

EXECUTION OF STAINLESS STEEL STRUCTURES



Technical Report: ED018

Execution of Stainless Steel Structures

**Technical Requirements and Model Clauses in
accordance with EN 1090-2**

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FOREWORD

The European Standard EN 1090: *Execution of steel structures and aluminium structures, Part 2: Technical requirements for the execution of steel structures*, was issued in 2008. The Standard is intended to be used in combination with EN 1993, Eurocode 3 *Design of steel structures*.

EN 1090-2 covers both carbon and stainless steel. In general, the same fabrication procedures used for carbon steel apply to stainless steel also. However, there are some important differences where special procedures apply to stainless steel and specific clauses throughout EN 1090-2 define these. As EN 1090-2 is a very lengthy document (over 170 pages), finding the stainless steel clauses is not easy. Additionally, stainless steel is often fabricated by specialist fabricators who do not predominantly work for the construction sector and therefore will find EN 1090-2 a difficult document to follow. This publication presents the specific stainless steel clauses given in EN 1090-2 with accompanying commentary, giving references for further information.

EN 1090-2 covers all forms of steel construction but, because of its universal coverage, it has many instances where an execution specification needs to give additional requirements or to choose optional requirements, to suit the particular structure. These additional and optional requirement choices may sometimes be necessary for stainless steel structures, for example applications where high quality products and workmanship are needed. To address the needs for project-specific requirements in an execution specification, this publication also sets out additional requirements that would reflect current best practice for structural stainless steel. The requirements are in the form of model clauses that may be combined with other project documents to achieve an execution specification that will be compatible with EN 1090-2. The model clauses are given with an accompanying commentary, and are shaded in grey throughout this document to differentiate them from the clauses which are fully specified in EN 1090-2. The text of these clauses will also be made available separately, as a Word document that may be downloaded from Steelbiz (www.steelbiz.org), to facilitate compilation of contract documents.

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SUMMARY

This document gives the clauses relating to stainless steel structures in EN 1090 *Execution of steel structures and aluminium structures. Part 2: Technical requirements for the execution of steel structures* with accompanying commentary. Additionally, it provides a set of optional and additional clauses that may be used in drawing up execution specifications for stainless steel structures, in conjunction with EN 1090-2, for individual projects. The clauses represent an industry 'best practice' view of how the general requirements of EN 1090-2 may be modified and supplemented, where permitted by that Standard, to achieve the quality and reliability to be expected for stainless steel structures designed in accordance with the Structural Eurocodes.

The clauses are grouped under headings which correspond to those of the principal headings in EN 1090-2 and are presented in a two column format. The left-hand column presents the clauses and the right-hand column presents a commentary, giving background or reference to further advice.

Appendix A lists those clauses in EN 1090-2 where stainless steel is specifically mentioned in EN 1090-2 and Appendix B lists those clauses where further information is required or where options may be specified which have corresponding model clauses in the main body of the document.

The information applies to elements subject to static or quasi-static actions (loads). Structures subject to fatigue loading are beyond the scope of this document.

1 INTRODUCTION

Most of the information given in Section 1.1, 1.2 and 1.6 is taken from *Steel Construction CE Marking* published by BCSA ^[1].

The normative references to which this document refers in Sections 4 to 12 are listed in Section 2. Additional standards and other documents which are referred to in the Commentary are listed as References in Appendix C.

1.1 CE Marking of fabricated structural steelwork

Under the Construction Products Regulation (CPR)^[2], new legal obligations have been placed on manufacturers, distributors and importers of construction products used within the EU to CE Mark their products where they are covered by either a harmonised standard or European Technical Assessment (ETA). CE Marking demonstrates compliance with the appropriate manufacturing standard for a product and applies not only to constituent products (such as steel beams, bolts etc.) but also to fabricated elements and systems made from CE Marked products.

The CPR required the CE Marking of all construction products from 1 July 2013 and requires the CE Marking of fabricated structural steelwork from 1 July 2014. It describes the legal obligations it places on the construction supply chain in terms of 'manufacturers', 'distributors' and 'importers'. The requirements of the CPR and CE Marking apply to construction products used on a project irrespective of whether that project was designed to National Standards or to the Eurocodes.

The harmonised standard covering the fabrication and installation of structural steelwork is EN 1090: *Execution of steel structures and aluminium structures*.

Part 1 of EN 1090 is *Requirements for Conformity Assessment of Structural Components*. This Part describes how manufacturers can demonstrate that the **components** they produce meet the declared performance characteristics (the structural characteristics which make them fit for their particular use and function).

Part 2 of EN 1090 is *Technical Requirements for Steel Structures*. This Part specifies the requirements for the execution of steel **structures** to ensure adequate levels of mechanical resistance and stability, serviceability and durability. It determines the performance characteristics for components that the manufacturer must achieve and declare through the requirements of Part 1. It covers technical requirements for a wide range of carbon steel, stainless steel and aluminium structures, dealing with both hot rolled and cold formed product forms. It is applicable to structural components in buildings and other similar structures. EN 1090 is made up of concise, mandatory clauses; the inclusion of explanatory guidance and additional information was not permitted in this context. The Standard also includes clauses stating where the execution specification for the works is required to give additional information or where it has the option to specify other requirements.

The Standard covers cold formed and hot finished austenitic, austenitic-ferritic (i.e. duplex) and ferritic stainless steel products. In general, the same procedures used for carbon steel apply to stainless steel also. However, stainless steel has some different material and mechanical properties from carbon steel: for example, austenitic stainless steel work hardens very rapidly and the residual stresses arising from forming are higher. Furthermore, stainless steel is often used because of its attractive appearance, in which case an overriding objective is to protect the surface of a stainless steel component during fabrication and erection; consequently, for example, no hard stamping of erection marks should be applied

and special procedures are required to prevent contamination from carbon steel pick-up. Care is also needed to specify the most appropriate finish for stainless steel. Because of these different properties and requirements, certain special practices are required for stainless steel.

1.2 Constructor requirements for CE Marking

In order to be able to CE Mark the structural steelwork that they produce, constructors are required to declare performance to the System 2+ level of assessment (as described in Annex V of the CPR). This requires them to undertake:

- Determination of the product-type on the basis of type testing (including sampling), type calculation, tabulated values or descriptive documentation of the product
- Factory Production Control (FPC), which will include
 - implementation of FPC system procedures
 - appointment of a responsible welding coordinator (RWC)
 - implementation of welding quality management system (WQMS) procedures
- Further testing of samples taken at the factory in accordance with the prescribed test plan

Constructors must also be assessed by a Notified Body that will carry out:

- Initial inspection of the manufacturing plant
- Initial inspection of the FPC
- Continuous surveillance, assessment and approval of the FPC, which will typically include an annual audit to ensure continued competence to the declared Execution Class (Table B.3 of EN 1090-1 sets out minimum levels for the routine surveillance intervals)

The Notified Body will then issue a FPC certificate and Welding Certificate identifying the Execution Class that the constructor has achieved. The Welding Certificate will state the stainless steel grades, thicknesses and welding processes.

In order for a constructor to demonstrate their right to CE Mark their products, they must provide the following three documents:

- Factory Production Control Certificate (issued by a Notified Body)
- Welding Certificate (issued by a Notified Body)
- Declaration of Performance (DoP) (issued by the constructor)

The scope of the DoP to be issued by the constructor for each project is set out in Article 6 of the CPR. The DoP details the performance declared for each of the essential characteristics which are appropriate and for which the constructor is responsible.

1.3 Reference to the designer during execution

For most steel structures, and especially for major structures, there is a need to maintain involvement of the designer of the permanent works, or at least someone who takes over full responsibility for the design of the permanent works, during construction.

There should be a means to refer matters of non-conformance with the execution specification to the designer, if acceptance of the non-conformance were to be considered. Also, if the constructor's erection method (see 9.3.2 of EN 1090-2) deviates from the design basis method of erection (see 9.3.1) the designer needs to be satisfied that the change will not be detrimental to the performance of the permanent works. The assignment and

definition of the role of the designer should be part of the contractual arrangements for the project and is outside the scope of this document.

1.4 Involvement of the constructor during design development

It is good practice to seek the advice of a constructor during the design development of a steel structure. For modest structures, that advice can take place before, and be outside of, any contractual arrangements for execution. However, it should be recognised that the design of major structures often requires the input of the chosen constructor during final design development, after contractual arrangements for execution have been initiated. The involvement of the constructor in this role is outside the scope of this document.

1.5 Competence of the designer and the constructor

Attention is drawn to two of the general assumptions in EN 1990, clause 1.3, that the design of the structure is made by appropriately qualified and experienced personnel and that the execution is carried out by personnel having the appropriate skill and experience. Structural details in stainless steel structures can be complex, and constrained access to the details, particularly for welding, may add to the difficulty of achieving the necessary quality. Designers and specifiers need to have the appropriate experience to recognise difficulties and to set practically achievable requirements. The appointed constructor needs to have personnel with appropriate experience in the execution of the stainless steelwork.

1.6 Execution Class

For any project, the required quality of fabrication or Execution Class must be specified, and guidance on the determination of the class is given in Annex B of EN 1090-2. There are four execution classes which range from EXC4 (most onerous) to EXC1 (least onerous). The main reason for giving four Execution Classes is to provide a level of reliability against failure that is matched both to the consequences of failure for the structure, component or detail, and to the difficulties of execution. Each class contains a set of requirements for fabrication and in situ construction. The requirements which are related to the choice of Execution Class are given in Annex A.3 of EN 1090-2.

EN 1090-2 requires the Execution Class to be specified for the works as a whole, an individual component and a detail of a component. In some cases the Execution Class for the structure, the components and the details will be the same while in other cases the Execution Class for the components and the details may be different from that for the whole structure.

The procedure for determining the Execution Class is a straightforward four step process:

1. Determine the Consequence Class

The purpose of categorising the Consequence Class is to ensure that buildings (and other structures) are constructed with the appropriate level of quality control within the execution process. Consequence Classes are derived on the basis of building type, building height (number of storeys), floor plan area per storey (for retail) and occupancy. A structure, or a part of it, could also contain components with different Consequence Classes. For more information, refer to Table B1 of EN 1990 or Table A.1 of EN 1991-1-7.

