 5 of EN 10025, a manufacturer's declaration that the product conforms with the maximum CEV given in Table 4 of EN 10025 may be used instead of a ladle analysis, provided that the manufacturer has a production control system that is certified to comply with EN 29002.

2) The CEV of weather resistant steel to be welded shall not exceed 0,54 %.

3) If the CEV cannot be confirmed from the material certificate to be in accordance with the welding process to be used, the steel shall be treated as nonconforming product.

4) If backing material is not another part of the steel component, it shall be steel with a carbon equivalent value (CEV) not exceeding 0,43 %, or be the same material as the most weldable of the parent materials to be joined by the weld.

5.2.4 Special properties

1) The project specification shall specify any special restrictions on either surface discontinuities or the repair of surface defects by grinding in accordance with EN 10163.

2) The project specification shall specify any testing required on materials to identify internal imperfections or laminations or cracks in zones to be welded, in accordance with 12.2.1.

3) The project specification shall specify any requirement for material to have improved deformation properties perpendicular to the surface of the product in accordance with EN 10164.

NOTE These are often termed "through thickness properties".

5.2.5 Nonconforming materials

1) If any materials are first designated as nonconforming and are subsequently proved to be in conformity by test or retest, the testing shall be recorded.

5.3 Welding consumables

1) All welding consumables shall conform with the requirements in the appropriate European Standard, unless otherwise stated in the project specification.

2) The type of welding consumables shall be appropriate to the welding process, the material to be welded and the welding procedure.

3) If weather resistant steel is to be welded, welding consumables of equivalent weather resistance to the parent metal shall be used, unless otherwise permitted by the project specification.

NOTE For single run fillet welds, butt welds in material less than 12 mm thick and for runs other than capping runs in other butt welds, it is possible that procedure tests may demonstrate that dilution is adequate to ensure weather resistance of the weld metal.

5.4 Mechanical fasteners

5.4.1 Hexagon bolts, hexagon nuts and plain washers

5.4.1.1 Terminology

- 1) In this European Prestandard the full designations according to ISO 1891 are used only in the headings of the sub-clauses.
- 2) In the text the following abbreviated terminology is used:
 - “bolt” meaning: “hexagon bolt”
 - “nut” meaning: “hexagon nut”
 - “washer” meaning: “plain washer or single chamfer plain washer”
 - “assembly” meaning: “a bolt with a nut and washer(s) as necessary”.

NOTE The terms “hexagon bolt” and “hexagon head bolt” are synonymous.

5.4.1.2 Mechanical properties

- 1) The mechanical properties for bolts shall be in accordance with EN 20898-1 and shall conform with one of the following mechanical property classes:

4.6, 4.8, 5.6, 5.8, 6.8, 8.8 or 10.9.

NOTE Care should be taken to avoid hydrogen embrittlement of materials used for bolts, nuts or washers, particularly during metal coating processes.

- 2) The mechanical properties of foundation bolts shall generally be as in 1). Alternatively foundation bolts may be fabricated from hot-rolled steel conforming to either EN 10025 grade S 235, S 275 or S 355 or EN 10113 grade S 275 or S 355.
- 3) The mechanical properties of nuts shall be in accordance with EN 20898-2 and shall conform with one of the following mechanical property classes:
 - 4, 5, 6, 8, 10 or 12.
- 4) The mechanical properties of washers shall be as listed in the Table 2 and Table 3.

5.4.1.3 Bolt assemblies

- 1) Bolt assemblies shall comprise matching bolts, nuts and washers conforming with an appropriate combination given in the Table 2 and Table 3.
- 2) If required by the project specification, the suitability of assemblies for preloaded application shall be verified with the procedure test described in A.1.
- 3) Pending the issue of an appropriate CEN or ISO standard, taper washers shall be in accordance with national standards.

Table 2 — Non-preloaded bolt assemblies

Bolts		Nuts		Washers	
Class	Standard ²⁾	Standard	Class	Standard	Class
4.6	EN 24016	EN 24034	pc 4 for d > M16	ISO 7091 ⁶⁾	100 HV
4.8	EN 24018		pc 5 for d ≤ M16		
5.6	EN 24014 EN 24017	EN 24034	pc 5		
5.8 ¹⁾	—	—	—		
6.8 ¹⁾	—	—	—		
8.8	EN 24014 EN 24017	EN 24032	pc 8 ³⁾⁴⁾	ISO 7089	200 HV
			pc 10 ³⁾⁴⁾	ISO 7090	200 HV
	prEN 781	prEN 780	pc 8	pr EN 784 ⁷⁾ prEN 785	n/a
10.9	EN 24014 EN 24017	EN 24032	pc 10 ³⁾⁵⁾	ISO 7089	200 HV
		EN 24033	pc 12 ⁵⁾	ISO 7090 ⁸⁾	200 HV
	prEN 781	prEN 780	pc 10	prEN 784 ⁷⁾ prEN 785	n/a
	prEN 782	prEN 783	pc 10	prEN 785	n/a

Notes:

¹⁾ There are no CEN or ISO standards for bolts or nuts appropriate for class 5.8 or 6.8 assemblies. However, such bolts may conform with the dimensions and tolerances of EN 24014, EN 24016, EN 24017 or EN 24018 (although not envisaged in those standards). The nuts may conform with the dimensions and tolerances of EN 24032 or EN 24034 (although not envisaged in those standards), provided that they are of a matching property class according to EN 20898-2.

²⁾ Bolts of classes 5.6, 8.8 and 10.9 may also conform with the dimensions and tolerances of EN 24016 or EN 24018 (although not envisaged in those standards).

³⁾ Nuts of pc 8 or pc 10 may also conform with the dimensions and tolerances of EN 24034 (although not envisaged in that standard).

⁴⁾ If class 8.8 bolts to EN 24014 or EN 24017 [or as envisaged in Note 2)] are metal coated, the nuts shall be of pc 10.

⁵⁾ If class 10.9 bolts to EN 24014 or EN 24017 [or as envisaged in Note 2)] are metal coated, the nuts shall be of pc 12 and conform with EN 24033.

⁶⁾ Plain washers of class 140 HV conforming to ISO 7089 may also be used.

⁷⁾ With bolts to prEN 781, plain washers to prEN 784 may be used under the nut, but washers placed under the bolt head shall be chamfered plain washers to prEN 785.

⁸⁾ Washers to prEN 784 or prEN 785 may also be used.

Table 3 — Preloaded bolt assemblies

Bolts		Nuts		Washers
Class	Standard	Standard	Class	
8.8	prEN 781	prEN 780	pc 8	prEN 784 ¹⁾ prEN 785
10.9	prEN 781	prEN 780	pc 10	
	prEN 782	prEN 783	pc 10	prEN 785

Note:

¹⁾ With bolts to prEN 781, plain washers to prEN 784 may be used under the nut, however, washers placed under the bolt head shall be chamfered plain washers to prEN 785.

5.4.2 Direct tension indicating washers

1) Direct tension indicating washers and associated hardened nut face and bolt face washers shall be in accordance with the relevant European Standard.

NOTE A European Standard for direct tension indicating washers is under preparation.

2) Direct tension indicating washers shall not be used with weather resistant steels.