STEEL BUILDINGS IN EUROPE

Multi-Storey Steel Buildings
Part 7: Model Construction Specification

7.5 Grouting materials

The grouting materials to be used shall conform to the requirements of § 5.7 of EN 1090-2.

8 PREPARATION AND ASSEMBLY

This Section specifies the requirements for cutting, shaping, holing and assembly of constituent steel components.

Structural steelwork shall be fabricated considering the surface treatment requirements in § 10 of EN 1090-2, and within the geometrical tolerances specified in § 11 of EN 1090-2.

8.1 Identification

At all stages of manufacturing, each piece or package of similar pieces of steel components shall be identifiable by a suitable system, according to the requirements of § 6.2 of EN 1090-2.

8.2 Handling and storage

Constituent products shall be handled and stored in conditions that are in accordance with product manufacturer's recommendations. Structural steel components shall be packed, handled and transported in a safe manner, so that permanent deformation does not occur and surface damage is minimized.

Handling and storage preventive measures specified in Table 8 of EN 1090-2 shall be applied as appropriate.

8.3 Cutting

Known and recognized cutting methods are sawing, shearing, disc cutting, water jet techniques and thermal cutting. Hand thermal cutting shall be used only if it is not practical to use machine thermal cutting. Cutting shall be carried out in such a way that the requirements for geometrical tolerances, maximum hardness and smoothness of free edges as specified in § 6.4 of EN 1090-2 are met.

8.4 Shaping

Steel may be bent, pressed or forged to the required shape either by the hot or by the cold forming processes, provided the properties are not reduced below those specified for the worked material.

Requirements of § 6.5 of EN 1090-2 shall be applied as appropriate.

8.5 Holing

Dimensions of holes, tolerances on hole-diameters and execution of holing shall comply with the requirements of § 6.6 of EN 1090-2.

8.6 Assembly

Assembly of components shall be carried out so as to fulfil the specified tolerances. Precautions shall be taken so as to prevent galvanic corrosion produced by contact between different metallic materials.

Requirements of § 6.9 and § 6.10 of EN 1090-2 shall be applied as appropriate.

9 WELDING

9.1 General

Welding shall be undertaken in accordance with the requirements of the relevant part of EN ISO 3834 or EN ISO 14554 as applicable.

A welding plan shall be provided as part of the production planning required by the relevant part of EN ISO 3834. The content of a welding plan is described in § 7.2.2 of EN 1090-2.

Welding may be performed by the welding processes defined in EN ISO 4063, that are listed in § 7.3 of EN 1090-2.

9.2 Qualification of welding procedures

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

Qualifications of welding procedures, depending on welding processes, are described in § 7.4.1.2 and § 7.4.1.3 of EN 1090-2.

9.3 Welders and welding operators

Welders shall be qualified in accordance with EN 287-1 and welding operators in accordance with EN 1418. Records of all welder and welding operator qualification tests shall be kept available.

9.4 Welding coordination

For Execution Class EXC2, EXC3 and EXC4, welding coordination shall be maintained during the execution of welding by welding coordination personnel suitably qualified for, and experienced in the welding operations they supervise as specified in EN ISO 14731.

With respect to the welding operations being supervised, and for structural carbon steels, welding coordination personnel shall have a technical knowledge according to Table 14 of EN 1090-2.

9.5 Preparation and execution of welding

Precautions shall be taken to avoid stray arcing, and if stray arcing does occur the surface of the steel shall be lightly ground and checked. Visual checking shall be supplemented by penetrant or magnetic particle testing.

Precautions shall be taken to avoid weld spatter. For Execution Class EXC3 and EXC4, it shall be removed.

Visible imperfections such as cracks, cavities and other not permitted imperfections shall be removed from each run before deposition of further runs.

All slag shall be removed from the surface of each run before each subsequent run is added and from the surface of the finished weld.

Particular attention shall be paid to the junctions between the weld and the parent metal.

Any requirements for grinding and dressing of the surface of completed welds shall be specified.