2. Define the Service Category

Service categories are the method used in EN 1090-2 to consider the risk from the actions to which the structure and its parts are likely to be exposed during erection and use, such as fatigue and likelihood of seismic actions. They also consider the stress levels in the components in relation to their resistance. Service categories are determined from Table B.1 of EN 1090-2. Only category SC1 structures are covered by the scope of the present document.

3. Define the Production Category

Production categories are the method used in EN 1090-2 to consider the risk from the complexity of the execution of the structure and its components, e.g. application of particular techniques, procedures or controls. Production categories are determined from Table B.2 of EN 1090-2 and it should be noted that a structure or part of a structure may contain components or structural details that belong to different production categories. However, in all cases, the Execution Class is not sensitive to the Production Category selected.

4. Derive the Execution Class

Having determined the Consequence Class, Service Category and Production Category for a building, the required Execution Class is derived simply from Table B.3 of EN 1090-2.

Whilst each building needs to be considered on its own merits, Execution Class 2 (EXC2) will be appropriate for the majority of buildings constructed in non-seismic zones. If the Execution Class is not specified on a project, Clause 4.1.2 of EN 1090-2 states that EXC2 shall apply. EXC4 should be applied to special structures or structures with extreme consequences of a structural failure as required by national provisions.

Annex B of EN 1090-2 is classed as 'informative'. Therefore the approach described is not mandatory and the selection of Execution Class can be based on experience, provided that the decision can be suitably justified. However, the next revision of EN 1993-1-1, which is due to be issued in 2014, will contain a 'normative' annex on the selection of Execution Class, putting an obligation on the designer to specify the Execution Class.

Over-specification of the Execution Class should be avoided wherever possible, to prevent unnecessary costs being introduced. For example, EXC2 may be the Execution Class derived for a project but full traceability (an EXC3 requirement) may be required instead of the partial (or batch) traceability requirement of EXC2. In such a case, rather than specifying EXC3 on the basis of achieving this single Clause requirement, it is suggested that EXC2 should still be specified but with the higher level of traceability added to the specification.

1.7 Scope and format of this document

This document covers all clauses in EN 1090-2 which specifically refer to stainless steel, with an accompanying commentary in italics in the right hand column. These clauses are grouped under headings that correspond to those of the principal headings in EN 1090-2 and are given the status '*to note*'.

This document also offers a set of clauses that may be used for individual projects to supplement and quantify the rules for stainless steel structures in EN 1090-2. Immediately following the headings, an extract from EN 1090-2 is given, and an indication whether the clause is additional information required or optional information permitted by the Standard (denoted '*addition*' or '*option*'). Each of the new 'model' clauses introduced in this document is given a reference number for ease of use and cross reference; when used in a project, an alternative numbering system may be chosen to suit the project documentation. All model clauses and their reference numbers are shaded for ease of identification; not all of them will be needed for a particular contract and they may be included or omitted as appropriate. (All the clauses are available without commentary in a separate Word file from Steelbiz (www.steelbiz.org), for incorporation into project documents.) Reference to clauses within EN 1090-2 is made simply by quoting the clause number. The model clauses are arranged in a two-column format. The left column contains the proposed clauses. The right column gives a commentary to each clause, to inform the person drawing up project documents; those commentaries are not intended to be included within the execution specification.

It is emphasised that this document is intended to clarify and assist the production of an execution specification that expresses clearly what the designer requires for a particular project. This will be of benefit in pricing and execution of the work and should lead to improvements in economy and quality of the finished structure.

The information applies to elements subject to static or quasi-static actions (loads). Structures subject to fatigue loading are beyond the scope of this document.

1.8 Future evolution of EN 1090-2

EN 1090-2 is currently being revised and it is expected that the clauses relating to structural sheeting will be taken out of EN 1090-2 and that a new part, EN 1090-4 will be published, dedicated to this product form (widely used for roofing and wall panels).

2 NORMATIVE REFERENCES

Section 2 of EN 1090-2 lists the normative references to which it refers. The normative references to which the clauses in this document refer in Sections 4 to 12 are listed below. For a particular project, those relevant to the selected clauses should be included in the list of reference standards for the contract.

Since EN 1090-2 was issued, a number of new relevant standards have been published and these are shown in italics.

Additional standards and other documents which are referred to in the Commentary clauses are listed in the References in Appendix C.

The normative references are undated: the latest edition of the referenced document (including any amendments) applies.

2.2 Constituent products

2.2.1 Steels

EN 10017 Steel rod for drawing and/or cold rolling. Dimensions and tolerances

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

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 10088 Stainless steels.

Part 1: List of stainless steels

Part 2: Technical delivery conditions for sheet/plate and strip of corrosion resisting steels for general purposes

Part 3: Technical delivery conditions for semi-finished products, bars, rods, wire, sections and bright products of corrosion resisting steels for general purposes

Part 4: Technical delivery conditions for sheet/plate and strip of corrosion resisting steels for construction purposes

Part 5: Technical delivery conditions for bars, rods, wire, sections and bright products of corrosion resisting steels for construction purposes

(Parts 4 and 5 are the harmonised standards for stainless steel flat and long products for use in construction. They were first issued in 2009 and hence were too late to be referenced in EN 1090-2.)

EN 10204 Metallic products — Types of inspection documents

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

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

EN ISO 1127 Stainless steel tubes. Dimensions, tolerances and conventional masses per unit length

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

EN ISO 9445 Continuously cold-rolled stainless steel. Tolerances on dimensions and form

Part 1: Narrow strip and cut lengths

Part 2: Wide strip and plate/sheet

EN ISO 18286 Hot-rolled stainless steel plates. Tolerances on dimensions and shape

2.2.3 Welding consumables

EN 1600 Welding consumables. Covered electrodes for manual metal arc welding of stainless and heat resisting steels. Classification. (withdrawn)

EN 13479 Welding consumables. General product standard for filler metals and fluxes for fusion welding of metallic materials

EN ISO 3581 Welding consumables. Covered electrodes for manual metal arc welding of stainless and heat-resisting steels. Classification
(Replaces EN 1600)

EN ISO 13918 Welding. Studs and ceramic ferrules for arc stud welding

EN ISO 14343 Welding consumables. Wires electrodes, strip electrodes, wires and rods for fusion welding of stainless and heat resisting steels. Classification

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

2.2.4 Mechanical fasteners

EN 14399 High-strength structural bolting assemblies for preloading

Part 1: General requirements

Part 2: Suitability test for preloading

EN 15048-1 Non-preloaded structural bolting assemblies. Part 1: General requirements

EN ISO 898 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

Part 2: Nuts with specified property classes. Coarse thread and fine pitch thread

EN ISO 2320 Prevailing torque type steel nuts. Mechanical and performance properties

EN ISO 3506-1 Mechanical properties of corrosion-resistant stainless-steel fasteners.

Part 1: Bolts, screws and studs

Part 2: Nuts

Part 3: Set screws and similar fasteners not under tensile stress

Part 4: Tapping screws

EN ISO 7040 Prevailing torque type hexagon regular nuts (with non-metallic insert). Property classes 5, 8 and 10

EN ISO 7042 Prevailing torque type all-metal hexagon high nuts. Property classes 5, 8, 10 and 12

EN ISO 7089 Plain washers — Normal series — Product grade A (ISO 7089:2000)

EN ISO 7090 Plain washers, chamfered — Normal series — Product grade A (ISO 7090:2000)

EN ISO 7091 Plain washers — Normal series — Product grade C (ISO 7091:2000)

EN ISO 7093-1 Plain washers — Large series — Part 1: Product grade A (ISO 7093-1:2000)

EN ISO 7719 Prevailing torque type all-metal hexagon regular nuts. Property classes 5, 8 and 10

EN ISO 10511 Prevailing torque type hexagon thin nuts (with non-metallic insert)

EN ISO 10512 Prevailing torque type hexagon regular nuts (with non-metallic insert) with metric fine pitch thread. Property classes 6, 8 and 10

EN ISO 10513 Prevailing torque type all-metal hexagon high nuts with metric fine pitch thread. Property classes 8, 10 and 12

2.2.5 High strength cables

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

2.3 Preparation

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

2.4 Welding

EN 729 Quality requirements for welding. Fusion welding of metallic materials. (withdrawn)

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

EN ISO 3834 Quality requirements for fusion welding of metallic materials.
Part 1: Criteria for the selection of the appropriate level of quality requirements
Part 2: Comprehensive quality requirements
Part 3: Standard quality requirements
Part 4: Elementary quality requirements
Part 5: Documents with which it is necessary to conform to claim conformity to the quality requirements of ISO 3834-2, ISO 3834-3 or ISO 3834-4
(EN ISO 3834 supersedes EN 729, which is withdrawn.)

EN ISO 14555 Welding. Arc stud welding of metallic materials

EN ISO 15609 Specification and qualification of welding procedures for metallic materials. Welding procedure specification

EN ISO 15613 Specification and qualification of welding procedures for metallic materials. Qualification based on pre-production welding test
(EN ISO 15613 is concerned with a pre-production welding test using a non-standard test piece representative of the production conditions.)

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
(It is necessary to support a welding procedure specification (WPS) with evidence of satisfactory procedure tests in the form of a welding procedure qualification record (WPQR) prepared in accordance with EN ISO 15614-1. This standard describes the conditions for the execution of welding procedure tests and the limits of validity within the ranges of qualification.)

EN ISO 15620 Welding. Friction welding of metallic materials

2.5 Testing

EN 571-1 Non-destructive testing. Penetrant testing. Part 1 General principles.
(withdrawn)

EN 970 Non-destructive examination of fusion welds. Visual examination.
(withdrawn)

EN 1290 Non-destructive examination of welds. Magnetic particle examination of welds. (withdrawn)

EN 1435 Non-destructive examination of welds. Radiographic examination of welded joints. (withdrawn)

EN 1713 Non-destructive testing of welds. Ultrasonic testing. Characterization of indications in welds. (withdrawn)

EN 1714 Non-destructive testing of welded joints. Ultrasonic testing of welded joints. (withdrawn)

EN 12062 Non-destructive examination of welds. General rules for metallic materials. (withdrawn)

EN ISO 3452-1 Non-destructive testing. Penetrant testing. Part 1 General principles

(EN ISO 3452-1 supersedes EN 571-1, which is withdrawn.)

