



BSI Standards Publication

Execution of steel structures and aluminium structures

Part 2: Technical requirements for steel structures

National foreword

This British Standard is the UK implementation of EN 1090-2:2018+A1:2024. It supersedes BS EN 1090-2:2018, which is withdrawn.

The start and finish of text introduced or altered by amendment is indicated in the text by tags. Tags indicating changes to CEN text carry the number of the CEN amendment. For example, text altered by CEN amendment A1 is indicated by A1 A1.

BSI, as a member of CEN, is obliged to publish EN 1090-2:2018 as a British Standard. However, attention is drawn to the fact that during the development of this European Standard, the UK committee decided to abstain from voting to approve it as a European Standard because it was unable to reach a consensus position.

The UK committee has concerns over the lack of clarity between the scope of BS EN 1090-2:2018 and the scope of the new BS EN 1090-4, particularly regarding product forms, material grades, thickness limits and joining processes.

Another concern with EN 1090-2:2018 is its relationship with both BS EN 1990: 2002+A1:2005 and the design rules in the BS EN 1993 series, particularly about reliability differentiation and the integrity of welded joints. Although EN 1090-2:2018 contains sufficient choices to ensure full compatibility with these standards, care must be taken to ensure the correct choices are made. Further information on these choices is given in Clause NA.2.27.3 of the National Annex to BS EN 1993-1-1:2005+A1:2014.

The UK participation in its preparation was entrusted to Technical Committee CB/203, Design & execution of steel structures.

A list of organizations represented on this committee can be obtained on request to its committee manager.

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English Version

Execution of steel structures and aluminium structures -
Part 2: Technical requirements for steel structures

Exécution des structures en acier et des structures en
aluminium - Partie 2: Exigences techniques pour les
structures en acier

Ausführung von Stahltragwerken und
Aluminiumtragwerken - Teil 2: Technische Regeln für
die Ausführung von Stahltragwerken

This European Standard was approved by CEN on 22 January 2018 and includes Amendment 1 approved by CEN on 19 February 2024.

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European foreword

This document (EN 1090-2:2018+A1:2024) has been prepared by Technical Committee CEN/TC 135 “Execution of steel structures and aluminium structures”, the secretariat of which is held by SN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by November 2024 and conflicting national standards shall be withdrawn at the latest by November 2024.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN shall not be held responsible for identifying any or all such patent rights.

This document includes Amendment 1 approved by CEN on 19 February 2024.

This document supersedes  EN 1090-2:2018 .

The start and finish of text introduced or altered by amendment is indicated in the text by tags  .

This document has been prepared under a standardization request addressed to CEN by the European Commission. The Standing Committee of the EFTA States subsequently approves these requests for its Member States.

This document is part of the EN 1090 series, which comprises the following parts:

- EN 1090-1, *Execution of steel structures and aluminium structures - Part 1: Assessment and verification of constancy of performance for structural components*
- EN 1090-2, *Execution of steel structures and aluminium structures - Part 2: Technical requirements for steel structures*
- EN 1090-3, *Execution of steel structures and aluminium structures - Part 3: Technical requirements for aluminium structures*
- EN 1090-4, *Execution of steel structures and aluminium structures - Part 4: Technical requirements for cold-formed structural steel elements and cold-formed structures for roof, ceiling, floor and wall applications*
- EN 1090-5, *Execution of steel structures and aluminium structures - Part 5: Technical requirements for cold-formed structural aluminium elements and cold-formed structures for roof, ceiling, floor and wall applications*

Technical requirements for cold-formed structural steel elements, members and sheeting and cold-formed steel structures for roof, ceiling, floor, wall, and cladding applications have been removed from this Part of the EN 1090 series, as they are given in EN 1090-4.

Informative Annex B giving guidance for the determination of execution class has been removed as normative requirements for the selection of execution class are now included in of EN 1993-1-1:2005/A1:2014, Annex C.

A new informative Annex D has been included giving guidance on a procedure for checking the capability of thermal cutting processes.

A new informative Annex I has been included giving guidance on determination of the loss of preload from thick coatings on contact surfaces in preloaded connections.

Normative Annex J “Use of compressible washer-type direct tension indicators” has been removed.

A new informative Annex L has been included giving guidance on the selection of weld inspection classes.

Other annexes have been renumbered accordingly:

- Annex D becomes Annex B;
- Annex K becomes Annex J;
- Annex L becomes Annex K.

Annexes A, C, E, F, G, H and M have not been renumbered.

There have been some amendments included in these annexes.

The main text contains some changes. It includes updated cross-references to supporting standards and some corrections.

Any feedback and questions on this document should be directed to the users’ national standards body. A complete listing of these bodies can be found on the CEN website.

According to the CEN-CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Türkiye and the United Kingdom.

Introduction

This European Standard specifies requirements for execution of steel structures, in order to ensure adequate levels of mechanical resistance and stability, serviceability and durability.

This European Standard specifies requirements for execution of steel structures in particular those that are designed according to the EN 1993 series and the steel parts of composite steel and concrete structures designed according to the EN 1994 series.

This European Standard presupposes that the work is carried out with the necessary skill and adequate equipment and resources to perform the work in accordance with the execution specification and the requirements of this European Standard.

1 Scope

This European Standard specifies requirements for execution of structural steelwork as structures or as manufactured components, produced from:

- hot rolled, structural steel products up to and including grade S700;
- cold formed components and sheeting up to and including grade S700 (unless coming within the scope of EN 1090-4);
- hot finished or cold formed austenitic, austenitic-ferritic and ferritic stainless steel products;
- hot finished or cold formed structural hollow sections, including standard range and custom-made rolled products and hollow sections manufactured by welding.

For components produced from cold formed components, and cold formed structural hollow sections that are within the scope of EN 1090-4, the requirements of EN 1090-4 take precedence over corresponding requirements in this European Standard.

This European Standard can also be used for structural steel grades up to and including S960, provided that conditions for execution are verified against reliability criteria and any necessary additional requirements are specified.

This European Standard specifies requirements, which are mostly independent of the type and shape of the steel structure (e.g. buildings, bridges, plated or latticed components) including structures subjected to fatigue or seismic actions. Certain requirements are differentiated in terms of execution classes.

This European Standard applies to structures designed according to the relevant part of the EN 1993 series. Sheet piling, displacement piles and micropiles designed to EN 1993-5 are intended to be executed in accordance with respectively EN 12063, EN 12699 and EN 14199. This European Standard only applies to the execution of waling, bracing, and connections.

This European Standard applies to steel components in composite steel and concrete structures designed according to the relevant part of the EN 1994 series.

This European Standard can be used for structures designed according to other design rules provided that conditions for execution comply with them and any necessary additional requirements are specified.

This European Standard includes the requirements for the welding of reinforcing steels to structural steels. This European Standard does not include requirements for the use of reinforcing steels for reinforced concrete applications.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

2.1 Constituent products

2.1.1 Steels

EN 10017, *Steel rod for drawing and/or cold rolling - Dimensions and tolerances*

EN 10021, *General technical delivery conditions for steel products*

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

EN 10025-1, *Hot rolled products of structural steels - Part 1: General technical delivery conditions*

EN 10025-2, *Hot rolled products of structural steels - Part 2: Technical delivery conditions for non-alloy structural steels*

EN 10025-3, *Hot rolled products of structural steels - Part 3: Technical delivery conditions for normalized/normalized rolled weldable fine grain structural steels*

EN 10025-4, *Hot rolled products of structural steels - Part 4: Technical delivery conditions for thermomechanical rolled weldable fine grain structural steels*

EN 10025-5, *Hot rolled products of structural steels - Part 5: Technical delivery conditions for structural steels with improved atmospheric corrosion resistance*

EN 10025-6, *Hot rolled products of structural steels - Part 6: Technical delivery conditions for flat products of high yield strength structural steels in the quenched and tempered condition*

EN 10029, *Hot-rolled steel plates 3 mm thick or above - Tolerances on dimensions and shape*

EN 10034, *Structural steel I and H sections - Tolerances on shape and dimensions*

EN 10048, *Hot rolled narrow steel strip - Tolerances on dimensions and shape*

EN 10051, *Continuously hot-rolled strip and plate/sheet cut from wide strip of non-alloy and alloy steels - Tolerances on dimensions and shape*

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

EN 10056-1, *Structural steel equal and unequal leg angles - Part 1: Dimensions*

EN 10056-2, *Structural steel equal and unequal leg angles - Part 2: Tolerances on shape and dimensions*

EN 10058, *Hot rolled flat steel bars for general purposes - Dimensions and tolerances on shape and dimensions*

EN 10059, *Hot rolled square steel bars for general purposes - Dimensions and tolerances on shape and dimensions*

EN 10060, *Hot rolled round steel bars for general purposes - Dimensions and tolerances on shape and dimensions*

EN 10061, *Hot rolled hexagon steel bars for general purposes - Dimensions and tolerances on shape and dimensions*

EN 10080, *Steel for the reinforcement of concrete - Weldable reinforcing steel - General*

EN 10088-1, *Stainless steels - Part 1: List of stainless steels*

EN 10088-4:2009, *Stainless steels - Part 4: Technical delivery conditions for sheet/plate and strip of corrosion resisting steels for construction purposes*

EN 10088-5:2009, *Stainless steels - Part 5: Technical delivery conditions for bars, rods, wire, sections and bright products of corrosion resisting steels for construction purposes*

EN 10131, *Cold rolled uncoated and zinc or zinc-nickel electrolytically coated low carbon and high yield strength steel flat products for cold forming - Tolerances on dimensions and shape*

EN 10139, *Cold rolled uncoated low carbon steel narrow strip for cold forming - Technical delivery conditions*