Joint preparation shall be appropriate for the welding process. If qualification of welding procedures is performed in accordance with EN ISO 15614-1, EN ISO 15612 or EN ISO 15613, joint preparation shall comply with the type of preparation used in the welding procedure test. Tolerances for joints preparations, and fit-up shall be given in the WPSs.

Joint preparation shall be free from visible cracks. Visible cracks shall be removed by grinding and the joint geometry corrected as necessary.

If large notches or other errors in joint geometry are corrected by welding, a qualified procedure shall be used, and the area shall be subsequently ground smooth and feathered into the adjacent surface.

All surfaces to be welded shall be dry and free from material that would adversely affect the quality of the welds or impede the process of welding (rust, organic material or galvanizing).

Prefabrication primers (shop primers) may be left on the fusion faces only if they do not adversely affect the welding process. For Execution Class EXC3 and EXC4, prefabrication primers shall not be left on the fusion faces, unless welding procedure tests in accordance with EN ISO 15614-1 or EN ISO 15613 have been completed using such prefabrication primers.

Other special requirements are described in EN 1090-2, as indicated in Table 9.1.

Table 9.1 Special requirements

	Clause
Storage and handling of welding consumables	7.5.2
Weather protection	7.5.3
Assembly for welding	7.5.4
Preheating	7.5.5
Temporary attachments	7.5.6
Tack welds	7.5.7
Fillet welds	7.5.8
Butt welds	7.5.9
Stud welding	7.5.12
Slot and plug welds	7.5.13

9.6 Acceptance criteria

Welded components shall comply with the requirements specified in § 10 and § 11 of EN 1090-2.

The acceptance criteria for weld imperfections shall conform to the requirements of § 7.6 of EN 1090-2.

10 MECHANICAL FASTENING

Section 8 of EN 1090-2 covers requirements for shop and site fastening, including the fixing of profiled sheeting; it refers to bolting assemblies consisting of matching bolts, nuts and washers (as necessary).

Contract documents shall specify if, in addition to tightening, other measures or means are to be used to secure the nuts.

Minimum nominal fastener diameter, bolt length, length of protrusion, length of the unthreaded bolt shaft and clamp length shall comply with the requirements of § 8.2.2 of EN 1090-2.

Requirements given in § 8.2.3 of EN 1090-2 for washers shall apply.

Tightening of non-preloaded bolts shall comply with the requirements of § 8.3 of EN 1090-2.

Precautions and preparation of contact surfaces in slip resistant connections shall comply with the requirements of § 8.4 and Table 18 of EN 1090-2. Slip factor shall be determined by test as specified in Annex G of EN 1090-2.

Tightening methods of preloaded bolts shall comply with the requirements of § 8.5 of EN 1090-2, and shall be specified in the contract documents.

11 ERECTION

Section 9 of EN 1090-2 gives requirements for erection and other works undertaken on site including grouting of bases as well as those relevant to the suitability of the site for safe erection and for accurately prepared supports.

Erection shall not commence until the site for the construction works complies with the technical requirements with respect to the safety of the works. Safety items related to site conditions are listed in § 9.2 of EN 1090-2.

If the structural stability in the part-erected condition is not evident, a safe method of erection, on which the design was based, shall be provided. Items related to the design basis method of erection are listed in § 9.3.1 of EN 1090-2.

A method statement describing the steelwork contractor's erection method shall be prepared and checked in accordance with design rules. The erection method statement shall describe procedures to be used to safely erect the steelwork and shall take into account the technical requirements regarding the safety of the works. The erection method statement shall address all relevant items in § 9.3.1 of EN 1090-2; additional items are listed in § 9.3.2 of EN 1090-2.

Erection drawings or equivalent instructions, in accordance with the requirements of § 9.6.1 of EN 1090-2, shall be provided and form part of the erection method statement.

Site measurements for the works shall be in accordance with the survey requirements of § 9.4 of EN 1090-2.