EN ISO 17635 Non-destructive testing of welds. General rules for metallic materials

(EN ISO 17635 supersedes EN 12062, which is withdrawn.)

EN ISO 17636-2 Non-destructive testing of welds. Radiographic testing. Part 2 X- and gamma-ray techniques with digital detectors

(EN ISO 17636-2 supersedes EN 1435, which is withdrawn.)

EN ISO 17637 Non-destructive testing of welds. Visual testing of fusion-welded joints

(EN ISO 17637 supersedes EN 970, which is withdrawn.)

EN ISO 17638 Non-destructive testing of welds. Magnetic particle testing

(EN ISO 17638 supersedes EN 1290, which is withdrawn.)

EN ISO 17640 Non-destructive testing of welds. Ultrasonic testing. Techniques, testing levels, and assessment

(EN ISO 17640 supersedes EN 1714, which is withdrawn.)

EN ISO 23279 Non-destructive testing of welds. Ultrasonic testing.

Characterization of indications in welds

(EN ISO 23279 supersedes EN 1713, which is withdrawn.)

2.9 Miscellaneous

EN 508 Roofing products from metal sheet. Specification for self-supporting products of steel, aluminium or stainless steel sheet.

Part 1: Steel

Part 3: Stainless steel

3 TERMS AND DEFINITIONS

Some key definitions (taken from EN 1090-2, Section 3) are given below:

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 components

works

parts of construction works that are structural steelwork

structural steelwork

steel structures or manufactured steel components used in construction works

constructor

person or organization executing the works (the supplier in EN ISO 9000). More widely understood term is 'Steelwork Contractor'

structure

see EN 1990

manufacturing

all activities required to produce and deliver a component. As relevant, this comprises e.g. procurement, preparation and assembly, welding, mechanical fastening, transportation, surface treatment and the inspection and documentation thereof

execution

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

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 EN 1090-2 (formerly known as the project specification)

NOTE 1: Execution specification includes requirements where EN 1090-2 identifies items to be specified.

NOTE 2: Execution specification can be seen as the complete set of requirements for manufacture and installation of structural steel components with the manufacturing requirements given in a set of component specifications according to EN 1090-1.

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

component

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

component specification

document or documents giving all necessary information and technical requirements for manufacturing the structural component.

NOTE: The component specification is a part of the execution specification, as noted above.

4 SPECIFICATIONS AND DOCUMENTATION

4.1 Execution Specification

4.1.2 Execution classes

For a full explanation of execution classes, see Section 1.6.

4.2 Constructor's documentation

4.2.2 Quality plan

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

4.201 A quality plan for the execution of the works, in accordance with, shall be provided and maintained.

A quality plan should normally be required. The general requirements for the particular plan should be agreed with the client by the designer and specified in this clause.

5 CONSTITUENT PRODUCTS

5.2 Identification, inspection documents and traceability

(to note) For stainless steel products, the type of inspection documents according to EN 10204 shall be Type 3.1 inspection documents.

According to EN 10204, inspection certificate 3.1 "Type 3.1" is defined as follows:

- 1) Document issued by the manufacturer in which he declares that the products supplied are in compliance with the requirements of the order and in which he supplies test results.
- 2) The test unit and the tests to be carried out are defined by the product specification, the official regulation and corresponding rules and/or the order.
- 3) The document is validated by the manufacturer's authorized inspection representative, independent of the manufacturing department.
- 4) It shall be permissible for the manufacturer to transfer on to the inspection certificate 3.1 relevant test results obtained by specific inspection on primary or incoming products he uses, provided that the manufacturer operates traceability procedures and can provide the corresponding inspection documents required.

5.3 Structural steel products

5.3.1 General

(addition) Stainless steel products shall conform to the requirements of the relevant European product standards as listed in Table 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].

The Table 4 references to EN 10088 are out of date. EN 10088-4 is now the harmonised product standard for sheets, plates and strip. EN 10088-5 is the harmonised product standard for bars, rods and sections.

Include the new references in the specification.

Qualities and coating weights are not relevant for stainless steels.

5.301 Replace Table 4 in EN 1090-2 by the following Table:

NOTE Steel designations by name and number are given in EN 10088-1. EN 10088-4 and -5 are the harmonised standards for stainless steel flat and long products respectively.

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 9445-1, EN ISO 9445-2, 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 |

5.302 The grade of structural stainless steel shall be as specified in the execution specification.

The extent of each particular grade should be clearly specified, typically on drawings, in the component specification.

Annex A of EN 1993-1-4^[3] and Reference 4 give guidance on grade selection. A revised version of Annex A is due to be published in 2014 which gives a material selection procedure for structural stainless steel in typical building environments.

5.3.2 Thickness tolerances

(to note) The thickness tolerances for stainless steel plates and other products shall be Class A in accordance with EN 10029, unless otherwise specified.

Class A is usually sufficient, even where EXC4 is specified.

Note that EN ISO 18286 is now the current standard for tolerances for hot rolled stainless steel quarto plates, although EN 10029 still applies to carbon and alloy steels. The four classes of thickness tolerance in EN 10029 have been replaced by one class in EN ISO 18286, which is similar to EN 10029 Class B for plate widths up to 2000 mm. For widths from 2000-3000 mm, EN ISO 18286 tolerances are much wider.

5.3.3 Surface conditions

(addition) 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.

Additional requirements related to special restrictions on either surface imperfections or repair of surface defects by grinding in accordance with EN 10088 shall be specified.

Table 6 of EN 10088-4 gives type of process route and surface finish for flat products.

Table 7 of EN 10088-5 gives type of surface finish and process route for long products

Guidance on surface finishes is given in Reference 5.

(addition) If the relevant specification does not adequately define decorative or specialist surface finishes, the finish shall be specified.

5.303 Decorative or specialist finishes shall be in accordance with the following:
(Insert details)

Reference 6 has more information on special finishes on stainless steel. Reference 7 gives information on colouring stainless steel.

5.304 Prior to execution, a reference sample of surface finish that meets the requirements of 5.303 shall be provided, together with a record of the agreed viewing/inspection conditions. This sample shall be used for subsequent matching during execution.

While a written and/or photographic description of the finish is the best that will probably be available for use in a specification at tender stage, it is critical to agree the type of finish with reference to a sample prior to fabrication. (See also optional clause 7.402 in this document, in which pre-production welding tests qualified in accordance with EN ISO 15613 are specified to obtain a trial sample that can be used in order to establish weld quality for integrity, and for appearance (if a high quality surface finish is required).)

5.3.4 Special properties

(addition)In addition, requirements related to the following items shall be specified if relevant:
c) special delivery conditions of stainless steels, for example Pitting Resistance Equivalent (Nitrogen) (PRE(N)) or accelerated corrosion testing. The PRE(N) shall be given by $(Cr + 3.3 Mo + 16 N)$, in which the elements are in percent by weight, unless otherwise specified.
d) processing conditions if constituent products are to be processed before delivery.

Pitting resistance equivalent numbers (PREN) are a theoretical way of comparing the pitting corrosion resistance of various types of stainless steels, based on their chemical compositions. They are useful for comparing different grades within the same stainless steel family (i.e. austenitic, ferritic, duplex), but cannot be used to predict whether a particular grade will be suitable for a given application in which pitting corrosion may be a hazard. In some industries, notably the oil and gas sector, material specifications may place tighter restrictions on the PREN for specific grades than that implied by the minimum composition of the grade defined in EN or ASTM Standards. Accelerated corrosion testing is generally only required for applications immersed in seawater.

PREN values and accelerated corrosion testing are not usually required for materials used in onshore building structures, for which guidance on grade selection is given in Annex A of EN 1993-1-4^[3].

For applications beyond the scope of Annex A, see Reference 8 or 9 for more

information on accelerated corrosion testing and determining the PREN respectively.

5.305 Where specified in the execution specification, the following special delivery conditions are required:
(Insert details)

Give details of any requirements such as PREN or accelerated corrosion testing.

5.306 Where constituent products are to be processed before delivery, the processing shall comply with the following requirements:
(Insert details)

Might be needed for bending of open and hollow sections – seek specialist advice e.g. Reference 10. If welding is involved, weld procedure tests should be carried out in accordance with EN ISO 15614 for a standardised test piece or with EN ISO 15613 for a non-standardised test piece. See also Reference 11, which is a photo guide giving visual acceptance criteria for different welding procedures, degrees of surface finish and weld geometries.

5.5 Welding consumables

(addition) All welding consumables shall conform to the requirements in EN 13479 and the appropriate product standard as listed in Table 5.

5.501 Replace Table 5 in EN 1090-2 by the following Table:

EN 1600 has been replaced by EN ISO 3581.

Table 5 - Product standards for welding consumables

| Welding consumables | Product standards |
|--|-------------------|
| Covered electrodes for manual arc welding of stainless and heat resisting steels | EN ISO 3581 |
| Wire electrodes, wires and rods for arc welding of stainless and heat-resisting steels | EN ISO 14343 |
| Tubular cored electrodes for metal arc welding with or without a gas shield of stainless and heat-resisting steels | EN ISO 17633 |

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

Suitable welding consumables for a range of parent materials are given in References 4 and 23. Advice can also be obtained from the consumable supplier. Tables of fabrication parameters are given in Reference 12.

5.6 Mechanical fasteners

5.6.3 Structural bolting assemblies for non-preloaded applications

(to note) Austenitic stainless steel structural bolting assemblies for non-preloaded applications shall conform to EN 15048-1 or EN 14399-1.

Stainless steel fasteners are widely available in geometries in accordance with DIN 931 and DIN 933. These standards are now withdrawn and superseded by EN ISO 4014 and EN ISO 417 respectively.

(addition) 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 mechanical properties shall be specified for austenitic stainless steel bolting assemblies with larger diameter than those specified in EN ISO 3506-1 and EN ISO 3506-2 and for all sizes of austenitic-ferritic bolting assemblies.