EN 10140, *Cold rolled narrow steel strip - Tolerances on dimensions and shape*

EN 10143, *Continuously hot-dip coated steel sheet and strip - Tolerances on dimensions and shape*

EN 10149 (all parts), *Hot rolled flat products made of high yield strength steels for cold forming*

EN 10163 (all parts), *Delivery requirements for surface condition of hot-rolled steel plates, wide flats and sections*

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

EN 10169, *Continuously organic coated (coil coated) steel flat products - Technical delivery conditions*

EN 10204, *Metallic products - Types of inspection documents*

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

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

A1 EN 10210-3, *Hot finished steel structural hollow sections of non-alloy and fine grain steels - Part 3 : Technical delivery conditions for high strength and weather resistant steels* **A1**

EN 10219-1, *Cold formed welded structural hollow sections of non-alloy and fine grain steels - Part 1: Technical delivery conditions*

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

A1 EN 10219-3, *Cold formed welded steel structural hollow sections of non-alloy and fine grain steels - Part 3 : Technical delivery conditions for high strength and weather resistant steels* **A1**

EN 10268, *Cold rolled steel flat products with high yield strength for cold forming - Technical delivery conditions*

EN 10279, *Hot rolled steel channels - Tolerances on shape, dimensions and mass*

EN 10296-2:2005, *Welded circular steel tubes for mechanical and general engineering purposes - Technical delivery conditions - Part 2: Stainless steel*

EN 10297-2:2005, *Seamless circular steel tubes for mechanical and general engineering purposes - Technical delivery conditions - Part 2: Stainless steel*

EN 10346, *Continuously hot-dip coated steel flat products for cold forming - Technical delivery conditions*

EN 10365, *Hot rolled steel channels, I and H sections - Dimensions and masses*

EN ISO 1127, *Stainless steel tubes - Dimensions, tolerances and conventional masses per unit length (ISO 1127)*

EN ISO 9444-2, *Continuously hot-rolled stainless steel - Tolerances on dimensions and form - Part 2: Wide strip and sheet/plate (ISO 9444-2)*

EN ISO 9445 (all parts), *Continuously cold-rolled stainless steel - Tolerances on dimensions and form - Part 1: Narrow strip and cut lengths (ISO 9445 series)*

EN ISO 18286, *Hot-rolled stainless steel plates - Tolerances on dimensions and shape (ISO 18286)*

ISO 4997, *Cold-reduced carbon steel sheet of structural quality*

2.1.2 Steel castings

EN 1559-1, *Founding - Technical conditions of delivery - Part 1: General*

EN 1559-2, *Founding - Technical conditions of delivery - Part 2: Additional requirements for steel castings*

EN 10340, *Steel castings for structural uses*

2.1.3 Welding consumables

EN ISO 636, *Welding consumables - Rods, wires and deposits for tungsten inert gas welding of non-alloy and fine-grain steels - Classification (ISO 636)*

EN ISO 2560, *Welding consumables - Covered electrodes for manual metal arc welding of non-alloy and fine grain steels - Classification (ISO 2560)*

EN ISO 3581, *Welding consumables - Covered electrodes for manual metal arc welding of stainless and heat-resisting steels - Classification (ISO 3581)*

EN ISO 13918, *Welding - Studs and ceramic ferrules for arc stud welding (ISO 13918)*

EN ISO 14171, *Welding consumables - Solid wire electrodes, tubular cored electrodes and electrode/flux combinations for submerged arc welding of non alloy and fine grain steels - Classification (ISO 14171)*

EN ISO 14174, *Welding consumables - Fluxes for submerged arc welding and electroslag welding - Classification (ISO 14174)*

EN ISO 14175, *Welding consumables - Gases and gas mixtures for fusion welding and allied processes (ISO 14175)*

EN ISO 14341, *Welding consumables - Wire electrodes and weld deposits for gas shielded metal arc welding of non alloy and fine grain steels - Classification (ISO 14341)*

EN ISO 14343, *Welding consumables - Wire electrodes, strip electrodes, wires and rods for arc welding of stainless and heat resisting steels - Classification (ISO 14343)*

EN ISO 16834, *Welding consumables - Wire electrodes, wires, rods and deposits for gas shielded arc welding of high strength steels - Classification (ISO 16834)*

EN ISO 17632, *Welding consumables - Tubular cored electrodes for gas shielded and non-gas shielded metal arc welding of non-alloy and fine grain steels - Classification (ISO 17632)*

EN ISO 17633, *Welding consumables - Tubular cored electrodes and rods for gas shielded and non-gas shielded metal arc welding of stainless and heat-resisting steels - Classification (ISO 17633)*

EN ISO 18275, *Welding consumables - Covered electrodes for manual metal arc welding of high-strength steels - Classification (ISO 18275)*

EN ISO 18276, *Welding consumables - Tubular cored electrodes for gas-shielded and non-gas-shielded metal arc welding of high strength steels - Classification (ISO 18276)*

EN ISO 26304, *Welding consumables - Solid wire electrodes, tubular cored electrodes and electrode-flux combinations for submerged arc welding of high strength steels - Classification (ISO 26304)*

2.1.4 Mechanical fasteners

EN 14399 (all parts), *High-strength structural bolting assemblies for preloading*

EN 15048 (all parts), *Non-preloaded structural bolting assemblies*

EN ISO 898-1, *Mechanical properties of fasteners made of carbon steel and alloy steel - Part 1: Bolts, screws and studs with specified property classes - Coarse thread and fine pitch thread (ISO 898-1)*

EN ISO 898-2, *Mechanical properties of fasteners made of carbon steel and alloy steel - Part 2: Nuts with specified property classes - Coarse thread and fine pitch thread (ISO 898-2)*

EN ISO 3506-1, *Mechanical properties of corrosion-resistant stainless steel fasteners - Part 1: Bolts, screws and studs (ISO 3506-1)*

EN ISO 3506-2, *Mechanical properties of corrosion-resistant stainless steel fasteners - Part 2: Nuts (ISO 3506-2)*

EN ISO 4042, *Fasteners - Electroplated coatings (ISO 4042)*

EN ISO 6789 (all parts), *Assembly tools for screws and nuts - Hand torque tools (ISO 6789)*

EN ISO 7089, *Plain washers - Normal series - Product grade A (ISO 7089)*

EN ISO 7090, *Plain washers, chamfered - Normal series - Product grade A (ISO 7090)*

EN ISO 7091, *Plain washers - Normal series - Product grade C (ISO 7091)*

EN ISO 7092, *Plain washers - Small series - Product grade A (ISO 7092)*

EN ISO 7093-1, *Plain washers - Large series - Part 1: Product grade A (ISO 7093-1)*

EN ISO 7094, *Plain washers - Extra large series - Product grade C (ISO 7094)*

EN ISO 10684, *Fasteners - Hot dip galvanized coatings (ISO 10684)*

EN ISO 21670, *Fasteners - Hexagon weld nuts with flange (ISO 21670)*

2.1.5 High strength cables

prEN 10138-3, *Prestressing steels - Part 3: Strand*

EN 10244-2, *Steel wire and wire products - Non-ferrous metallic coatings on steel wire - Part 2: Zinc or zinc alloy coatings*

EN 10264-3, *Steel wire and wire products - Steel wire for ropes - Part 3: Round and shaped non alloyed steel wire for high duty applications*

EN 10264-4, *Steel wire and wire products - Steel wire for ropes - Part 4: Stainless steel wire*

EN 12385-1, *Steel wire ropes - Safety - Part 1: General requirements*

EN 12385-10, *Steel wire ropes - Safety - Part 10: Spiral ropes for general structural applications*

EN 13411-4, *Terminations for steel wire ropes - Safety - Part 4: Metal and resin socketing*

2.1.6 Structural bearings

EN 1337-2, *Structural bearings - Part 2: Sliding elements*

EN 1337-3, *Structural bearings - Part 3: Elastomeric bearings*

EN 1337-4, *Structural bearings - Part 4: Roller bearings*

EN 1337-5, *Structural bearings - Part 5: Pot bearings*

EN 1337-6, *Structural bearings - Part 6: Rocker bearings*

EN 1337-7, *Structural bearings - Part 7: Spherical and cylindrical PTFE bearings*

EN 1337-8, *Structural bearings - Part 8: Guide Bearings and Restraint Bearings*

2.2 Preparation

EN ISO 286-2, *Geometrical product specifications (GPS) - ISO code system for tolerances on linear sizes - Part 2: Tables of standard tolerance classes and limit deviations for holes and shafts (ISO 286-2)*

EN ISO 9013, *Thermal cutting - Classification of thermal cuts - Geometrical product specification and quality tolerances (ISO 9013)*

CEN/TR 10347, *Guidance for forming of structural steels in processing*

2.3 Welding

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

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

EN 1011-3, *Welding - Recommendations for welding of metallic materials - Part 3: Arc welding of stainless steels*

EN ISO 3834 (all parts), *Quality requirements for fusion welding of metallic materials (ISO 3834)*

EN ISO 4063, *Welding and allied processes - Nomenclature of processes and reference numbers (ISO 4063)*

EN ISO 5817:2014, *Welding - Fusion-welded joints in steel, nickel, titanium and their alloys (beam welding excluded) - Quality levels for imperfections (ISO 5817:2014)*

EN ISO 9606-1:2017, *Qualification testing of welders - Fusion welding - Part 1: Steels (ISO 9606-1:2017)*

EN ISO 9692-1, *Welding and allied processes - Types of joint preparation - Part 1: Manual metal arc welding, gas-shielded metal arc welding, gas welding, TIG welding and beam welding of steels (ISO 9692-1)*

EN ISO 9692-2, *Welding and allied processes - Joint preparation - Part 2: Submerged arc welding of steels (ISO 9692-2)*