The condition and location of the supports shall be checked visually and by appropriate measurement before the commencement of erection. If supports are unsuited to erection, they shall be corrected prior to the commencement of erection. Nonconformities shall be documented.

All foundations, foundation bolts and other supports for the steelwork shall be suitably prepared to receive the steel structure. Installation of structural bearings shall comply with the requirements of EN 1337-11. Erection shall not commence until the location and levels of the supports, anchors or bearings comply with the acceptance criteria in § 11.2 of EN 1090-2, or an appropriate amendment to the specified requirements.

If foundation bolts are to be pre-stressed, arrangements shall be made that the upper 100 mm of the bolt, as a minimum, has no adhesion to the concrete. Foundation bolts intended to move in sleeves shall be provided with sleeves three times the diameter of the bolt, with a minimum of 75 mm.

Whilst erection is proceeding, the supports for the steelwork shall be maintained in an equivalent condition to their condition at the commencement of erection.

Areas of supports that require protection against rust staining shall be identified and appropriate protection provided.

Compensation for settlement of supports is acceptable, unless otherwise specified in the contract documents. This shall be done by grouting or packing between steelwork and support. The compensation will generally be placed beneath the bearing.

Shims and other supporting devices used as temporary supports under base plates shall be placed in accordance with the requirements of § 8.3, 8.5.1, 9.5.4 and 9.6.5.3 of EN 1090-2.

Grouting, sealing and anchoring shall be set in accordance with their specification and the requirements of § 5.8, 9.5.5 and 9.5.6 of EN 1090-2.

Components that are individually assembled or erected at the site shall be allocated an erection mark, in accordance with the requirements of § 6.2 and 9.6.2 of EN 1090-2.

Handling and storage on site shall comply with the requirements of § 6.3 and 9.6.3 of EN 1090-2.

Any site trial erection shall be performed in accordance with the requirements of Clauses 6.10 and 9.6.10 of EN 1090-2.

The erection of the steelwork shall be carried out in conformity with the erection method statement and in such a way as to ensure stability at all times.

Foundation bolts shall not be used to secure unguyed columns against overturning unless they have been checked for this design situation.

Throughout the erection of the structure, the steelwork shall be made safe against temporary erection loads, including those due to erection equipment or its operation and against the effects of wind loads on the unfinished structure.

At least one third of the permanent bolts in each connection should be installed before that connection can be considered to contribute to stability of the part completed structure.

All temporary bracing and temporary restraints shall be left in position until erection is sufficiently advanced to allow its safe removal.

All connections for temporary components provided for erection purposes shall be made in accordance with the requirements of EN 1090-2 and in such a way that they do not weaken the permanent structure or impair its serviceability.

If backing bars and draw cleats are used to support the structure during welding, it shall be ensured that they are sufficiently strong and that their retaining welds are appropriate for the erection load conditions.

If the erection procedure involves rolling or otherwise moving the structure, or part of the structure, into its final position after assembly, provision shall be

made for controlled braking of the moving mass. Provision for reversing the direction of movement may need to be considered.

All temporary anchoring devices shall be made secure against unintentional release.

Only jacks that can be locked in any position under load shall be used unless other safety provisions are made.

Care shall be taken that no part of the structure is permanently distorted or over-stressed by stacking of steelwork components or by erection loads during the erection process.

Each part of the structure shall be aligned as soon as practicable after it has been erected and final assembly completed as soon as possible thereafter.

Permanent connections shall not be made between components until sufficient of the structure has been aligned, levelled, plumbed and temporarily connected to ensure that components will not be displaced during subsequent erection or alignment of the remainder of the structure.

Alignment of the structure and lack-of-fit in connections may be adjusted by the use of shims (see above). If lack-of-fit between erected components cannot be corrected by the use of shims, components of the structure shall be locally modified in accordance with the methods specified in EN 1090-2. The modifications shall not compromise the performance of the structure in the temporary or permanent state. This work may be executed on site. Care shall be taken with structures built of welded latticed components and space structures to ensure that they are not subjected to excessive forces in an attempt to force a fit against their inherent rigidity.