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

The chemical composition and mechanical properties of stainless steel fasteners are specified in EN ISO 3506. Bolts, screws and studs are designated by a letter followed by three numbers, e.g. A2-70 or A4-80. The letter refers to the group of stainless steel: austenitic (A), martensitic (C) or ferritic (F). The letter is followed by a number (1, 2, 3, 4 or 5) which reflects the corrosion resistance; 1 representing the least durable and 5 the most durable. The final two numbers denote the property class, which describes the mechanical properties of the bolt, screw, stud or nut. The number is 10% of the minimum ultimate tensile strength of the bolt in MPa.

For most structural applications, it is generally recommended that austenitic bolts grade A2 or A4 and property class 70 or 80 are used. Steels of grade A2 have equivalent corrosion resistance to grade 1.4301. Steels of grade A4 contain molybdenum and have equivalent corrosion resistance to grade 1.4401. Property class 70 fasteners are made from cold drawn bar. Property class 80 fasteners are made from severely hard cold drawn bar.

Although not included in EN ISO 3506, austenitic-ferritic (duplex) bolts and nuts are available in grade 1.4462 with mechanical properties in accordance with property class 80 and superior corrosion resistance to austenitic fasteners.

The corrosion resistance of a stainless steel fastener should be at least equivalent to the material being joined, i.e., grade A2 bolts (or better) can be used to join grade 1.4301 material but grade A4 bolts (or better) should be used to join grade 1.4401 material.

5.601 The property classes of non-preloaded bolts and nuts, and surface finishes, shall be as specified in the component specification. *EN ISO 3506 gives the property classes.*

5.602 The details of the insulation kits are as follows:
(Insert details) *Reference 13 gives guidance on the correct installation of insulation kits.*

5.6.4 Structural bolting assemblies for preloading

(addition) Stainless steel bolts shall not be used in preloaded applications unless otherwise specified. If used, they shall be treated as special fasteners.

There is a lack of data about the variable torque characteristics of stainless steel bolts which means there are no design rules in EN 1993-1-4 for connections which are preloaded to withstand vibration, load reversal or fatigue loading. Special care is needed during bolt tightening – for example, if stainless steel bolts are highly torqued, galling can occur (see 8.10). Special tightening procedures need to be defined (see 8.501).

Additionally, there are no design rules in EN 1993-1-4 for stainless steel bolts which are preloaded to avoid slip, because of a lack of data about stress relaxation (due to room temperature creep) and concern about the low coefficients of friction for stainless steel.

5.603 The property classes of preloaded bolts and nuts, and surface finishes, shall be as specified in the execution specification and shall comply with tests specified in 5.606. *Not commonly used.*

5.6.5 Direct tension indicators

(to note) Direct tension indicators shall not be used with stainless steels.

A carbon steel direct tension indicator will not give a correct prediction of the tension in a stainless steel bolt. Stainless steel direct tension indicators are not available.

5.6.8 Locking devices

(option) If required, locking devices such as prevailing torque nuts or other types of bolts which effectively prevent loosening of the assembly if subjected to impact or significant vibration, shall be specified.

Unless otherwise specified, products from EN ISO 2320, EN ISO 7040, EN ISO 7042, EN ISO 7719, EN ISO 10511, EN ISO 10512 and EN ISO 10513 may be used.

5.604 Locking devices shall be provided where shown in the execution specification. *Locking devices are necessary to prevent the nuts from working loose due to vibration. Typically, locations are shown on the drawings.*

5.605 Where locking devices are specified, they shall comply with the relevant standard in 5.6.8 and ...
(Insert any particular requirements for locking devices) *The products listed in the standard are suitable for use as locking devices. Insert any project-specific requirements for type of device etc.*

5.6.9 Washers

5.6.9.1 Plain washers
(to note) Washers from EN ISO 7089, EN ISO 7090, EN ISO 7092 or EN ISO 7093-1 may be used for stainless steels.

5.6.12 Special fasteners

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

5.606 Where special fasteners are specified in the execution specification, they shall comply with the following requirements:
(Insert details) *For example, if stainless steel bolts are used in preloaded applications, additional tests may need to be specified to ensure that the performance is such that preload can be achieved:*
Tensile stress relaxation testing in accordance with EN 10319-1 (rods) and EN 10319-2 (bolts) ^[14].
Slip testing in accordance with Annex G of EN 1090-2.
Suitability for preloading in accordance with EN 14399-2.
Torque/clamp force testing in accordance with EN ISO 16047 ^[15].

5.7 Studs and stud connectors

(to note) Studs for arc stud welding including shear connectors for steel/concrete composite construction shall comply with the requirements of EN ISO 13918. *Type SD3 in EN ISO 13918 is a stainless steel headed stud. A carbon steel stud, type SD1 might be acceptable when the stud is fully encased in concrete.*

6 PREPARATION AND ASSEMBLY

6.2 Identification

(option and addition)

Hard stamped, punched or drilled marks used for marking single components or packages of similar components are not permitted for stainless steels.

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

As surface appearance is often critical to stainless steel structures, it is important to ensure that there is no hard stamping of erection marks on stainless steel.

Note that the stamping equipment should also be stainless steel to avoid contamination of the surface of the stainless steel.

6.201 Soft or low stress stamps may be used except in areas specified in the execution specification.

6.202 Areas where identification marks are not permitted or shall not be visible after completion shall be specified in the execution specification.

Identification marks should normally be located in inconspicuous areas. Marks are small and therefore not usually intrusive visually. Typically, prohibited areas are shown on drawings.

6.3 Handling and storage

(to note)

The following handling and storage preventative measures are given in Table 8 for stainless steel:

Guidance on transportation, handling and storage is given in References 13 and 16. Surface contamination of stainless steel can occur when non-stainless steel equipment is used to handle stainless steel due to iron particles becoming embedded in the surface of the stainless steel and, if moisture is present, beginning to rust. Guidance on the removal of contamination is given in ASTM A380^[17].

Note that if a high quality surface appearance is not important and staining can be tolerated, it will not be necessary to adopt all the measures given in Table 8. Even if surface appearance is important, the measures in Table 8 need not all be adopted if a post-fabrication and erection clean-up in accordance with Reference 18 or ASTM A380 is specified.

| Extract of Table 8 - Handling and storage preventative measures for stainless steel | |
|--|---|
| 10 | Handling and storage of stainless steel so as to prevent contamination by fixtures or manipulators etc. Careful storage of stainless steel, so that the surfaces are protected from damage or contamination. |
| 11 | Use of protective film or other coating, to be left on as long as practicable. |
| 12 | Avoidance of storage in salt-laden humid atmospheres. |
| 13 | Protection of storage racks by wooden, rubber or plastic battens or sheaths to avoid carbon steel, copper-containing, lead etc. rubbing surfaces. |
| 14 | Use of markers containing chloride or sulphide prohibited NOTE An alternative is to use protective film and apply all marks only into this film. |
| 15 | 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. |
| 16 | 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. |
| 17 | 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. |

6.5 Shaping

6.5.4 Cold forming

(option)

b) For stainless steels, unless otherwise specified, the minimum inside bend radii to be formed shall be:

- 1) $2t$ for austenitic grades 1.4301, 1.4401, 1.4404, 1.4541 and 1.4571;
- 2) $2,5t$ for austenitic-ferritic (duplex) grade 1.4462.

where t is the thickness of the material.

Reference 19 gives additional information about cold forming. Reference 20 gives guidance specifically related to fabrication of duplex stainless steels.

As with carbon steel, cold forming may lead to a reduction in the toughness of stainless steel. If toughness is a critical requirement, the designer should consider the consequences of the cold forming process on the toughness of the material. The reduction in toughness of austenitic grades due to cold forming will not be significant.

6.501 The minimum inside bend radius for grade (*Insert grade designation*) shall be as follows:
(*Insert details*)

More or less onerous requirements may be inserted in this clause. Smaller bend radii are commonly used.

6.5.4 Cold forming (cont.)

(addition)

c) For other grades of stainless steels, the minimum inside bend radii shall be specified. Smaller inside bend radii may be permitted if due consideration is given to issues such as steel specification, condition and thickness and the direction of bending in relation to the rolling direction.

In order to counteract the effects of spring-back, stainless steel needs to be over-bent to a slightly higher degree than carbon steel.

NOTE The power requirements for bending stainless steel are higher than for bending geometrically similar carbon steel components, due to work hardening (by about 50% in the case of the austenitic steels or even more in the case of 1.4462 austenitic-ferritic (duplex) steel).

6.502 For other grades of stainless steel, the minimum inside bend radius shall be as follows:
(Insert details)

Only needed when other grades are specified.

A minimum inside bend radius of 2 t can be assumed to be acceptable for all austenitic grades, and 2,5 t for all austenitic-ferritic (duplex) grades. For ferritic stainless steels, a smaller minimum bend radius is likely to apply, such as 1.0 t.

6.5.4 Cold forming (cont.)

(option) d) Cold formed sections and sheeting may be shaped by cranking, smooth curving or crimping as appropriate to the materials to be used.

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

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

6.503 For cold formed components and sheeting, a protective membrane shall be applied before forming.
(Insert details of what constitutes adequate protection.)

This is only required for applications where a high quality surface finish is important. It usually takes the form of an adhesively applied plastic film. It should be left on as long as practicable and removed just before handover. More guidance is given in Reference 13.

6.5.4 Cold forming (cont.)

- (option) e) 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) welded joint in the cross-section shall be positioned close to the neutral axis, in order to reduce the bending stresses at the weld.

Conditions 1) and 2) are rather restrictive; more generous requirements may be included in the optional clause below.

6.504 The bending of stainless steel circular tubes by cold forming shall comply with the following requirements:
(Insert details)

Advice should be sought from a specialist bending contractor regarding whether a higher d/t ratio or lesser bend radius could be specified. Alternatively, appropriate pre-production tests should be carried out to ensure that bending does not cause mechanical damage and the dimensional tolerances are acceptable.

For tubes of diameter < 100 mm, a less restrictive condition of the bend radius (at the centreline of tube) may be applicable, e.g. the radius should not be less than $2,5d$ where d is the outer diameter.