EN ISO 11970, *Specification and qualification of welding procedures for production welding of steel castings (ISO 11970)*

EN ISO 13916, *Welding - Guidance on the measurement of preheating temperature, interpass temperature and preheat maintenance temperature (ISO 13916)*

EN ISO 14554 (all parts), *Quality requirements for welding - Resistance welding of metallic materials (ISO 14554 series)*

EN ISO 14555, *Welding - Arc stud welding of metallic materials (ISO 14555)*

EN ISO 14731, *Welding coordination - Tasks and responsibilities (ISO 14731)*

EN ISO 14732, *Welding personnel - Qualification testing of welding operators and weld setters for mechanized and automatic welding of metallic materials (ISO 14732)*

EN ISO 15607, *Specification and qualification of welding procedures for metallic materials - General rules (ISO 15607)*

CEN ISO/TR 15608, *Welding - Guidelines for a metallic material grouping system*

EN ISO 15609 (all parts), *Specification and qualification of welding procedures for metallic materials - Welding procedure specification (ISO 15609 series)*

EN ISO 15610, *Specification and qualification of welding procedures for metallic materials - Qualification based on tested welding consumables (ISO 15610)*

EN ISO 15611, *Specification and qualification of welding procedures for metallic materials - Qualification based on previous welding experience (ISO 15611)*

EN ISO 15612, *Specification and qualification of welding procedures for metallic materials - Qualification by adoption of a standard welding procedure (ISO 15612)*

EN ISO 15613, *Specification and qualification of welding procedures for metallic materials - Qualification based on pre-production welding test (ISO 15613)*

EN ISO 15614-1, *Specification and qualification of welding procedures for metallic materials - Welding procedure test - Part 1: Arc and gas welding of steels and arc welding of nickel and nickel alloys (ISO 15614-1)*

EN ISO 15614-11, *Specification and qualification of welding procedures for metallic materials - Welding procedure test - Part 11: Electron and laser beam welding (ISO 15614-11)*

EN ISO 15614-12, *Specification and qualification of welding procedures for metallic materials - Welding procedure test - Part 12: Spot, seam and projection welding (ISO 15614-12)*

EN ISO 15614-13, *Specification and qualification of welding procedures for metallic materials - Welding procedure test - Part 13: Upset (resistance butt) and flash welding (ISO 15614-13)*

EN ISO 15620, *Welding - Friction welding of metallic materials (ISO 15620)*

EN ISO 17652-1, *Welding - Test for shop primers in relation to welding and allied processes - Part 1: General requirements (ISO 17652-1)*

EN ISO 17652-2, *Welding - Test for shop primers in relation to welding and allied processes - Part 2: Welding properties of shop primers (ISO 17652-2)*

EN ISO 17652-3, *Welding - Test for shop primers in relation to welding and allied processes - Part 3: Thermal cutting (ISO 17652-3)*

EN ISO 17652-4, *Welding - Test for shop primers in relation to welding and allied processes - Part 4: Emission of fumes and gases (ISO 17652-4)*

EN ISO 17660 (all parts), *Welding - Welding of reinforcing steel (ISO 17660 series)*

2.4 Testing

EN 10160, *Ultrasonic testing of steel flat product of thickness equal or greater than 6 mm (reflection method)*

EN ISO 3452-1, *Non-destructive testing - Penetrant testing - Part 1: General principles (ISO 3452-1)*

EN ISO 6507 (all parts), *Metallic materials - Vickers hardness test - Part 1: Test method (ISO 6507 series)*

EN ISO 9018, *Destructive tests on welds in metallic materials - Tensile test on cruciform and lapped joints (ISO 9018)*

EN ISO 9712, *Non-destructive testing - Qualification and certification of NDT personnel (ISO 9712)*

EN ISO 17635, *Non-destructive testing of welds - General rules for metallic materials (ISO 17635)*

EN ISO 17636 (all parts), *Non-destructive testing of welds - Radiographic testing (ISO 17636 series)*

EN ISO 17637, *Non-destructive testing of welds - Visual testing of fusion-welded joints (ISO 17637)*

EN ISO 17638, *Non-destructive testing of welds - Magnetic particle testing (ISO 17638)*

EN ISO 17640, *Non-destructive testing of welds - Ultrasonic testing - Techniques, testing levels and assessment (ISO 17640)*

EN ISO 23279, *Non-destructive testing of welds - Ultrasonic testing - Characterization of indications in welds (ISO 23279)*

2.5 Erection

EN 1337-11, *Structural bearings - Part 11: Transport, storage and installation*

ISO 4463 (all parts), *Measurement methods for building - Setting-out and measurement*

2.6 Corrosion protection

EN ISO 1461, *Hot dip galvanized coatings on fabricated iron and steel articles - Specifications and test methods (ISO 1461)*

EN ISO 2063 (all parts), *Thermal spraying - Metallic and other inorganic coatings - Zinc, aluminium and their alloys (ISO 2063 series)*

EN ISO 2808, *Paints and varnishes - Determination of film thickness (ISO 2808)*

EN ISO 8501 (all parts), *Preparation of steel substrates before application of paints and related products - Visual assessment of surface cleanliness (ISO 8501)*

EN ISO 8502 (all parts), *Preparation of steel substrates before application of paints and related products - Tests for the assessment of surface (ISO 8502)*

EN ISO 8503 (all parts), *Preparation of steel substrates before application of paints and related products - Surface roughness characteristics of blast-cleaned steel substrates (ISO 8503)*

EN ISO 8504 (all parts), *Preparation of steel substrates before application of paints and related products - Surface preparation methods (ISO 8504)*

EN ISO 12670, *Thermal spraying - Components with thermally sprayed coatings - Technical supply conditions (ISO 12670)*

EN ISO 12679, *Thermal spraying - Recommendations for thermal spraying (ISO 12679)*

EN ISO 12944 (all parts), *Paints and varnishes - Corrosion protection of steel structures by protective paint systems (ISO 12944-1 series)*

EN ISO 14713-1:2017, *Zinc coatings - Guidelines and recommendations for the protection against corrosion of iron and steel in structures - Part 1: General principles of design and corrosion resistance (ISO 14713-1)*

EN ISO 14713-2, *Zinc coatings - Guidelines and recommendations for the protection against corrosion of iron and steel in structures - Part 2: Hot dip galvanizing (ISO 14713-2)*

ISO 19840, *Paints and varnishes - Corrosion protection of steel structures by protective paint systems - Measurement of, and acceptance criteria for, the thickness of dry films on rough surfaces*

2.7 Miscellaneous

EN 1090-4, *Execution of steel structures and aluminium structures - Part 4: Technical requirements for cold-formed structural steel elements and cold-formed structures for roof, ceiling, floor and wall applications*

EN 1993-1-6, *Eurocode 3 - Design of steel structures - Part 1-6: Strength and Stability of Shell Structures*

EN 1993-1-8, *Eurocode 3: Design of steel structures - Part 1-8: Design of joints*

EN 1993-1-9:2005, *Eurocode 3: Design of steel structures - Part 1-9: Fatigue*

EN 1993-2:2006, *Eurocode 3 - Design of steel structures - Part 2: Steel Bridges*

EN 13670, *Execution of concrete structures*

ISO 2859-5, *Sampling procedures for inspection by attributes - Part 5: System of sequential sampling plans indexed by acceptance quality limit (AQL) for lot-by-lot inspection*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- IEC Electropedia: available at <https://www.electropedia.org/>
- ISO Online browsing platform: available at <https://www.iso.org/obp>

3.1

construction works

everything that is constructed or results from construction operations

Note 1 to entry: This term covers both building and civil engineering works. It refers to the complete construction comprising both structural and non-structural components.

3.2

works

parts of construction works that are structural steelwork

3.3

structural steelwork

steel structures or manufactured steel components used in construction works

3.4

constructor

 person or organization responsible for the execution of the works 

3.5

structure

organized combination of connected parts designed to carry loads and provide adequate rigidity

[SOURCE: EN 1990:2002, 1.5.1.6]

3.6

manufacturing

activity required to produce and deliver a component

Note 1 to entry: As relevant, this comprises e.g. procurement, preparation and assembly, welding, mechanical fastening, transportation, surface treatment, and the inspection and documentation thereof.

3.7

execution

activity performed for the physical completion of the works

Note 1 to entry: i.e. manufacturing, erection and the inspection and documentation thereof.

3.7.1

execution specification

set of documents covering technical data and requirements for a particular steel structure including those specified to supplement and qualify the rules of this European Standard

Note 1 to entry: Execution specification includes requirements where this European Standard identifies items to be specified by provision of additional information or adoption of permitted options (see Annex A).

3.7.2

execution class

classified set of requirements specified for the execution of the works as a whole, of an individual component or of a detail of a component

3.8

constituent product

material and product used for manufacturing a component and which remains as part of it, e.g. structural steel product, stainless steel product, mechanical fastener, welding consumable

3.9

component

part of a steel structure, which may itself be an assembly of several smaller components

3.9.1

cold formed component

cold formed long products or profiled sheet having various cross section shapes, either open or with edges abutting, constant along their length, made from coated or uncoated hot or cold rolled flat products whose thicknesses are only slightly modified by the cold forming process (e.g. profiling, drawing, press forming, flanging, etc.)

[SOURCE: EN 10079:2007, 3.4.9]

3.10

preparation

activity performed on the constituent steel products to produce the parts ready for assembly and inclusion in components

Note 1 to entry: As relevant, this comprises e.g. identification, handling and storage, cutting, shaping and holing.