Unless otherwise prohibited in the contract documents, drifts may be used to align connections. Elongation of holes for bolts used for transmission of loads shall not be more than the values given in § 6.9 of EN 1090-2.

In case of misalignment of holes for bolts, the method of correction shall be checked for consistency with the requirements of § 12 of EN 1090-2.

Realigned holes may be proven to comply with the oversize or slotted hole requirements specified in 8.1 of EN 1090-2, provided the load path has been checked.

Correction of misalignment by reaming or using a hollow milling cutter is preferred, but if the use of other cutting methods is unavoidable the internal finish of all holes formed by these other methods shall be specifically checked for consistency with the requirements of § 6 of EN 1090-2.

Completed site connections shall be checked in accordance with 12.5 of EN 1090-2.

Erection tolerances are detailed in § 11.2.3 and Tables D.1.11 to D.1.15 and Tables D.2.19 to D.2.28 of Annex D of EN 1090-2.

12 CONSTRUCTOR'S DOCUMENTATION

Quality documentation, mandatory for Execution Classes EXC2 to EXC4, is defined in § 4.2.1 of EN 1090-2.

If required, a quality plan (defined in EN ISO 9000) for the execution of the works is described in § 4.2.2 of EN 1090-2. Annex C of EN 1090-2 gives a check-list for the content of a quality plan recommended for the execution of structural steelwork with reference to the general guidelines in ISO 10005.

Method statements giving detailed work instructions shall comply with the technical requirements relating to the safety of the erection works as given in § 9.2 and § 9.3 of EN 1090-2.

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

Design and structural engineering documentation shall be prepared before execution of the works, and approved by any approval body designated by the Owner. The documentation should contain:

- Design assumptions
- Software used (if any)
- Member and joint design verification
- General Arrangement drawings and joint details.

13 INTERFACES OF THE STEEL STRUCTURE

13.1 Interface to concrete surfaces

Information showing holding-down bolts and the interface of steelwork components to foundations shall include a Foundation Plan showing the base location, position and orientation of columns, the marks of all columns, any other components in direct contact with the foundations, their base location and level, and the datum level.

Similar information shall also be provided for components connecting to walls and other concrete surfaces.

Complete details of fixing steel and bolts to the foundations or walls, method of adjustment and packing space shall be provided.

Before erection of steelwork starts, the steelwork contractor shall inspect the prepared foundations and holding-down bolts for position and level; if he finds any discrepancies which are outside the deviations specified in § D.2.20 of EN 1090-2, he shall request that remedial work be carried out before erection commences.

Shims and other supporting devices used as temporary supports under base plates shall present a flat surface to the steel and be of adequate size, strength and rigidity to avoid local crushing of the substructure concrete or masonry.

If packings are subsequently to be grouted, they shall be placed so that the grout totally encloses them with a minimum cover of 25 mm unless otherwise specified.

If packings are left in position after grouting, they shall be made from materials with the same durability as the structure.

If adjustment to the position of the base is achieved using levelling nuts on the foundation bolts under the base plate, these may be left in position unless otherwise specified. The nuts shall be selected to ensure that they are suitable to maintain the stability of the part-erected structure but not to jeopardize the performance of the foundation bolt in service.

If spaces under base plates are to be grouted, fresh material shall be used in accordance with § 5.8 of EN 1090-2.

Grouting shall not be carried out under column base plates until a sufficient portion of the structure has been aligned, levelled, plumbed and adequately braced.

Grouting material shall be used as follows:

- The material shall be mixed and used in accordance with product manufacturer's recommendations notably regarding its consistency when used. Material shall not be mixed or used below 0°C unless the manufacturer's recommendations permit it.

- The material shall be poured under a suitable head so that the space is completely filled.
- Tamping and ramming against properly fixed supports shall be used if specified and/or recommended by the grout manufacturer.
- Vent holes shall be provided as necessary.