Note that the implications of curvature on the choice of buckling curve and the consequences on toughness requirements of cold forming need to be considered by the designer.

Some useful guidance on tube bending is given in Reference 10.

6.6 Holing

6.6.1 Dimensions of holes

(addition) Special dimensions should be specified for movement joints.

6.601 Where specified in the execution specification, holes with special dimensions shall be provided for connections for movement joints.

Only needed for special cases such as for mechanically operated structures. Design of such joints is a specialist activity; the specialist designer should give the requirements.

(addition) For countersunk bolts or hot rivets, 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.

6.602 For countersunk bolts, the nominal dimensions of the countersinking shall be such that after installation the bolt will be flush with the outer face of the outer ply.

Locations where countersunk bolts are required should be specified in the execution specification, typically on drawings.

6.6.2 Tolerances on hole diameter for bolts and pins

(option) Unless otherwise specified, hole diameters shall comply with the following:
a) holes for fit bolts and fitted pins: class H11 according to ISO 286-2;
b) other holes: $\pm 0,5$ mm, the hole diameter being taken as the average of entry and exit diameters.

6.603 Tolerances on hole diameters shall be as specified in the execution specification.

Special tolerances would only be needed in exceptional conditions. No clause is needed for normal steelwork. If pins are used, tolerances should be specified for both holes and pins. See EN ISO 286-2^[21] for guidance on classes of fit.

6.6.3 Execution of holing

(option) For EXC1 and EXC2, holes may be formed by punching without reaming unless otherwise specified.

6.604 Holes for fasteners shall be formed by drilling or by punching followed by reaming. The requirement of 6.6.3 for the size of the punched holes applies for all execution classes

Thermal cutting is not normally practicable or acceptable (it would have a lower fatigue category) for execution of holing but it is not explicitly excluded by 6.6.3. Clause 6.6.3 requires that punching before reaming be at least 2 mm undersize for EXC3 and EXC4.

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

6.605 Long slotted holes shall be executed as specified in the execution specification.

This option is only needed for special cases, such as slotted holes for pins in movement joints. Typically, details should be given on drawings.

6.9 Assembly

(to note) Contamination of stainless steel by contact with structural (carbon) steel should be avoided.

See commentary under clause 6.3.

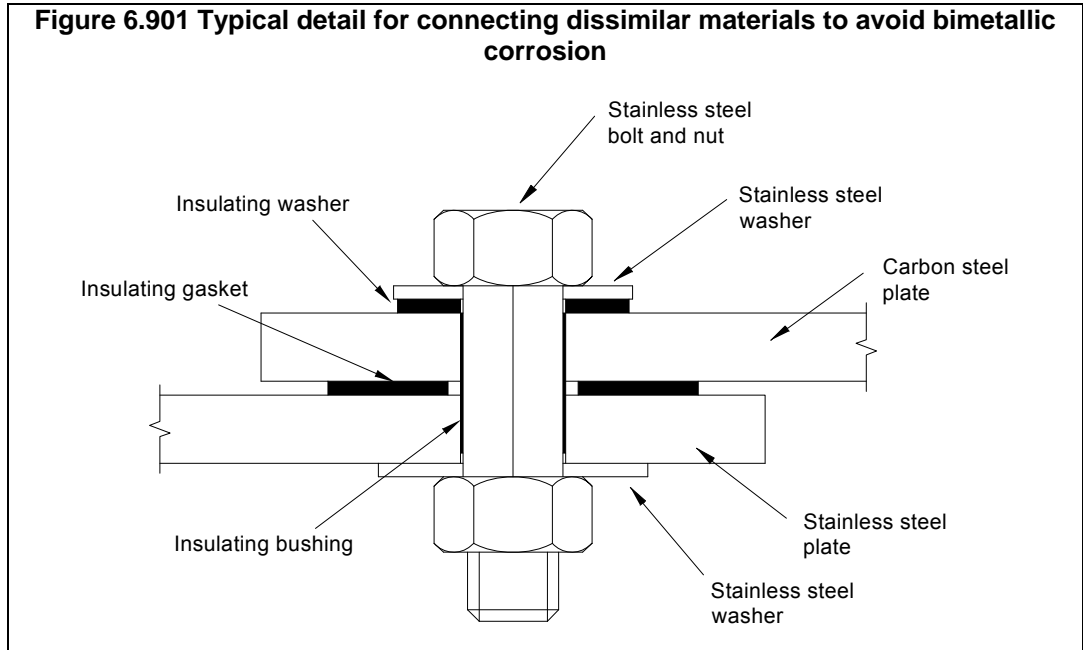
(to note) Precautions shall be taken so as to prevent galvanic corrosion produced by contact between different metallic materials.

The use of carbon steel bolts with stainless steel structural elements should always be avoided.

In bolted joints between carbon steel and stainless steel in potentially corrosive environments, provision should be made to electrically isolate the carbon steel and stainless steel elements. This entails the use of insulating washers and possibly bushings (Figure 6.901). The insulating washers and bushings should be made of a thermoset polymer such as neoprene (synthetic rubber), which is flexible enough to seal the joint when adequate pressure is applied and long lasting to provide permanent metal separation.

For welded joints involving carbon and stainless steels, it is generally recommended that any paint system applied to the carbon steel should extend over the weldment onto the stainless steel to a distance of at least 20 mm. (See also Reference 22.)

(to note)



(addition) All connections for temporary components provided for manufacturing purposes shall meet the requirements of this European Standard (EN 1090-2) and any special requirements including those related to fatigue which shall be specified.

6.901 The acceptability of the addition of welded temporary attachments and the making of butt welds additional to those required by the designer shall be verified according to the design rules. A record of the details of such attachments and butt welds shall be provided as part of the constructor's execution documentation. Areas where temporary attachments have been made shall be made good. If weld repairs are necessary these shall be carried out in accordance with the requirements of the appropriate Standard.

Restrictions on positioning of temporary attachments should be specified, typically on drawings. No temporary attachments should be allowed in areas where a high quality surface finish is required.

6.10 Assembly check

(option) The fit between manufactured components that are inter-connected at multiple connection interfaces shall be checked using dimensional templates, accurate three-dimensional measurements or by trial assembly. Requirements for whether, and to what extent, trial assembly is to be used shall be specified.

6.1001 Trial erection shall comply with the following requirements:
(Insert details)

For most structures, it should not be necessary to carry out a full trial erection. A trial erection may be necessary for reasons such as:

a) If a deviation from nominal geometry would have a significant effect on internal forces and moments.

b) If it is important that the steel fits together on site without any undue delay and/or remedial work.

c) If there are functional constraints – such as cross-fall and longitudinal vertical curve for clearance or drainage.

d) If required to check the alignment of visually critical elements, e.g. fascias.

(Requirements for a) should be given as essential tolerances, requirements for b), c) and d) should be given as functional tolerances.)

7 WELDING

7.1 General

(to note) Arc welding of stainless steels should follow the requirements and recommendations of EN 1011-1 and EN 1011-3.

Guidance is available from References 23, 24 and 25.

7.2 Welding plan

7.2.2 Content of a welding plan

(to note) The weld profile and finish for stainless steels shall be included in a welding plan.

Pre-production welding tests qualified in accordance with EN ISO 15613 can be specified in order to obtain a trial sample that can be used to establish weld quality for integrity and appearance.

7.4 Qualification of welding procedures and welding personnel

7.4.1 Qualification of welding procedures

7.4.1.1 General

(option) Welding shall be carried out with qualified procedures using a welding procedure specification (WPS) in accordance with the relevant part of EN ISO 15609, EN ISO 14555 or EN ISO 15620, as relevant. If specified, special deposition conditions for tack welds shall be included in the WPS.

7.401 In general, tack welds should be made to the same welding procedure specification as the permanent weld. If special deposition conditions for tack welds are required, they shall be included in the welding procedure specification.

In some cases, for instance if the tack weld will not be completely re-melted by the subsequent welding, it might be necessary to use a modified procedure. This should be investigated during welding procedure qualification.

7.4.1.2 Qualification of welding procedures for processes 111,113, 12, 13 and 14

(option) If EN ISO 15613 or EN ISO 15614-1 qualification procedures are used, the following conditions apply:

7.402 For particular joints, as specified in the execution specification, pre-production welding tests, qualified in accordance with EN ISO 15613, shall be carried out.

This clause may be used where the designer recognises that a particular joint or configuration is structurally critical and likely to be unusually difficult to perform successfully. Examples of such situations are where there is difficult or limited access or unusual orientation.

Joints that are difficult to weld are also likely to be difficult to inspect and even more difficult to repair, so the designer should seek the help of an experienced constructor to investigate alternative solutions.

Note: The restriction in the footnote to Table 12 concerning structural carbon steel strengths higher than S355 only applies to carbon steel: EN 1090-2 allows the use of EN ISO 15612 for group 8 austenitic stainless steels.

7.4.1.4 Validity of a welding procedure qualification

(option) The validity of a welding procedure depends on the requirements of the standard used for the qualification. If specified, welding production tests have to be carried out in accordance with the relevant standard of qualification, e.g. EN ISO 14555.

7.403 For stud shear connectors, in addition to validation of a welding procedure, production tests shall be carried out in accordance with 12.4.4.

Only needed for structures where such connectors are used.

7.4.3 Welding coordination

(addition) With respect to the welding operations being supervised, welding coordination personnel shall have a technical knowledge according to Table 15.

The certification of the FPC system for the manufacture of welded components shall include the verification of the competence of the responsible welding co-ordinator (RWC).

If the employer wishes to establish the competence of the RWC on a project-specific basis, the execution specification should specify a suitable pre-production welding test to EN ISO 15613 for the RWC to organize.

Note that EN 1090-2 does not include ferritic stainless steels in Table 15 but they have been added herein.

7.404 Replace Table 15 in EN 1090-2 by the following Table:

EN 10088-4 and -5 are the harmonised standards for stainless steel flat and long products respectively.