3.11

design basis method of erection

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

3.11.1

erection method statement

documentation describing the procedures to be used to erect a structure

3.12

inspection and test plan

ITP

plan that includes inspection and/or testing of documents and/or materials and/or workmanship

3.13**nonconformity**

non-fulfilment of a requirement

[SOURCE: EN ISO 9000:2015, 3.6.9, modified]

3.14**supplementary NDT****supplementary non-destructive testing**

NDT technique which is supplementary to visual examination (VT), e.g. magnetic particle (MT), penetrant (PT), eddy current (ET), ultrasonic (UT) or radiographic testing (RT)

3.15**tolerance**

difference between the upper limit of size and the lower limit of size

Note 1 to entry: Tolerance is an absolute value without sign.

[SOURCE: ISO 1803:1997, 3.11, Notes 2 and 3 deleted]

3.15.1**essential tolerance**

basic limit for a geometrical tolerance necessary to satisfy the design assumptions for structures in terms of mechanical resistance and stability

3.15.2**functional tolerance**

geometrical tolerance, which might be required to meet a function other than mechanical resistance and stability, e.g. appearance or fit up

3.15.3**special tolerance**

geometrical tolerance which is not covered by the tabulated types or values of tolerances given in this European Standard, and which needs to be specified in a particular case

3.15.4**manufacturing tolerance**

permitted range in the size of a dimension of a component resulting from component manufacture

3.16**high-strength steels****HSS**

structural steels (hollow sections, flat and long steel products) with minimum yield strength greater than 460 MPa in the thermomechanically rolled or quenched and tempered condition

Note 1 to entry: High-strength steels in this standard are divided into four categories, which are used to differentiate quality requirements:

- Category A1 for steel grades > S460 and ≤ S700, thermomechanically rolled;
- Category A2 for steel grades > S460 and ≤ S700, quenched and tempered;
- Category B1 for steel grades > S700 and ≤ S960, thermomechanically rolled;
- Category B2 for steel grades > S700 and ≤ S960, quenched and tempered.

Note 2 to entry: This definition does not apply to reinforcing steels. 

4 Specifications and documentation

4.1 Execution Specification

4.1.1 General

The necessary information and technical requirements for execution of each part of the works shall be agreed and complete before commencement of execution of that part of the works. There shall be procedures for making alterations to previously agreed execution specification. Execution specification shall consider such of the following items as are relevant:

- a) additional information, as listed in A.1;
- b) options, as listed in A.2;
- c) execution classes, see 4.1.2;
- d) preparation grades, see 4.1.3;
- e) tolerance classes, see 4.1.4;
- f) technical requirements regarding the safety of the works, see 4.2.3.

4.1.2 Execution classes

Four execution classes 1 to 4, denoted EXC1 to EXC4, are given, for which requirement strictness increases from EXC1 to EXC3 with EXC4 being based on EXC3 with further project specific requirements (e.g. see 7.6.1, 12.4.2.3 and 12.4.2.4).

The execution specification shall specify the relevant execution class or classes.

NOTE The requirements for the basis for the selection of execution classes are given in EN 1993-1-1:2005/A1:2014, Annex C.

The list of requirements related to execution classes is given in A.3.

4.1.3 Requirements for surface preparation for corrosion protection

With respect to the preparation of welds, edges and other areas with surface imperfections for the application of paint and related products, three preparation grades, denoted P1 to P3 according to EN ISO 8501-3, are given, for which requirement strictness increases from P1 to P3.

NOTE Preparation grades classify visible imperfections suitable for the application of paints and related products.

The execution specification shall specify the relevant preparation grades if appropriate.

Preparation grades may apply to the whole structure or to a part of the structure or to specific details. A structure can include several preparation grades. A detail or group of details will normally be ascribed one preparation grade.

4.1.4 Geometrical tolerances

Two types of geometrical tolerances are defined in 11.1 and in Annex B:

- a) essential tolerances;
- b) functional tolerances, with two classes for which requirement strictness increases from class 1 to class 2.

4.2 Constructor's documentation

4.2.1 Quality documentation

The following points shall be documented for EXC2, EXC3 and EXC4:

- a) organization chart and managerial staff responsible for each aspect of the execution;
- b) the procedures, methods and work instructions to be applied;
- c) an inspection and test plan specific to the works;
- d) a procedure for handling changes and modifications;
- e) a procedure for handling of nonconformities;
- f)  if specified,  hold-points or requirement to witness inspections or tests, and any consequent access requirements.

4.2.2 Quality plan

It shall be specified if a quality plan for execution of the works is required.

A quality plan shall include:

- a) a general management document which shall address the following points:
 - 1) review of specification requirements against process capabilities;
 - 2) the allocation of tasks and authority during the various phases of the project;
 - 3) principles and organization arrangements for inspection including allocation of responsibilities for each inspection task;
- b) quality documentation prior to execution. The documents shall be produced before execution of the construction step to which they relate;
- c) execution records, which are actual records of inspections and checks carried out, or which demonstrate qualification or certification of implemented resources.

Annex C gives a checklist for the content of a quality plan recommended for the execution of structural steelwork.

4.2.3 Safety of the erection works

Method statements giving detailed work instructions shall comply with the technical requirements relating to the safety of the erection works as given in 9.2 and 9.3.

4.2.4 Execution documentation

Sufficient documentation shall be prepared during execution and as a record of the as-built structure to demonstrate that the works have been carried out according to the execution specification.

5 Constituent products

5.1 General

Generally, constituent products to be used for the execution of steel structures shall be selected from the relevant European Standards listed in the following clauses.

If constituent products that are not covered by the standards listed are to be used, their properties shall be specified. The relevant properties to be specified shall be as follows:

- a) strength (yield and tensile);
- b) elongation;
- c) stress reduction of area requirements (STRA), if required;
- d) tolerances on dimensions and shape;
- e) impact strength or toughness, if required;
- f) heat treatment delivery condition;
- g) through thickness requirements (Z-quality), if required;
- h) limits on internal discontinuities or cracks in zones to be welded, if required.

In addition, if the steel is to be welded, its weldability shall be declared as follows:

- i) classification in accordance with the materials grouping system defined in CEN ISO/TR 15608 or;
- j) a maximum limit for the carbon equivalent of the steel, or;
- k) a declaration of its chemical composition in sufficient detail for its carbon equivalent to be calculated.

Definitions and requirements of EN 10021 shall apply together with those of the relevant European product standard.

5.2 Identification, inspection documents and traceability

The properties of supplied constituent products shall be documented in a way that enables them to be compared to the specified properties. Their conformity with the relevant product standard shall be checked in accordance with 12.2.

For metallic products, the inspection documents according to EN 10204 shall be as listed in Table 1. Type 3.2 inspection documents are also suitable if Type 3.1 documents are listed in Table 1.

For structural bolting assemblies and other fasteners, inspection documents according to the EN ISO 16228 series may be used instead of documents according to EN 10204.

Table 1 — Inspection documents for metallic products

Constituent product	Inspection documents
Structural steels (Tables 2 and 3) $\langle A_1 \rangle$ § $\langle A_1 \rangle$	
Structural steel grade $\leq$ S275	2.2 ^{a, b}
Structural steel grade $>$ S275	3.1 ^b
Stainless steels (Table 4)	
Minimum 0,2 % tensile yield strength $\leq$ 240 MPa	2.2
Minimum 0,2 % tensile yield strength $>$ 240 MPa	3.1
Steel castings	3.1 ^c
Welding consumables (Table 5)	2.2
Structural bolting assemblies to the EN 14399 series	3.1 ^{d, e}
Structural bolting assemblies to the EN 15048 series	2.1
Bolts ^f , nuts ^f , or washers ^f	2.1
Solid rivets for hot riveting	2.1
Self-tapping and self-drilling screws and blind rivets	2.1
Studs for arc stud welding	3.1
Expansion joints for bridges	3.1
High strength cables	3.1
Structural bearings	3.1
^a Inspection document 3.1 if specified minimum yield strength 275 MPa and specified impact energy tested at a temperature less than 0 °C. ^b EN 10025-1:2004 requires that the elements included in the CEV formula shall be reported in the inspection document. The reporting of other added elements required by EN 10025-2 shall include Al, Nb, and Ti. ^c Inspection document 2.2 if specified minimum yield strength $\leq$ 355 MPa and specified impact energy tested at a temperature of 20 °C. ^d If assemblies are marked with a manufacturing lot number and the manufacturer can trace the measured characteristic values from the internal (factory) production control records on the basis of this number, the 3.1 inspection certificate as in EN 10204 may be omitted. ^e The inspection documents shall include the results of the suitability tests. ^f Applicable if bolts, nuts or washers are supplied for use in non-preloaded applications and not as a component of a fastener assembly to the EN 14399 series or the EN 15048 series. $\langle A_1 \rangle$ § For HSS, the chemical composition (heat analysis) for the following 14 elements shall be required and certified: C, Si, Mn, P, S, Al, N, Cr, Cu, Mo, Ni, Nb, Ti and V, with the designation in accordance with EN 10027. $\langle A_1 \rangle$	

For EXC3 and EXC4, constituent products shall be traceable at all stages from receipt to hand over after incorporation in the works.

This traceability may be based on records for batches of product allocated to a common production process, unless traceability for each individual constituent product is specified.

For EXC2, EXC3 and EXC4, if differing grades and/or qualities of constituent products are in circulation together, each individual constituent product shall be designated with a mark that identifies its grade and its quality.

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

If marking is required, unmarked constituent products shall be treated as nonconforming product.

5.3 Structural steel products

5.3.1 General

Structural steel products shall conform to the requirements of the relevant European product standards as listed in Tables 2, 3 and 4, unless otherwise specified. Grades, qualities and, if appropriate, coating weights and finishes, shall be specified together with any required options permitted by the product standard, including those related to suitability for hot dip zinc-coating, if relevant.