Immediately before grouting, the space under the steel base plate shall be free from liquids, ice, debris and contaminants.

If treatment of steelwork, bearings and concrete surfaces is required before grouting, it shall be specified in the contract documents.

Care shall be taken that the external profile of grouting allows water to be drained away from structural steel components. If there is a danger of water or corrosive liquid becoming entrapped during service, the grout around base plates shall not be surcharged such that it rises above the lowest surface of the base plate and the geometry of the concrete grout shall form an angle from the base plate.

If no grouting is needed, and the edges of the base plate are to be sealed, the method shall be specified.

Anchoring devices in concrete parts of the structure or adjacent structures shall be set in accordance with their specification. Suitable measures shall be taken to avoid damage to concrete in order to achieve the necessary anchoring resistance.

Foundations shall be adequately designed by a qualified foundation engineer to support the building reactions and other loads which may be imposed by the building use. The design shall be based on the specific soil conditions of the building site.

13.2 Interface to neighbouring constructions

The mutual influence of neighbouring constructions for wind or snow actions must be carefully considered. Design wind and snow loads may vary considerably regarding the site and the construction environment, hence, precise indications shall be given, in the contract documents, concerning the surrounding constructions.

APPENDIX A MODEL PROJECT SPECIFICATION

The execution of steelwork for multi-storey buildings in Europe will generally be specified to be in accordance with EN 1090-2, and the design to be in accordance with applicable parts of the Eurocode Standards. These Standards, which cover technical requirements for a wide range of steel structures, include clauses where the execution/design specification for the works is required to give additional information or where it has the option to specify other requirements.

Appendix A offers a set of clauses that may be used for multi-storey steel building projects to supplement and quantify the rules of the Europeans Standards.

The clauses are arranged in a two-column format. The left column contains the proposed clauses. The right column gives a commentary to several clauses, for the information of the person drawing up project documents; those commentaries are not intended to be included within the execution specification. The model specification must be made specific to the construction project by completing the relevant clauses with appropriate information.

The model project specification proposed in this Appendix covers structural steelwork produced from hot rolled structural steel products only. It does not cover structural steelwork produced from cold formed structural steel (only cold formed profiled steel sheeting and cold formed stressed-skin sheeting used as a structural diaphragm are herein covered), structural hollow sections, channels and tubes and stainless steel products. This model project specification relates principally to conventional construction using constituent products to the standards referenced in EN 1090-2. If more complex forms of construction are involved or other products are used, designers need to consider any modifications that might be needed to the execution specification to ensure that the desired quality and/or functionality are achieved.

For consistency, in Appendix A, those clause headings that are numbered and in bold, correspond to the Section headings of this document.

Proposed Clauses		Commentary
3	**BASIS OF STRUCTURAL DESIGN**	
3.1	Design of steel structures shall conform to the basic requirements of § 2.1 of EN 1990.	
3.2	Reliability, durability and quality management shall conform to Clauses 2.2, 2.4 and 2.5 of EN 1990.	
3.3	The following additional specific events shall be taken into account for the design and the execution of the structure: *(insert list)*	§ *2.1(4) of EN 1990.*
3.4	The design working life of the structure shall be equal to ... years.	§ *2.3 of EN 1990.* *For the specification of the intended design working life of a permanent building, see Table 2.1 of EN 1990.* *A working life of 50 years will provide adequate durability for common multi--storey buildings.*
3.5	For the following additional specific circumstances, the limit states that concern the protection of the contents shall be classified as ultimate limit states: *(insert list)*	§ *3.3(2) of EN 1990.*
3.6	The serviceability requirements of the project shall be as follows: *(insert requirements)*	§ *3.4(1) of EN 1990.*
4.	**ACTIONS ON STRUCTURES**	
4.1	**Self-weight and imposed loads**	
4.1.1	The following imposed loads shall be considered for serviceability limit state verifications: *(insert list)*	§ *3.3.2(4) of EN 1991-1-1.* *In accordance with the service conditions and the requirements concerning the performance of the structure.*
4.1.2	The characteristic values of densities of construction and stored materials shall be taken as follows: *(insert list)*	*Clauses 4.1(1) and 4.1(2) of EN 1991-1-1.* *Especially for materials which are not covered by the Tables in Annex A of EN 1991-1-1.*
4.1.3	Loads of heavy equipments shall be as specified on the relevant drawings.	§ *6.1(4) of EN 1991-1-1.* *e.g. in communal kitchens, radiology rooms, boiler rooms, etc.*
4.2	Snow loads	
4.2.1	In the following circumstances, tests and proven and/or properly validated numerical methods may be used to obtain snow loads on the construction works: *(insert particular circumstances, if any)*	§ *1.5 of EN 1991-1-3.* *These circumstances should be agreed upon with the Client and the relevant authority.*
4.2.2	Particular snow loads shall comply with the following requirements: *(insert special requirements, if any)*	§ *4.1(1) of EN 1991-1-3.* *To cover unusual local conditions, the National Annex may additionally allow the Client and the relevant authority to agree upon different characteristic values of snow load.*