Table 15 - Technical knowledge of the coordination personnel Stainless steels

| EXC | Steels (steel group) | Reference standards | Thickness (mm) | | |
|------|----------------------------------|--|----------------|------------------|----------|
| | | | $t \leq 25$ | $25 < t \leq 50$ | $t > 50$ |
| EXC2 | Austenitic (8) Ferritic (7.1) | EN 10088-4:2009, Table 3 EN 10088-5:2009, Table 4 EN 10296-2:2005, Table 1 EN 10297-2:2005, Table 2 | B | S | C |
| | Austenitic-ferritic (10) | EN 10088-4:2009, Table 4 EN 10088-5:2009, Table 5 EN 10296-2:2005, Table 1 EN 10297-2:2005, Table 3 | S | C | C |
| EXC3 | Austenitic (8) Ferritic (7.1) | EN 10088-4:2009, Table 3 EN 10088-5:2009, Table 4 EN 10296-2:2005, Table 1 EN 10297-2:2005, Table 2 | S | C | C |
| | Austenitic-ferritic (10) | EN 10088-4:2009, Table 4 EN 10088-5:2009, Table 5 EN 10296-2:2005, Table 1 EN 10297-2:2005, Table 3 | C | C | C |
| EXC4 | All | All | C | C | C |

7.5 Preparation and execution of welding

7.5.4 Assembly for welding

(option) Assembly of hollow section components to be welded should be in accordance with the guidance given in Annex E of EN 1090-2, unless otherwise specified.

7.501 The assembly of hollow sections shall comply with the following requirements: *(Insert details)*

Insert a clause if the assembly of hollow sections to be welded is other than in accordance with Annex E.

Advice from a specialist hollow section constructor should be followed.

7.5.6 Temporary attachments

(addition) Any areas where welding of temporary attachments is not permitted shall be specified.

7.502 Welding of temporary attachments is not permitted in the following areas: *(Insert details)*

Restrictions on welding of temporary attachments should be specified, typically on drawings. No welding of temporary attachments should be allowed in areas where a high quality surface finish is required.

7.5.9 Butt welds

7.5.9.2 Single sided welds

(option) Flush grinding of single-sided butt welds in joints between hollow sections executed without backing is not permitted, unless otherwise specified; if those welds are fully backed they may be ground off flush with the general surface profile of the parent metal.

7.503 Where flush grinding of welds in joints between hollow sections without backing is permitted, grinding shall comply with the following requirements: (Insert details)

Insert a clause if flush grinding is to be allowed and show, usually on drawings, where this is permitted.

Advice from a specialist hollow section constructor should be followed if grinding is to be allowed.

Over-grinding the weld will lead to a concave weld profile and a reduction in strength of the connection.

7.5.14 Spot welds for thin gauge components

7.5.14.1 Arc spot welds

(option) For stainless steels, weld washers are accepted only if specified and according to the service conditions.
NOTE 1 Weld washers can introduce crevices into the joint; the acceptability of these crevices depends on the service conditions.

7.504 Weld washers are acceptable for stainless steel.

Weld washers are intended to reduce the risk of burn-through in thin sheet during arc spot welding. Without the washer, it is a difficult weld to make consistently. In corrosive environments, there is a risk of crevice corrosion, for example in roofing in a coastal area.

7.5.15 Other weld types

(addition) The requirements for other weld types, e.g. seal welds, shall be specified and shall be subject to the same welding requirements as specified in this European Standard (EN 1090-2).

7.505 Other weld types shall comply with the following requirements: (Insert details)

Special requirements for other types of weld should be specified and the relevant welds indicated, usually on drawings.

7.5.17 Execution of welding

(addition) Requirements for grinding and dressing of the surface of completed welds shall be specified.

If a high quality surface finish is important, grinding and dressing should be specified to give the same finish on the weld as on the parent material. A trial sample could be used to establish the required level of grinding and dressing.

It is important to avoid contamination of stainless steel by tools which have been used on carbon steel (see the handling and storage measures in the extract of Table 8). Special grinding wheels are available for use on stainless steel.

7.506 Butt welds shall be ground flush only where specified in the execution specification.

Grinding flush should only be required in specific circumstances such as enhanced fatigue classification, or where weld caps can interfere with the sealing of formwork or precast units. The grinding of external weld caps could make the joint more noticeable because it tends to produce a wider feature and should not normally be specified for appearance reasons.

7.7 Welding of stainless steels

7.7.1 Amendments to EN 1011-1 requirements

(to note)

EN 1011-1 has been amended since EN 1090-2 was issued in 2008 and the amendments in 7.7.1 are no longer applicable.

7.7.2 Amendments to EN 1011-3 requirements

(to note)

EN 1011-3 has been amended since EN 1090-2 was issued in 2008 and the amendments in 7.7.2 are no longer applicable.

Further information on welding stainless steel is given in References 23 and 24. Guidance on post-fabrication cleaning for structural components is given in References 18 and 26 for mechanical and chemical cleaning methods respectively.

Temperature indicating crayons should not be used on stainless steel to check the interpass temperature (pre-heat and post-weld heat treatments are not normally used). This is because these crayons sometimes contain low melting point metals which, if they enter the liquid stainless weld metal, may cause hot cracking. It is difficult to completely remove these markers, so there is the

risk that remnants will remain even if a procedure would require thorough cleaning.

If removal of the coloured oxide films formed during welding is necessary, it should be specified. Due consideration should be given to corrosion resistance, environment, aesthetics and the implications of dressing off and cleaning the weld zone. All slag associated with welding should be removed unless otherwise specified.

The discolouration of the weld zone after welding is influenced by the amount of oxygen in the “backing gas” during welding. Coloured photographic reference scales are available to assist with specifying acceptable discolouration [27].

7.7.3 Welding dissimilar steels

(addition) The requirements for welding different stainless steel types to each other or to other steels, such as carbon steels, shall be specified.

The welding coordinator shall take into account the appropriate welding techniques, welding processes and welding consumables. The issues associated with contamination of the stainless steel and galvanic corrosion should be considered carefully.

For welding stainless steel to carbon steel, an over-alloyed filler metal should be used to ensure adequate mechanical properties and corrosion resistance of the joint. Over-alloyed fillers avoid dilution of the alloying elements in the fusion zone of the parent stainless steel.

When welding stainless steel to galvanized steel, the zinc coating around the area to be joined needs to be removed before welding. The inclusion of zinc can result in embrittlement or reduced corrosion resistance of the finished weld and the fumes given off when attempting to weld through the galvanized layer are a significant health hazard. Once the galvanizing has been removed, welding requirements are as for ordinary carbon steel.

7.701 The following requirements are specified for welding dissimilar steels:
(Insert details)

8 MECHANICAL FASTENING

8.2 Use of bolt assemblies

8.2.2 Bolts

(addition) The nominal fastener diameter used for structural bolting shall be at least M12, unless otherwise specified together with the associated requirements.

8.201 Bolt sizes for structural bolting shall be as specified in the execution specification.

Usually, all bolt sizes should be stated on drawings. Bolts smaller than M12 are rare for structural applications.

(option) If it is intended that a connection utilises the shear capacity of the unthreaded shank of bolts, then the dimensions of the bolts shall be specified to allow for the tolerances on the length of the unthreaded portion.

8.202 Where the structure has been designed to utilise the shear resistance of the unthreaded shank of bolts, this is specified in the execution specification and the dimensions of the bolts are given.

The locations and dimensions need to be given, usually on drawings. Reliance on the resistance of the unthreaded shank, rather than the threaded part, is inadvisable because it requires a higher level of control on bolt supply and installation to ensure that only unthreaded parts exist in the part of the connection where the resistance to shear is required.

8.2.4 Washers

(option) Generally washers are not required for use with non-preloaded bolts in normal round holes. If required, it shall be specified whether washers are to be placed under the nut or the bolt head, whichever is rotated, or both.

8.203 Washers shall be provided under the nut or the bolt head of non-preloaded bolts, whichever is rotated.

This option might be needed if there is a concern that the surface of the stainless steel might be damaged during tightening.

(addition) Dimensions and steel grades of plate washers shall be specified. They shall not be thinner than 4 mm.

8.204 The dimensions and steel grades of plate washers shall be as specified in the execution specification.

If plate washers are required, their thickness and grade should be such that they are adequate for the design forces in the bolts, taking account of the geometry of the connection. They should also have at least equivalent corrosion resistance to the bolt and parent material.

8.4 Preparation of contact surfaces in slip resistant connections

(addition) This clause is not applicable to stainless steels for which any requirement related to contact surfaces shall be specified.

See clause 5.6.4 and 5.606. Note that the test method to determine the slip factor given in Annex G of EN 1090-2 can be used for stainless steel.

8.401 The requirements for contact surfaces of slip resistant connections are as follows:
(Insert details)

To be determined by test, see clause 5.606.

8.5 Tightening of preloaded bolts

8.5.1 General

(option) Any of the tightening methods given in Table 20 may be used unless restrictions on their use are specified.

8.501 The following restrictions apply to the tightening methods given in Table 20 for preloading bolts.
(Insert details)

The torque method, combined method and HRC method can be used to tighten stainless steel bolts, although tests are required to determine specific guidelines and any restrictions which may need to be imposed, e.g. avoid over-tightening in case galling occurs (see 5.606).

8.9 Use of special fasteners and fastening methods

(addition) Any procedure tests required for use of special fasteners and fastening methods in non-preloaded or preloaded applications shall be specified.

8.901 Where the use of special fasteners and fastening methods in non-preloaded or preloaded applications is specified, the following procedure tests shall be carried out:
(Insert details)

This clause applies to special stainless steel fasteners, which are not usually used in construction.

Advice on procedure tests should be sought from fastener manufacturers.

8.10 Galling and seizure of stainless steels

(to note) The following methods may be used to avoid galling problems:

a) dissimilar standard grades of stainless steel may be used which vary in composition, work hardening rate and hardness (e.g. Grade A2-C4, A4-C4 or A2-A4 bolt-nut combination from EN ISO 3506-1 and EN ISO 3506-2);

b) in severe cases, a proprietary high work-hardening stainless steel alloy may be used for one component or hard surface coatings applied, e.g. nitriding;

c) anti-galling agents such as PTFE dry film spray.

If dissimilar metals or coatings are used, it is necessary to ensure that the required corrosion resistance is obtained.