Steel products to be used in the manufacture of cold formed components shall have properties that conform to the required suitability for cold forming process. Carbon steels suitable for cold forming are listed in Table 3.

Table 2 — Product standards for structural carbon steels

Products	Technical delivery requirements	Dimensions	Tolerances
I and H sections	EN 10025-1 and EN 10025-2 EN 10025-3 EN 10025-4 EN 10025-5 EN 10025-6 as relevant	EN 10365	EN 10034
Hot-rolled taper flange I sections		EN 10365	EN 10024
Channels		EN 10365	EN 10279
Equal and unequal leg angles		EN 10056-1	EN 10056-2
T Sections		EN 10055	EN 10055
Plates, flats, wide flats		Not applicable	EN 10029 EN 10051
Bars and rods		EN 10017, EN 10058, EN 10059, EN 10060, EN 10061	EN 10017, EN 10058, EN 10059, EN 10060, EN 10061
Hot finished hollow sections	EN 10210-1 [A1] EN 10210-3 as relevant [A1]	EN 10210-2	EN 10210-2
Cold formed hollow sections	EN 10219-1 [A1] EN 10219-3 as relevant [A1]	EN 10219-2	EN 10219-2
[A1] The national product standards or national recommendations or steel producer's guidelines should be considered. [A1]			
NOTE 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.			

Table 3 — Product standards for sheet and strip suitable for cold forming

Products	Technical delivery requirements	Tolerances
Non-alloy structural steels	EN 10025-2	EN 10051
Weldable fine grain structural steels	EN 10025-3, EN 10025-4	EN 10051
High yield strength steels for cold forming	EN 10149 series, EN 10268	EN 10029, EN 10048, EN 10051, EN 10131, EN 10140
Cold reduced steels	ISO 4997	EN 10131
Continuously coated hot dip coated steels	EN 10346	EN 10143
Continuously organic coated steel flat products	EN 10169	EN 10169
Narrow strips	EN 10139	EN 10048 EN 10140

Table 4 — Product standards for stainless steels

Products	Technical delivery requirements	Tolerances
Sheets, plates and strips	EN 10088-4	EN ISO 9444-2, EN ISO 9445 (all parts), EN ISO 18286
Tubes (welded)	EN 10296-2	EN ISO 1127
Tubes (seamless)	EN 10297-2	
Bars, rods and sections	EN 10088-5	EN 10017, EN 10058, EN 10059, EN 10060, EN 10061
Steel designations by name and number are given in EN 10088-1.		

For structural steel products other than those conforming to the requirements of the relevant European product standards as listed in Tables 2, 3 and 4, a declaration of the characteristics of the steel products shall be compared with the required properties given in the execution specification (see 5.1).

With respect to the properties that are declared, the basis for the declarations shall be provided.

NOTE For instance, reference standards for test methods used to establish values for declared properties, whether properties are specific to an identified lot, cast or heat; and whether chemical properties are based on ladle or product analysis.

5.3.2 Thickness tolerances

Unless otherwise specified, the thickness tolerances for structural steel plates shall be class A in accordance with EN 10029 for hot rolled steel plates and EN ISO 18286 for hot-rolled stainless steel plates.

5.3.3 Surface conditions

For carbon steels, surface condition requirements are as follows:

- a) class A1 for plates and wide flats in accordance with the requirements of EN 10163-2;
- b) class C1 for sections in accordance with the requirements of EN 10163-3.

Execution specifications shall specify if imperfections such as cracks, shell and seams shall be repaired.

For stainless steel, the surface finish requirements shall be as follows:

- a) sheet, plate and strip: in accordance with the requirements of EN 10088-4;
- b) bars, rods and sections: in accordance with the requirements of EN 10088-5.

The execution specification shall specify additional requirements related to the following items: special restrictions on either surface imperfections or repair of surface defects by grinding in accordance with the EN 10163 series, or with the EN 10088-4 and EN 10088-5 for stainless steel, if required.

For other products, the surface condition requirements shall be specified in terms of appropriate European or International specifications.

The surface condition of constituent products shall be such that the relevant requirements for surface preparation grade in accordance with 10.2 can be achieved.

5.3.4 Additional properties

Unless otherwise specified, internal discontinuity quality class S1 of EN 10160 shall be used for welded cruciform joints transmitting primary tensile stresses through the plate thickness on a band of width four times the thickness of the plate each side of the proposed attachment.

It shall be specified whether areas close to bearing diaphragms or stiffeners should be checked for the existence of internal discontinuities. In this case quality class S1 of EN 10160 shall apply to a band of flange or web plate of width 25 times the plate thickness each side of a bearing diaphragm or stiffener if attached by welding.

In addition, requirements related to the following items shall be specified if relevant:

- a) testing on constituent products, other than stainless steels, to identify internal discontinuities or cracks in zones to be welded;
- b) improved deformation properties perpendicular to the surface of constituent products, other than stainless steels, in accordance with EN 10164;
- c) special delivery conditions of stainless steels, for example Pitting Resistance Equivalent Number (PREN) or accelerated corrosion testing. The PREN shall be given by $(1 \times \%Cr + 3,3 \times \%Mo + 16 \times \%N)$, in which the elements are in mass fraction percent, unless otherwise specified;
- d) processing conditions if constituent products are to be processed before delivery.

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

5.4 Steel castings

Steel castings shall conform to the requirements in EN 10340. The technical delivery conditions (grades, qualities and, if appropriate, surface conditions) shall be specified together with any required options permitted by the product standard including necessary information and options as required in EN 1559-1 and EN 1559-2. Unless otherwise specified the properties of delivered castings shall be evaluated by testing.

Unless otherwise specified, the testing shall include:

- a) 100 % visual inspection;
- b) the following destructive tests on items taken at random during production. The execution specification shall specify whether the items shall be destructive product samples, extension pieces or separate items cast simultaneously:
 - 1) tensile and elongation tests (one unit per melt);
 - 2) impact tests (three units per melt);
 - 3) reduction of area test (one unit per melt if relevant);
 - 4) chemical analysis (one unit per melt);
 - 5) microscopic examination of cross-sections (one unit per melt).
- c) the following non-destructive tests on items taken at random from each manufacturing lot:
 - 1) MT or PT of surface-breaking discontinuities on 10 % of each manufacturing lot, and;
 - 2) UT or RT to detect sub-surface discontinuities on 10 % of each manufacturing lot.

Unless otherwise specified, the acceptance criteria for cast steel components are:

- SM2 and LM3/AM3 to EN 1369 for MT;
- Severity level 2 to EN 12680-1 for UT;
- Severity level 3 for RT.

5.5 Welding consumables

All welding consumables shall conform to the requirements of the appropriate product standard as listed in Table 5.

Table 5 — Product standards for welding consumables

Welding consumables	Product standards
Shielding gases for arc welding and cutting	EN ISO 14175
Wire electrodes and deposits for gas-shielded metal arc welding of non-alloy and fine grain steels	EN ISO 14341
Solid wires, solid wire-flux and tubular cored electrode-flux combinations for submerged arc welding of non-alloy and fine grain steels	EN ISO 14171
Covered electrodes for manual arc welding of high strength steels	EN ISO 18275
Tubular cored electrodes for metal arc welding with and without gas shield of non-alloy and fine grain steels	EN ISO 17632
Fluxes for submerged arc welding	EN ISO 14174
Covered electrodes for manual arc welding of stainless and heat resisting steels	EN ISO 3581
Rods, wires and deposits for tungsten inert gas welding of non-alloy and fine grain steels	EN ISO 636
Covered electrodes for manual arc welding of non-alloy and fine grain steels	EN ISO 2560
Wires electrodes, wires and rods for arc welding of stainless and heat-resisting steels	EN ISO 14343
Wire electrodes, wires, rods and deposits for gas-shielded arc welding of high strength steels	EN ISO 16834
Wire and tubular cored electrodes and electrode-flux combinations for submerged arc welding of high strength steels	EN ISO 26304
Tubular cored electrodes for metal arc welding with or without a gas shield of stainless and heat-resisting steels	EN ISO 17633
Tubular cored electrodes for gas shielded metal arc welding of high strength steels	EN ISO 18276

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

If steel according to EN 10025-5 is to be welded, welding consumables shall be used which ensure that the completed welds have a weather resistance at least equivalent to the parent metal. Unless otherwise specified, one of the options given in Table 6 shall be used.

Table 6 — Welding consumables to be used with steels according to EN 10025-5

Process	Option 1	Option 2	Option3
111	Matching	2,5 % Ni	1 % Ni 0,5 % Mo
135	Matching	2,5 % Ni	1 % Ni 0,5 % Mo
121,122	Matching	2 % Ni	1 % Ni 0,5 % Mo
Matching: $\geq 0,4$ % Cu and other alloy elements			
NOTE See also 7.5.10.			

For stainless steels, welding consumables, which give weld deposits of at least equivalent corrosion resistance to the parent metal, shall be used, unless otherwise specified.

5.6 Mechanical fasteners

5.6.1 General

The corrosion resistance of the bolting assemblies, other fasteners and sealing washers shall be comparable to that specified for the fastened components.

Hot dip galvanized coatings of fasteners shall conform to EN ISO 10684.

Electroplated coatings of fasteners shall conform to EN ISO 4042.

Non-electrolytically applied zinc flake coatings of fasteners shall conform to EN ISO 10683.

Protective coatings of components for mechanical fasteners shall comply with the requirements of the relevant product standard or, in the absence thereof, with the manufacturer's recommendation.

NOTE Attention is drawn to the risk of hydrogen embrittlement during electroplating or hot dip galvanizing of bolting assemblies with property class 10.9.