Proposed Clauses		Commentary
4.3	**Wind loads**	
4.3.1	(Optional) The following rules for the velocity pressure distribution for leeward wall and sidewalls shall apply: *(insert rules)*	§ *7.2.2 of EN 1991-1-4.* *Certain rules may also be given in the National Annex.*
4.4	**Thermal actions**	
4.4.1	The following specific operational thermal effects shall apply: *(insert list of specific thermal actions)*	§ *5.2(2)P of EN 1991-1-5.* *due to heating, technological or industrial processes.*
4.4.2	The following specific values of ΔT_M and ΔT_P shall apply: *(insert values)*	§ *5.2(3)P of EN 1991-1-5.* ΔT_M *: linear temperature difference component;* ΔT_P *: temperature difference between different parts of a structure given by the difference of average temperatures of these parts.*
4.5	**Actions during execution**	
4.5.1	The following rules concerning the safety of persons, on and around the construction site, shall apply: *(insert rules)*	*These rules are outside the scope of EN 1991-1-6.*
4.5.2	Construction loads shall be as specified in the relevant drawings	*See Tables 2.2 and 4.1 of EN 1991-1-6.*
4.5.3	Tolerances for the possible deviations to the theoretical position of construction loads shall be as specified in the relevant drawings	*If construction loads are classified as fixed loads.*
4.5.4	The limits of the potential area of spatial variation of construction loads shall be as specified in the relevant drawings	*If construction loads are classified as free loads.*
4.5.5	The following minimum wind velocity during execution phases shall apply: ...	§ *3.1(5) of EN 1991-1-6.* *In the absence of any choice in the National Annex.*
4.5.6	The following rules of combination of snow loads and wind action with the construction loads shall apply: *(insert rules)*	§ *3.1(7) of EN 1991-1-6.* *In the absence of any choice in the National Annex.*
4.5.7	The geometric imperfections of the structure and the structural elements during execution shall be as follows : *(insert values)*	§ *3.1(8) of EN 1991-1-6.* *In the absence of any choice in the National Annex.*
4.5.8	Criteria associated with serviceability limit states during execution shall be as follows: *(insert criteria)*	§ *3.3(2) of EN 1991-1-6.* *In the absence of any choice in the National Annex.*
4.5.9	The maximum allowable wind velocity during crane operations shall be ...	§ *4.7(1) of EN 1991-1-6.*
4.6	**Accidental actions**	
4.6.1	The following notional accidental loads shall apply: *(insert accidental actions)*	*Equivalent static design forces due to vehicular impact;* *Frontal and lateral dynamic design forces due to impact from river and canal traffic, as well as the height of application of the impact force and the impact area;* *Classification of structures subject to impact from derailed railway traffic (§ 4.5.1.2 of EN 1991-1-7);*