Note: The greasing of bolts is beneficial but may result in contamination by dirt and can present problems for storage.

If surfaces are under load and in relative motion, fastener thread galling or cold welding can occur due to local adhesion and rupture of the surfaces. In applications where disassembly will not occur and any loosening of fasteners is structurally undesirable, it may be an advantage.

Slowing down the installation RPM speed may also help avoid galling.

The use of an anti-galling grade of stainless steel (such as S21800) for one or both of the mating surfaces also helps to avoid galling.

9 ERECTION

Reference 13 gives general guidance on erecting or installing both architectural and structural stainless steel.

9.6 Erection and work at site

9.6.5 Erection methods

9.6.5.3 Fit-up and alignment

(option) Shims shall be made of flat steel unless otherwise specified. Shims shall have similar durability to that of the structure. For stainless steel structures they shall be made of stainless steel and have a minimum thickness of 2 mm if used externally.

9.601 If shims are provided in slip resistant connections, the class of contact surface and surface treatment of the shims shall be the same as for the contact surfaces of the primary components.

See clause 5.6.4 and 5.606 for further information about preloaded connections.

10 SURFACE TREATMENT

10.1 General

(addition) The requirements to take account of the particular coating system to be applied shall be specified.

10.101 Where surfaces are to be coated with *(Insert the particular coating system)* they shall comply with the following additional requirements:
(Insert details)

Stainless steel is rarely painted as it has inherent corrosion resistance. If painting is required, paint manufacturers should be consulted. A trial sample could also be prepared to establish the suitability of the paint system. See also Reference 7.

10.2 Preparation of steel substrates

(option) These requirements do not apply to stainless steels. If there are requirements for surface cleanliness of stainless steels, they shall be specified.

10.201 The requirements for surface cleanliness are as follows:
(Insert details)

References 13 and 28 may give relevant information on surface cleanliness.

10.4 Galvanic coupling

(to note) Unintended contact between different metallic constituent products, e.g. stainless steels to aluminium or structural steel shall be avoided. If stainless steel is to be welded to structural (carbon) steel, corrosion protection for the steel structure shall continue from the weld on to the stainless steel by 20 mm as a minimum. See also 6.3, 6.9 and 7.7.3

Further information is given in Reference 22.

10.9 Repairs after cutting or welding

(addition) It shall be specified if repair, or additional protective treatment, is required to cut edges and adjacent surfaces after cutting.

10.901 After cutting, cut edges and adjacent surfaces shall be ... *(Insert requirements)*, where specified in the execution specification.

Cut edges and adjacent surfaces may need to be repaired if a high quality surface finish is required. Alternatively, cut edges may need further treatment to eliminate sharp edges, which can be hazardous during handling.

10.10 Cleaning after erection

10.10.2 Cleaning of stainless steel components

(addition) Cleaning procedures shall be appropriate for the grade of constituent product, surface finish, function of the component and corrosion risk. The method, level and extent of cleaning shall be specified.

Strong acid solutions sometimes used to clean the masonry and tiling of buildings shall not be permitted to come into contact with structural (carbon) steel, including stainless steel. If such contamination does happen, acid solutions shall be washed off immediately with large amounts of clean water

More information is given in Reference 28.

The frequency of cleaning should also be specified. The more frequently cleaning is carried out, the greater the benefit.

The cleaning frequency should be

between once a year for rural atmospheres and every 3 months for recessed areas in urban atmospheres.

Where cleaning is specified it should apply to all parts of the structure, and not just those easily accessible and visible.

10.1001 Cleaning procedures shall comply with the following requirements:
(Insert details)

11 GEOMETRICAL TOLERANCES

11.3 Functional tolerances

11.3.1 General

(option) Functional tolerances in terms of accepted geometrical deviations shall be in accordance with one of the following two options:

- a) the tabulated values described in 9.3.2 of EN 1090-2, or
- b) the alternative criteria defined in 9.3.3 of EN 1090-2.

If no option is specified the tabulated values shall apply.

11.301 The tabulated values in D.2 shall apply and the tolerance class shall be class 1.

This confirms the default requirement.

11.302 In addition to the requirements in D.2, the following functional tolerances apply:
(Insert requirements)

Where there are particular requirements, such as the achievement of a visually good alignment of fascia surfaces, these should be specified.

12 INSPECTION, TESTING AND CORRECTION

12.2 Constituent products and components

12.2.1 Constituent products

(option) There are no requirements for specific testing of products unless otherwise specified.

12.201 Specific testing of ... *(Insert relevant constituent product)* shall comply with the following requirements:
(Insert details)

Insert any special requirements, or refer to the drawings, if they are specified there.

12.4 Welding

12.4.2 Inspection after welding

12.4.2.3 Visual inspection of welds

(to note) The visual inspection shall be performed after completion of welding in an area and before any other NDT inspection is carried out.

Visual inspection shall include:

- a) the presence and location of all welds;
- b) inspection of the welds in accordance with EN 970;
- c) stray arcs and areas of weld spatter

Reference 11 is a photo guide giving visual acceptance criteria for different welding procedures, degrees of surface finish and weld geometries.

Surface examination of stainless steel welds can be more important than that for carbon steels because stainless steel is primarily used to combat corrosion and a small surface flaw in the weld can render the stainless steel vulnerable to corrosion attack.

12.4.2.4 Additional NDT methods

(to note) The following NDT methods shall be carried out in accordance with the general principles given in EN 12062 and with the requirements of the standard particular to each method:

- a) penetrant testing (PT) according to EN 571-1;
- b) magnetic particle inspection (MT) according to EN 1290;
- c) ultrasonic testing (UT) according to EN 1714, EN 1713;
- d) radiographic testing (RT) according to EN 1435.

The field of application of NDT methods is specified in their relevant standards.

Magnetic particle testing (MT) is not an option for austenitic stainless steels because they are non-magnetic.

Ultrasonic methods are of limited use on welds because of difficulties in interpretation; however they can be used on parent metal.

Note:

EN 12062 is replaced by EN ISO 17635.

EN 571-1 is replaced by EN ISO 3452-1.

EN 1290 is replaced by EN ISO 17638.

EN 1714 is replaced by EN ISO 17640.

EN 1713 is replaced by EN ISO 23279.

EN 1435 is replaced by EN ISO 17636-2.

12.5 Mechanical fastening

12.5.1 Inspection of non-preloaded bolted connections

(addition) If an insulation system is required at junctions between stainless steel and other metals, the requirements for checking the installation shall also be specified.

Further information is given in Reference 22.

12.501 The requirements for checking the installation of the insulation are as follows:
(Insert requirements)

It is possible to check the integrity of the insulation using an electrical resistance meter or 'megger'. However, this only provides reliable results in truly dry conditions and if there is no alternative electrical conduction path through other connected structural components.

12.5.2 Inspection and testing of preloaded bolted connections

12.5.2.1 Inspection of friction surfaces

(addition) If preloaded bolts are used for stainless steel connections, the requirements for inspection and testing shall be specified.

12.502 The requirements for inspection and testing of stainless steel friction surfaces in preloaded bolted connections are as follows:
(Insert details)

Preloaded bolts are rarely used with stainless steel. See clause 5.6.4 and 5.606 for further information about preloaded connections.

12.5.5 Special fasteners and fastening methods

12.5.5.1 General

(addition) Requirements for inspection of connections using special fasteners or special fastening methods in accordance with 8.9 shall be specified.

12.503 Where the use of special fasteners and fastening methods in non-preloaded or preloaded applications is specified, requirements for inspection shall be as follows:
(Insert details)

This clause applies to special stainless steel fasteners, which are not usually used in construction.

Give guidance on when special fasteners might be used and how their installation may be inspected and tested.

12.7 Erection

12.7.3 Survey of geometrical position of connection nodes

12.7.3.6 Definition of nonconformity

(to note) Accuracy of construction shall be interpreted in relation to the expected deflections, cambers, presets, elastic movements and thermal expansion of components.

NOTE 2 EN 1993-1-4 gives values for the coefficient of thermal expansion for common stainless steels.

The coefficient of thermal expansion between 20 and 100° C is:

Austenitics: $16 \times 10^{-6}/K$

Austenitic-ferritics: $13 \times 10^{-6}/K$

Ferritics: $10 \times 10^{-6}/K$

Carbon steel: $12 \times 10^{-6}/K$

Appendix A: Clauses in EN 1090-2 making specific reference to stainless steel

| Clause | Title |
|-----------------|--|
| 5.2 | Table 1 - Inspection documents for metallic products |
| 5.3.1 | Table 4 - Product standards for stainless steels |
| 5.3.2 | Thickness tolerances |
| 5.3.3 | Surface conditions |
| 5.3.4 | Special properties |
| 5.5 | Table 5 - Product standards for welding consumables |
| 5.5 | Welding consumables |
| 5.6.3 | Structural bolting assemblies for non preloaded applications |
| 5.6.4 | Structural bolting assemblies for preloading |
| 5.6.5 | Direct tension indicators |
| 5.6.9.1 | Plain washers (Amendment A1, issued in 2011) |
| 6.2 | Identification |
| 6.3 | Table 8 - List of handling and storage preventative measures |
| 6.5.4 b) and c) | Cold forming |
| 6.9 | Assembly |
| 7.1 | Welding - General |
| 7.2.2 i) | Content of a welding plan |
| 7.4.3 | Table 15 - Technical knowledge of the coordination personnel: Stainless steels |
| 7.5.14.1 | Arc spot welds |
| 7.7 | Welding of stainless steels |
| 8.4 | Preparation of contact surfaces in slip resistant connections |
| 8.10 | Galling and seizure of stainless steels |
| 9.6.5.3 | Fit-up and alignment |
| 10.2 | Preparation of steel substrates |
| 10.4 | Galvanic coupling |
| 10.10.2 | Cleaning of stainless steel components |
| 12.5.1 | Inspection of non-preloaded bolted connections |
| 12.5.2.1 | Inspection of friction surfaces |
| 12.7.3.6 | Definition of nonconformity |

APPENDIX B: Clauses in EN 1090-2 where additional information is required or options may be specified