5.6.2 Terminology

In the text, the following terms are used:

- a) “washer” meaning: “plain or chamfered washer”;
- b) “assembly” meaning: “a bolt with a nut and washer(s) as necessary”.

5.6.3 Structural bolting assemblies for non-preloaded applications

Carbon steel, alloy steel and stainless steel structural bolting assemblies for non-preloaded applications shall conform to the requirements of the EN 15048 series.

Assemblies according to EN 14399 may also be used for non-preloaded applications.

Property classes of bolts and nuts and, if appropriate, surface finishes shall be specified together with any required options permitted by the product standard.

The technical delivery conditions shall be specified for:

- a) carbon steel or alloy steel bolting assemblies with larger diameter than those specified in EN ISO 898-1 and EN ISO 898-2;
- b) austenitic or austenitic-ferritic stainless steel bolting assemblies with larger diameter than those specified in EN ISO 3506-1 and EN ISO 3506-2;
- c) weather resistant assemblies (see 5.6.6).

Fasteners according to EN ISO 898-1 and EN ISO 898-2 shall not be used to join stainless steels according to the EN 10088-4 and EN 10088-5 unless otherwise specified. If insulation kits are to be used full details of their use shall be specified.

The shanks of pins shall be to tolerance class h13 to EN ISO 286-2 (b11 if coated).

NOTE These values are the same as those for fit bolts to EN 14399-8.

5.6.4 Structural bolting assemblies for preloading

High strength structural bolting assemblies for preloading include system HR, system HV and HRC bolting assemblies. They shall conform to the testing requirements in EN 14399-2 and in the appropriate European Standard as listed in Table 7.

Property classes of bolts and nuts and, if appropriate, surface finishes shall be specified together with any required options permitted by the product standard.

Table 7 — Product standards for high strength structural bolting assemblies for preloading

Bolts and nuts	Washers
EN 14399-3	EN 14399-5 EN 14399-6
EN 14399-4	
EN 14399-7	
EN 14399-8	
EN 14399-10	

Stainless steel bolting assemblies shall not be used in preloaded applications unless otherwise specified. If used they shall be considered as special fasteners (see 5.6.11).

5.6.5 Direct tension indicators

Direct tension indicators and associated HN/HB nut face and bolt face washers shall be in accordance with EN 14399-9.

Direct tension indicators shall not be used with weather resistant steels or stainless steels.

5.6.6 Weather resistant assemblies

Weather resistant assemblies shall be made of improved atmospheric corrosion resistance material the chemical composition of which shall be specified.

NOTE Type 3 Grade A fasteners to ASTM standard A325 would be suitable.

Their mechanical characteristics, performances and delivery conditions shall conform to the requirements in EN 14399-1 or EN 15048-1 as relevant.

5.6.7 Foundation bolts

The mechanical properties of foundation bolts shall be in accordance with EN ISO 898-1 or fabricated from hot-rolled steel conforming to EN 10025-2 to EN 10025-4.

Unless otherwise specified, reinforcing steels shall not be used. If their use is specified, the steel shall conform to EN 10080 and the grade shall be specified.

NOTE EN 13670 specifies requirements for reinforcing steel bars used as foundation bolts or anchors.

5.6.8 Locking devices

If required, devices which effectively prevent loosening or loss of preload of the assembly if subjected to impact, significant vibration or cyclic loading, shall be specified.

For the prevention of loosening, prevailing torque nuts from EN ISO 7040, EN ISO 7042, EN ISO 7719 and EN ISO 10511 and the performance requirements given in EN ISO 2320 may be used unless otherwise specified.

5.6.9 Washers

5.6.9.1 Plain washers

Washers supplied as part of a fastener assembly shall comply with the relevant product standard for that assembly.

Washers supplied separately may be used in non-preloaded applications and shall be in accordance with EN ISO 7089, EN ISO 7090, EN ISO 7091, EN ISO 7092, EN ISO 7093-1 or EN ISO 7094 for carbon steel, EN ISO 7089, EN ISO 7090, EN ISO 7092 or EN ISO 7093-1 for stainless steels.

5.6.9.2 Taper washers

Taper washers shall meet the hardness and other requirements specified for plain washers as specified in 5.6.9.1 with the exception of dimensions applicable to shape, which shall be specified.

5.6.9.3 Plate washers

Plate washers shall be dimensioned with nominal clearances according to Table 11 and with dimensions that ensure that the washer overlaps the connected component by at least as much as a standard plain washer would when used with normal round holes.

5.6.10 Solid rivets for hot riveting

Solid rivets for hot riveting shall comply with the relevant product standard, which shall be specified.

5.6.11 Special fasteners

Special fasteners are fasteners that are not covered by European or International Standards. They shall be specified, as well as any tests necessary.

NOTE For the use of special fasteners, see 8.8.

Resin injection bolts shall be classified as special fasteners.

5.6.12 Delivery and identification

Fasteners according to 5.6.3 to 5.6.5 shall be delivered and identified in accordance with the requirements of the relevant product standard.

Fasteners according to 5.6.6 to 5.6.11 shall be delivered and identified as follows:

- a) they shall be delivered in an appropriate durable packaging and labelled such that the content is readily identifiable.
- b) labelling or accompanying documentation shall be in accordance with the requirements of the product standard and should contain the following information in a legible and durable form:
 - 1) manufacturer's identification and, if relevant, lot numbers;
 - 2) type of fastener and material and, if appropriate, its assembly;

3) protective coating.

c) marking of fasteners shall be in accordance with the requirements of the product standard.

5.7 Studs and shear connectors

Studs for arc stud welding shall comply with the requirements of EN ISO 13918.

Studs or shear connectors other than the stud types in EN ISO 13918 shall be classified as special fasteners and comply with 5.6.11.

5.8 Reinforcing steel welded to structural steel

Reinforcing steels to be welded to structural steel shall be suitable for welding according to EN 10080.

5.9 Grouting materials

The grouting materials to be used shall be specified. It shall be cement based grout, special grout or fine concrete.

Cement based grout for use between steel bases or bearing plates and concrete foundations shall be as follows:

- | | |
|--|--|
| a) for nominal thickness not exceeding 25 mm: | Neat Portland cement; |
| b) for nominal thickness between 25 and 50 mm: | Fluid Portland cement mortar that is not leaner than 1:1 cement to fine aggregate; |
| c) for nominal thickness of 50 mm and above: | Dry as possible Portland cement mortar that is not leaner than 1:2 cement to fine aggregate. |

Special grouts include cement based grouts used with admixtures, expanding grout and resin based grout. Those with low shrinkage characteristics are recommended.

Special grout shall be accompanied by detailed instructions for use that are attested by the manufacturer.

Fine concrete shall only be used between steel bases or bearing plates and concrete foundations that have gaps with nominal thickness of 50 mm and above.

5.10 Expansion joints for bridges

Requirements for type and characteristics of expansion joints shall be specified.

5.11 High strength cables, rods and terminations

Wires for high strength cables shall be cold drawn or cold rolled steel wires and conform to the requirements of EN 10264-3 or EN 10264-4. The tensile strength grade and, if appropriate, coating class according to EN 10244-2 shall be specified.

Strands for high strength cables shall conform to the requirements of prEN 10138-3. The designation and class of the strand shall be specified.

Steel wire ropes shall conform to the requirements of EN 12385-1 and EN 12385-10. The minimum breaking load and diameter of the steel wire rope and, if appropriate, requirements related to corrosion protection shall be specified.

The filling material for the sockets shall conform to the requirements of EN 13411-4. It shall be selected taking into account service temperature and actions such that continued creeping of the loaded strand through the socket is prevented.

5.12 Structural bearings

Structural bearings shall comply with the requirements of EN 1337-2, EN 1337-3, EN 1337-4, EN 1337-5, EN 1337-6, EN 1337-7 or EN 1337-8 as relevant.

6 Preparation and assembly

6.1 General

This clause specifies the requirements for cutting, shaping, holing and assembly of constituent products for inclusion into components, and for assembly of components.

NOTE Welding and mechanical fastening are dealt with in Clauses 7 and 8.

Structural steelwork shall be fabricated considering the requirements in Clause 10 and within the tolerances specified in Clause 11.

Equipment used in the manufacturing process shall be maintained to ensure that use, wear and failure do not cause significant inconsistency in the manufacturing process.

6.2 Identification

At all stages of manufacturing each piece or package of similar pieces of steel components shall be identifiable by a suitable system.

Identification may be achieved as appropriate by batching or by the shape and the size of the component or by the use of durable and distinguishing marks applied in a way not producing damage. Chiselled notches are not permitted.

The following requirements apply to hard stamped, punched or drilled marks used for marking single components or packages of similar components, unless otherwise specified:

- a) they are permitted only for steel grades up to and including S500;
- b) they are not permitted for stainless steels;
- c) they shall only be used in the specified areas where the marking method would not affect the fatigue life.

If the use of hard stamps, punched or drilled marks is not permitted, it shall be specified whether soft or low stress stamps may be used.

Soft or low stress stamps may be used for stainless steels unless otherwise specified.

Any zones where identification marks are not permitted or shall not be visible after completion shall be specified.

6.3 Handling and storage

Constituent products shall be handled and stored in conditions that are in accordance with product manufacturer's recommendations.

A constituent product shall not be used beyond a shelf life specified by its manufacturer. Products that have been handled or stored in a way or for a length of time that could have led to significant deterioration shall be checked before use to ensure that they still comply with the relevant product standard.

Structural steel components shall be packed, handled and transported in a safe manner, so that permanent deformation does not occur and surface damage is minimized. Handling and storage preventive measures specified in Table 8 shall be applied as appropriate.