Annex A of EN 1090-2 includes two tables, one listing the clauses where information is required and one where options may be specified. The following table lists all those clauses, with relevant extracts of clause texts and gives reference to the model clauses in the main body of this document. In the Table, 'A.1' refers to Table A.1 of EN 1090-2, which lists the clauses where information is required and 'A.2' refers to Table A.2, which lists where options may be specified. Only those clauses that relate to matters within the scope of this document are listed.

| Clause | Statement in clause | Addit. A.1 | Option. A.2 | Model clause |
|----------|---|------------|-------------|---------------|
| 4.2.2 | It shall be specified if a quality plan for execution of the works is required. | | ✓ | 4.201 |
| 5.3.1 | Structural steel products shall conform to the requirements of the relevant European product standards as listed in ... unless otherwise specified..... | ✓ | | 5.301 & 5.302 |
| 5.3.3 | If the relevant specification does not adequately define ... the finish shall be specified. | ✓ | | 5.303 & 5.304 |
| 5.3.4 | c) special delivery conditions of stainless steel ... | ✓ | | 5.305 |
| 5.3.4 | d) processing conditions if constituent products are to be processed before delivery. | ✓ | | 5.306 |
| 5.5 | Revised standard for welding consumables included in Table 5. | ✓ | | 5.501 |
| 5.6.3 | Property classes of bolts and nuts and, if appropriate, surface finishes shall be specified ... | ✓ | | 5.601 |
| 5.6.3 | If insulation kits are to be used full details of their use shall be specified. | ✓ | | 5.602 |
| 5.6.4 | Property classes of preloaded bolts | ✓ | | 5.603 |
| 5.6.8 | If required the locking devices ... shall be specified. | | ✓ | 5.604 |
| 5.6.8 | Unless otherwise specified, products from ... may be used. | | ✓ | 5.605 |
| 5.6.12 | Special fasteners.....shall be specified..... | ✓ | | 5.606 |
| 6.2 | Soft or low stress stamps ... unless otherwise specified | | ✓ | 6.201 |
| 6.2 | Any zones where identification marks are not permitted or shall not be visible after completion shall be specified. | ✓ | | 6.202 |
| 6.5.4 b) | For stainless steels, unless otherwise specified, the minimum inside bend radii shall be: | | ✓ | 6.501 |

| Clause | Statement in clause | Addit. A.1 | Option. A.2 | Model clause |
|----------|---|---------------|----------------|--------------|
| 6.5.4 c) | For other grades ... the minimum inside bend radii shall be specified. | ✓ | | 6.502 |
| 6.5.4 d) | It shall be specified if constituent products require protective membranes to be applied before forming. | | ✓ | 6.503 |
| 6.5.4 e) | For circular tubes bending by cold forming shall comply with the following three conditions, unless otherwise specified: | | ✓ | 6.504 |
| 6.6.1 | Special dimensions should be specified for movement joints. | ✓ | | 6.601 |
| 6.6.1 | The dimensions of the countersinking shall be specified accordingly. | ✓ | | 6.602 |
| 6.6.2 | Unless otherwise specified, hole diameters shall comply with the following: | | ✓ | 6.603 |
| 6.6.3 | For EXC1 and EXC2, holes may be formed by punching without reaming unless otherwise specified. | | ✓ | 6.604 |
| 6.6.3 | Long slotted holes shall be ... unless otherwise specified. | | ✓ | 6.605 |
| 6.9 | All connections for temporary components provided for manufacturing purposes shall meet ... and any special requirements including those related to fatigue which shall be specified. | ✓ | | 6.901 |
| 6.10 | Requirements for whether, and to what extent, trial assembly is to be used shall be specified. | | ✓ | 6.1001 |
| 7.4.1.1 | If specified, special deposition conditions for tack welds shall be included in the WPS. | | ✓ | 7.401 |
| 7.4.1.2b | b) If EN ISO 15613 or EN ISO 15614-1 qualification procedures are used, the following conditions apply: * Use of these procedures is invoked by specifying EXC3 or EXC4. There is no option to add further conditions to those in 7.4.1.2b. However, optional clause 7.402 is given, to require pre-production tests. | | ✓ | * |
| 7.4.1.4 | If specified, welding production tests have to be carried out in accordance with the relevant standard of qualification, e.g. EN ISO 14555. | | ✓ | 7.403 |
| 7.4.3 | Revised standards included in Table 15 | ✓ | | 7.404 |
| 7.5.4 | Assembly of hollow section components to be welded should be in accordance with the guidance given in Annex E, unless otherwise specified. | | ✓ | 7.501 |
| 7.5.6 | Any areas where welding of temporary attachments is not permitted shall be specified. | ✓ | | 7.502 |

| Clause | Statement in clause | Addit. A.1 | Option. A.2 | Model clause |
|----------|--|---------------|----------------|--------------|
| 7.5.9.2 | Flush grinding of single-sided butt welds in joints between hollow sections executed without backing is not permitted, unless otherwise specified... | | ✓ | 7.503 |
| 7.5.14.1 | For stainless steels, weld washers are accepted only if specified and according to the service environment. | | ✓ | 7.504 |
| 7.5.15 | The requirements for other weld types, e.g. seal welds, shall be specified | ✓ | | 7.505 |
| 7.5.17 | Any requirements for grinding and dressing of the surface of completed welds shall be specified. | ✓ | | 7.506 |
| 7.7.3 | Requirements for dissimilar welding | ✓ | | 7.701 |
| 8.2.2 | The nominal fastener diameter used for structural bolting shall be ... unless otherwise specified | ✓ | | 8.201 |
| 8.2.2 | If it is intended ... then the dimensions of the bolts shall be specified to allow for the tolerances on the length of the unthreaded portion. | | ✓ | 8.202 |
| 8.2.4 | If required, it shall be specified whether washers are to be placed under the nut or the bolt head, whichever is rotated, or both. | | ✓ | 8.203 |
| 8.2.4 | Dimensions and steel grades of plate washers shall be specified. They shall not be thinner than 4 mm. | ✓ | | 8.204 |
| 8.4 | Requirements for contact surface of slip resistant surfaces | ✓ | | 8.401 |
| 8.5.1 | Any of the tightening methods given in Table 20 may be used unless restrictions on their use are specified. | | ✓ | 8.501 |
| 8.9 | Such methods shall be used only where specified. Any procedure tests required ... shall be specified. | ✓ | | 8.901 |
| 9.6.5.3 | Shims shall be made of flat steel unless otherwise specified. | | ✓ | 9.601 |
| 10.1 | Requirements to take into account the particular coating system to be applied | ✓ | | 10.101 |
| 10.2 | Requirements for surface cleanliness of stainless steels | | ✓ | 10.201 |
| 10.9 | It shall be specified if repair or additional protective treatment is required for cut edges and | ✓ | | 10.901 |
| 10.10.2 | The method, level and extent [of cleaning after erection] shall be specified | ✓ | | 10.1001 |

| Clause | Statement in clause | Addit. A.1 | Option. A.2 | Model clause |
|----------|--|---------------|----------------|---|
| 11.3.1 | Functional tolerances in terms of accepted geometrical deviations shall be in accordance with one of the following two options: | ✓ | | 11.301 <i>(But 11.3.1 only provides for either Table D.2 or the classes specified in 11.3.3)</i> |
| 11.3.3 | If specified, the following alternative criteria may be applied: | | ✓ | 11.302 <i>(Does not refer to the classes but provides scope for criteria additional to D.2)</i> |
| 12.2.1 | There are no requirements for specific testing of products unless otherwise specified. | | ✓ | 12.201 |
| 12.5.1 | If an insulation system is required at junctions ... the requirements for checking ... shall also be specified | ✓ | | 12.501 |
| 12.5.2 | If preloaded bolts are used ... the requirements ... shall be specified | ✓ | | 12.502 |
| 12.5.5.1 | Requirements for inspection of connections using special fasteners or special fastening methods in accordance with 8.9 shall be specified. | ✓ | | 12.503 |

APPENDIX C: REFERENCES

- 1 Steel Construction CE Marking, British Constructional Steelwork Association, Version 2, August 2013. *Downloadable from www.steelconstruction.info*
- 2 Construction Products Regulation (EU) No. 305/2011 of the European Parliament and of the Council of 9 March 2011, Official Journal of the European Union L88/5 4.4.2011
- 3 EN 1993-1-4 Eurocode 3. Design of steel structures. General rules. Supplementary rules for stainless steels, 2006
- 4 Design Manual for Structural Stainless Steel, Third Edition, Euro Inox and SCI, 2006. *Downloadable from www.steel-stainless.org/designmanual*
- 5 Guide to stainless steel finishes, Building Series Vol 1, Euro Inox 2005. *Downloadable from www.euro-inox.org*
- 6 Depth, Pattern and Texture - The Third Dimension in Stainless Steel Surfaces, Building Series, Volume 14, Euro Inox 2008. *Downloadable from www.euro-inox.org*
- 7 Colouring Stainless Steel, Materials and Applications Series, Volume 16, Euro Inox 2011. *Downloadable from www.euro-inox.org*
- 8 VDA 621-415 Testing of Corrosion Protection of Vehicle Paint by Alternating Cycles Test, Verband der Automobilindustrie
- 9 ASTM G48 Standard Test Methods for Pitting and Crevice Corrosion Resistance of Stainless Steels and Related Alloys by Use of Ferric Chloride Solution
- 10 Bending stainless steel tube – Design benefits in engineering and architecture, Materials and Applications Series, Volume 15, Euro Inox, 2012. *Downloadable from www.euro-inox.org*
- 11 Reference Photo Guide for Stainless Steel Welds. Materials and Applications series Vol 14, Euro Inox 2011
- 12 Stainless Steels: Tables of Fabrication Parameters, Materials and Applications Series, Volume 17, Euro Inox 2012. *Downloadable from www.euro-inox.org*
- 13 Erection and installation of stainless steel components, Building Series, Volume 10, Euro Inox, 2006. *Downloadable from www.euro-inox.org*
- 14 EN 10319 Metallic Materials. Tensile stress relaxation testing.
Part 1: Procedure for testing machines
Part 2: Procedure for bolted joint models
- 15 EN ISO 16047 Fasteners. Torque/clamp force testing
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