Table 8 — List of handling and storage preventive measures

Lifting	
1	Protection of components from damage at the lifting points
2	Avoidance of single point lifting of long components by use of spreader beams as appropriate
3	Bundling together lightweight components particularly prone to edge damage, twisting and distortion if handled as individual items. Care taken to avoid localized damage where component touch each other, to unstiffened edges at lifting points or other zones where a significant proportion of the weight of the bundle is imposed on a single unreinforced edge
Storage	
4	Stacking of manufactured components stored before transportation or erection clear of the ground to be kept clean
5	Necessary supports to avoid permanent deformations
6	Storage of profiled sheeting, and other materials supplied with pre-finished decorative surfaces according to the requirements of relevant standards
Protection against corrosion	
7	Avoidance of accumulation of water
8	Precautions in order to avoid the penetration of moisture into bundles of sections with metallic pre-coatings NOTE In case of prolonged open storage on site, the bundles of sections should be opened and the sections separated to avoid the occurrence of 'black or white rust'.
Stainless steels	
9	Handling and storage of stainless steel to prevent contamination by fixtures or manipulators etc. Careful storage of stainless steel, so that the surfaces are protected from damage or contamination
10	If appropriate, use of protective film or other coating, to be left on as long as practicable
11	Avoidance of storage in salt-laden humid atmospheres
12	Protection of storage racks by suitable wooden, rubber or plastic battens or sheaths to avoid carbon steel, copper-containing, lead etc. rubbing surfaces
13	Use of markers containing chloride or sulphide prohibited NOTE An alternative is to use protective film and apply all marks only into this film.
14	Protection of stainless steel from direct contact with carbon steel lifting tackle or handling equipment such as chains, hooks, strapping and rollers or the forks of fork lift trucks by use of isolating materials or light plywood or suction cups. Use of appropriate erection tools to ensure that surface contamination does not occur
15	Avoidance of contact with chemicals, including dyes, glues, adhesive tape, undue amounts of oil and grease NOTE If it is necessary to use them, their suitability is to be checked with their manufacturer.
16	Use of segregated manufacturing used for carbon steel and stainless steel to prevent carbon steel pick-up. Use of separate tools dedicated for use with stainless steel only, particularly grinding wheels and wire brushes. Wire brushes and wire wool of stainless steel, preferably an austenitic grade
Transport	
17	Special measures needed for protecting manufactured components in transit

6.4 Cutting

6.4.1 General

Cutting shall be carried out in such a way that the requirements for geometrical tolerances, maximum hardness and smoothness of free edges as specified in this European Standard are met.

Known and recognized cutting methods are sawing, shearing, disc cutting, water jet techniques and thermal cutting. Hand thermal cutting should be used only if it is not practical to use machine thermal cutting. For some cutting methods, precautions should be taken if the cut edges are to be free edges (i.e. not to be subsequently welded) for components subject to fatigue (see 6.4.4).

If a process does not conform, it shall not be used until corrected and checked again. It may be used on a restricted range of constituent products that do produce conforming results.

If coated materials are to be cut, the method of cutting shall be selected to minimize any damage to the coating.

Burrs that could cause injury or prevent the proper alignment or bedding of sections or sheeting shall be removed.

6.4.2 Shearing and nibbling

The free edge surfaces shall be checked and smoothed as necessary in order to remove significant defects. If grinding or machining is used after shearing or nibbling, the minimum depth of grinding or machining shall be 0,5 mm.

6.4.3 Thermal cutting

The capability of automated thermal cutting processes shall be checked annually as set out below.

Four samples shall be produced from the constituent product to be cut by the process:

- a) a straight cut from the thickest constituent product;
- b) a straight cut from the thinnest constituent product;
- c) a sharp corner from a representative thickness;
- d) a curved arc from a representative thickness.

Measurements shall be taken on the straight samples over at least a 200 mm length on each and checked against the required quality of the cut surface. The sharp corner and curved samples shall be visually inspected to establish that they produce edges of equivalent standard to the straight cuts.

Alternatively, the guidance given in Annex D may be used to check the capability of automated thermal cutting processes.

The quality requirements for cut surfaces to be left as free edges (i.e. not to be subsequently incorporated into a weld) shall be according to Table 9 when assessed in accordance with EN ISO 9013, unless otherwise specified.

Table 9 — Quality of the cut surfaces

Execution classes	Perpendicularity or angularity tolerance, u	Mean height of the profile, Rz5
EXC1	Cut edges to be free from significant irregularities and dross shall be removed	
EXC2	Range 5	Range 4
EXC3 and EXC4	Range 4	Range 4

6.4.4 Hardness of free edge surfaces

Processes that are likely to produce local hardness shall have their capability checked.

For carbon steels $\geq$ S460 the hardness of free edge surfaces shall be no more than 450 (HV10).

The execution specification may specify other requirements for the hardness of free edge surfaces.

NOTE 1 These specified requirements can be necessary if the free edge is subject to fatigue or impact forces or susceptible to hydrogen embrittlement or to ensure that the free edge is suitable for preparation according to 10.2 prior to application of paints and related products. For free edges to be hot dip galvanized, see EN ISO 14713-2.

Unless otherwise specified, the check of the capability of the processes shall be as follows:

- four samples shall be produced from procedure tests on constituent product encompassing the range of constituent products processed that are most susceptible to local hardening;
- four local hardness tests shall be done on each sample in locations likely to be affected. The tests shall be in accordance with the EN ISO 6507 series.

NOTE 2 The requirements for checking of hardness after welding are included in procedure testing (see 7.4.1).

For thermal cutting, guidance is given in Annex D.

In order to limit the hardness of free edge surfaces, preheating of material shall be applied as necessary.

A1 NOTE 3 For HSS, the steel producer can recommend the need for preheating of the material for thermal cutting. As an alternative, the cut edges can be machined to remove the hardened layer such that the 450[HV10] limit is not exceeded. **A1**

6.5 Shaping

6.5.1 General

A1 Steel may be bent, pressed or forged to the required shape, by either a hot or cold forming process, provided the properties conform to those specified in the execution specification. **A1**

Requirements and recommendations for hot, cold forming and flame straightening of steels shall be as given in the relevant product standards and in CEN/TR 10347.

Shaping by controlled application of heat may be used under the conditions specified in 6.5.2 and 6.5.3.

Shaped components that exhibit cracking or lamellar tearing, or damage to surface coatings, shall be treated as non-conforming products.

6.5.2 Hot forming

Shaping by hot forming [A₁] may [A₁] conform to the requirements relating to hot forming in the relevant product standard and to the recommendations of the steel [A₁] producer [A₁]. Unless otherwise specified, hot forming of stainless steels is not permitted.

For steels according to EN 10025-4 and in the delivery condition +M according to EN 10025-2 hot forming is not permitted.

For quenched and tempered steels, hot forming is not permitted unless the requirements of EN 10025-6 are fulfilled.

Shaping by hot forming ($T > 580\text{ °C}$) of components is not permitted if the nominal yield strength is achieved by cold forming.

For steel grades up to and including S355, the hot forming process shall take place in the red hot (600 °C to 650 °C) state and the temperature, timing and cooling rate shall be appropriate to the particular type of steel. Bending and forming in the blue heat range (250 °C to 380 °C) is not permitted.

For steel grades S450+N (or +AR) according to EN 10025-2, and S420 and S460 according to EN 10025-3, the hot forming process shall take place in the temperature range 960 °C to 750 °C with subsequent cooling at air temperature. The cooling rate should be such as to prevent hardening as well as excessive grain coarsening. If this is not practicable, a subsequent normalizing treatment shall be carried out.

Hot forming is not allowed for S450 according to EN 10025-2 if no delivery condition is indicated.

NOTE If no delivery condition is indicated, steel products S450 could be delivered in the thermomechanical delivery condition.

6.5.3 Flame straightening

6.5.3.1 General

If distortion is to be corrected by flame straightening, this shall be undertaken by local application of heat.

For steel grades greater than S355, and if specified for other grades, a documented procedure shall be developed. The procedure shall include at least:

- a) maximum steel temperature and procedure of cooling allowed;
- b) method of heating;
- c) method used for temperature measurements;
- d) identification of workers entitled to apply the process.

The procedure shall be qualified based on the results of tensile, impact and hardness tests. With respect to the thermally heated zone, the location used for temperature measurement and the locations and orientation for the test samples to be used shall be specified.

6.5.3.2 Additional requirements for stainless steels

Flame straightening of stainless steels should be avoided especially for duplex, low nickel austenitic and martensitic grades. If it is inevitable, the maximum temperatures shall be kept as low as possible, and the period of exposure to heat shall be kept as short as possible. In addition, the following conditions shall be considered:

- a) the surface shall be free from sulfurous agents and other impurities such as labelling, iron dust and grease;

- b) the acetylene oxygen flame shall be adjusted neutrally or slightly oxygen-excessive;
- c) the thermal exposure time (preheating + time at temperature + cooling off time) should be as short as possible. Cooling off shall be done by using water or compressed air;
- d) the conditions in Table 10 shall be observed;
- e) arresters or striking tools as well as other tools should consist of CrNi-steel or should be chromeplated.

After straightening, annealing colours and oxide scales shall be completely removed using suitable measures.

Flame straightening shall only be performed by competent staff under supervision of the welding coordinator.

It should be noted that for cold-worked stainless steels, softening due to flame straightening may affect the mechanical properties.

Table 10 — Flame straightening conditions for stainless steels

Steel grade	Temperature of flame straightening (°C)	Radiant heat colour	Maximum exposure time (minutes)
Ferritic steels	500 - 600	Blue-grey until commencement of dark red	4
Austenitic steels	650 - 750	Brown-red to dark red	12
Austenitic-ferritic steels	500 - 600	Blue-grey until commencement of dark red	8

6.5.4 Cold forming

Shaping by cold forming, produced either by roll forming, pressing or folding shall conform to the requirements for cold formability given in the relevant product standard. Hammering shall not be used.

NOTE Cold-forming leads to reduction in the ductility. Furthermore, attention is drawn to the risk of hydrogen embrittlement associated with subsequent processes such as acid treatment during coating or hot dip galvanization.

- a) For carbon or alloy steel grades higher than S355, if a stress relief treatment is carried out after cold forming, the following two conditions shall be satisfied:
 - 1) temperature range: 530 °C to 580 °C;
 - 2) holding time: 2 min/mm of material thickness, but with a minimum time of 30 min.

A1 deleted text **A1**

- b) For annealed stainless steels up to a thickness of 3 mm, unless otherwise specified, the minimum inside bend radii r to be formed shall be:
 - 1) $r = 0$ for austenitic grades;
 - 2) $r = t$ for austenitic-ferritic and ferritic grades;

where t is the thickness of the material or the diameter of rods.

- c) For other stainless steels and thicknesses, unless otherwise specified, the minimum inside bend radii r to be formed shall be:

$r = (4,2 - A_5/10) t$ for values of A_5 limited to 42 and where t is the plate thickness or diameter of rods.

A1 deleted text **A1**

Unless otherwise specified in prEN 1090-4 for cold formed components and sheeting:

- d) Cold formed sections may be shaped by cranking, smooth curving or crimping as appropriate to the materials to be used;
- e) For cold formed components and sheeting used as structural components, shaping by cold forming shall comply with the following two conditions:
- 1) the surface coatings and the accuracy of profile shall not be impaired;
 - 2) it shall be specified if constituent products require protective membranes to be applied before forming.

NOTE Some coatings and finishes are particularly prone to abrasive damage, both during forming and subsequently during erection. For further information, see EN 508-1 and EN 508-3.

- f) Bending by cold forming of hollow section components may be used provided that hardness and geometry of the as-bent constituent product are checked;

NOTE Bending by cold forming may cause alteration of section properties (e.g. concavity, ovality and wall thinning) and increased hardness.

- g) For circular tubes bending by cold forming shall comply with the following three conditions, unless otherwise specified:
- 1) the ratio of the overall diameter of the tube to the wall thickness shall not exceed 15;
 - 2) the bend radius (at the centreline of the tube) shall not be less than $1,5d$ or $d+100$ mm, whichever is the larger, in which d is the overall diameter of the tube;
 - 3) the longitudinal seam weld in the cross-section shall be positioned close to the neutral axis, in order to reduce the bending stresses at the weld.

6.6 Holing

6.6.1 Dimensions of holes

This clause applies to the making of holes for connections with mechanical fasteners and pins.

The definition of the nominal hole diameter combined with the nominal diameter of the bolt to be used in the hole determines whether the hole is “normal” or “oversize”. The terms “short” and “long” applied to slotted holes refer to two types of holes used for the structural design of preloaded bolting assemblies. These terms may be used also to designate clearances for non-preloaded bolting assemblies.

The execution specification shall specify special dimensions for movement joints.

The nominal clearances for bolts and for pins not intended to act in fitted conditions shall be as specified in Table 11. The nominal clearance is:

- a) the difference between the nominal hole diameter and the nominal bolt diameter for round holes;
- b) the difference between respectively the length or the width of the hole and the nominal bolt diameter for slotted holes.

Table 11 — Nominal clearances for bolts and pins (mm)

Nominal bolt or pin diameter d (mm)	12 ^a	14	16	18	20	22	24	27 to 36 ^b
Normal round holes ^c	1 ^{d e}		2					3
Oversize round holes	3		4				6	8
Short slotted holes (on the overall length) ^f	4		6				8	10
Long slotted holes (on the overall length) ^f	1,5 d							
^a Also applicable to diameters less than 12 mm, unless otherwise specified. ^b Also applicable to diameters more than 36 mm, unless otherwise specified. ^c For applications such as towers and masts the nominal clearance for normal round holes shall be reduced by 0,5 mm unless otherwise specified. ^d For coated fasteners, 1 mm nominal clearance can be increased by the coating thickness of the fastener. ^e Bolts with nominal diameter 12 mm and 14 mm, or countersunk bolts may also be used in 2 mm clearance holes if specified. ^f For bolts in slotted holes the nominal clearances across the width shall be the same as the clearances on diameter specified for normal round holes.								

For fit bolts the nominal hole diameter shall be equal to the shank diameter of the bolt.

NOTE 1 For fit bolts to EN 14399-8, the nominal diameter of the shank is 1 mm larger than nominal diameter of the threaded portion.

For solid rivets for hot riveting, the nominal hole diameter shall be specified.

For countersunk bolts or solid rivets for hot riveting, nominal dimensions of the countersinking and tolerances on those shall be such that after installation the bolt or rivet shall be flush with the outer face of the outer ply. The dimensions of the countersinking shall be specified accordingly. If countersinking through more than one ply, the plies shall be held firmly together during countersinking.

If countersunk bolts are identified as being for use in tension or preloaded applications, the nominal depth of countersinking shall be at least 2 mm less than the nominal thickness of the outer ply.

NOTE 2 The 2 mm is to allow for adverse tolerances.

6.6.2 Tolerances on hole diameter for bolts and pins

Unless otherwise specified, hole diameters shall comply with the following:

- a) holes for fit bolts and fitted pins: class H11 according to EN ISO 286-2;
- b) thermally cut and other holes: $-0,5/+0,5$ mm.

the hole diameter being taken as the average of the maximum and minimum diameters (see Figure 1).

6.6.3 Execution of holing

Holes for fasteners or pins may be formed by any process (e.g. drilling, punching, laser, plasma or other thermal cutting) provided that this leaves a finished hole such that:

- a) cutting requirements relating to local hardness and quality of cut surface, according to 6.4 are fulfilled;
- b) all matching holes for fasteners or pins 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.

Punching is permitted provided that the nominal thickness of the component is not greater than 1,4 times the nominal diameter of the hole, or for a non-circular hole, its minimum dimension. Outside of these dimensional limitations, holes may be formed by punching unless otherwise specified.

NOTE 1 The steel producer can give additional recommendations for punching holes in HSS. 

Where untreated punched holes are not permitted, holes may be punched at least 2mm less than full size and then reamed or drilled until all trace of the original punched surface has been removed.

NOTE 2 Generally, punching without subsequent reaming or drilling would not be suitable in bolted joints where any of the following conditions applies:

- the joint is subject to cyclic or seismic loading, or;
- it is a lap joint where the fasteners are above Grade 8.8, or;
- the joint is designed to be slip resistant.

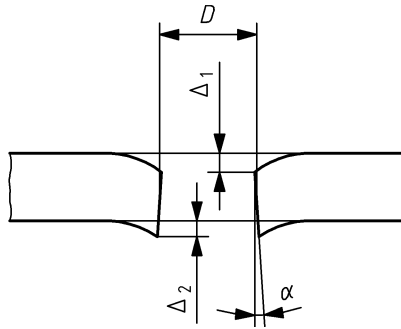
The process capability of punching used for holing shall be checked annually as follows:

- a) a representative number of samples shall be produced from procedure tests on constituent product encompassing the range of hole diameters, constituent product thickness and grades processed;
- b) hole sizes shall be checked at both ends of each hole using go/no go gauges or other appropriate methods. Holes shall comply with the appropriate tolerances specified in 6.6.2.

If the process does not conform, it shall not be used until corrected. It may be used on a restricted range of constituent products and hole sizes that do produce conforming results.

Holes formed by punching or thermal cutting shall also conform to the following:

- c) the taper angle (α) shall not exceed that shown in Figure 1;
- d) the burrs (Δ) shall not exceed that shown in Figure 1;
- e) at splices, the holes in mating surfaces shall be punched in one direction in all components.



$$D = \frac{(d_{\max} + d_{\min})}{2}$$

$$\max(\Delta_1 \text{ or } \Delta_2) \leq \max(D/10 ; 2 \text{ mm})$$

$$\alpha \leq 4^\circ \text{ (i.e. 7 \%)}$$

Figure 1 — Permitted distortions of punched or thermally cut holes

Holes for fit bolts and fit pins may be either drilled full size or reamed *in situ*. If the holes are to be reamed *in situ*, they shall be made at least 3 mm undersized initially by drilling or punching. If the fastener is to fit through multiple plies, they shall be held firmly together during drilling or reaming. The reaming shall be carried out with a fixed spindle device. Acidic lubricant shall not be used.

Countersinking of normal round holes for countersunk bolts or rivets shall be undertaken after holing.

Long slotted holes shall be either punched in one operation or formed by drilling or punching two holes and completed by thermal cutting, unless otherwise specified.

Burrs shall be removed from holes before assembly. If holes are drilled in one operation through parts clamped together which would not otherwise be separated after drilling, removing of burrs is necessary only from the outside of the outer plies.

6.7 Cut outs

Over-cutting of re-entrant corners shall not be permitted. Re-entrant corners are those where the open angle between the faces is less than 180°.

Unless otherwise specified, re-entrant corners and notches shall be rounded off with a minimum radius of 5mm.

Unless otherwise specified, punched cut outs are permitted. At punched cut outs in plates over 16 mm in thickness, the deformed materials shall be removed by grinding.

6.8 Full contact bearing surfaces

If full contact bearing surfaces are specified, the cutting length, squareness of ends and flatness of bearing surfaces shall comply with the tolerances specified in Clause 11.

6.9 Assembly

Assembly of components shall be carried out so as to fulfil the specified tolerances.

Precautions shall be taken so as to prevent galvanic corrosion produced by contact between different metallic materials.

Contamination of stainless steel by contact with structural steel shall be avoided.