Proposed Clauses		Commentary
4.7	**Seismic actions**	
4.7.1	The Importance Class of the project shall be (*insert class*)	*Table 4.3 of EN 1998-1.* *Ordinary buildings (other than schools, fire stations, power plants, hospitals, etc.) correspond to Importance Class II;*
4.7.2	The Ground Type shall be as specified on the relevant documents.	*Table 3.1 of EN 1998-1.* *Depending on the particular conditions of the project, contract documents should specify whether ground investigations and/or geological studies should be performed to identify the ground type;*
4.7.3	The seismic zone of the project shall be (*insert zone*)	*According to the seismic zone map, decided by the National Authority, and found in the National Annex of EN 1998-1*
4.7.4	Earthquake resistant steel building shall be designed according to ... concept (*insert concept*)	*DCL, DCM or DCH.*
5.	**DESIGN OF STEEL STRUCTURES**	
5.1	**General rules**	
5.1.1	To ensure durability, the building and its components shall either be designed for environmental actions (and fatigue if relevant) or else protected from them.	§ *2.1.3.3(1)B of EN 1993-1-1.*
5.1.2	The effects of deterioration of material and corrosion (and fatigue where relevant) shall be taken into account by appropriate choice of material (see EN 1993-1-4 and EN 1993-1-10), and details (see EN 1993-1-9), or by structural redundancy and by the choice of an appropriate protection system.	§ *2.1.3.3(2)B of EN 1993-1-1.*
5.1.3	For the following components, the possibility of their safe replacement shall be verified as a transient design situation *(insert list of the components of the building that need to be replaceable)*	§ *2.1.3.3(3)B of EN 1993-1-1.*
5.1.4	With reference to Annex A1.4 of EN 1990, vertical deflections (according to Figure A1.1), horizontal deflections (according to Figure A1.2) and vibrations of structures on which the public can walk shall comply with the following limits: *(insert serviceability limits states)*	§ *7 of EN 1993-1-1.*
5.2	**Design of joints**	
5.2.1	Bolted connections Category shall be as specified on the relevant documents.	§ *3.4.1 of EN 1993-1-8.*
5.2.2	Friction surfaces for slip-resistant connections using pre-loaded 8.8 or 10.9 bolts shall be as specified on the relevant documents.	§ *3.9 of EN 1993-1-8.*
5.2.3	According to EN ISO 25817, the quality level of welds shall be as specified on the relevant documents.	§ *4.1 of EN 1993-1-8.*

Proposed Clauses		Commentary
5.2.4	The frequency of inspection of welds shall conform to the requirements of EN 1090-2 and shall be as specified on the relevant documents.	§ *4.1 of EN 1993-1-8.*
5.3	**Material toughness and through thickness properties**	
5.3.1	The guidance given in section 2 of EN 1993-1-10:2005 shall be used for the selection of materials for fracture toughness.	
5.3.2	The guidance given in section 3 of EN 1993-1-10:2005 shall be used for the selection of materials for through-thickness properties	
5.4	**Composite steel and concrete structures**	
5.4.1	The exposed surfaces of the profiled steel sheeting for composite slabs shall be adequately protected to resist the particular atmospheric conditions as specified on the relevant documents.	*Clause 4.2 of EN 1994-1-1:2004.* *A zinc coating of total mass 275 g/m² (including both sides) is sufficient for the internal floors in a non-aggressive environment.*
5.4.2	The effect of curvature due to shrinkage shall be as specified on the relevant documents	*Clause 7.3.1(8) of EN 1994-1-1:2004.* *When the ratio of span to overall depth of the beam is not greater than 20, the effect of curvature due to shrinkage (of normal weight concrete) need not be included.*
6.	**EXECUTION SPECIFICATION**	
6.1	**General**	
6.1.1	The requirements for the execution of structural steelwork for the project are given in the following documents: *(Insert list)*	*Insert a list of the relevant drawings and other documents, including reference to EN 1090-2.*
6.2	**Execution Class**	
6.2.1	For building structures, EXC2 shall generally apply, except where specified otherwise on the drawings.	*The use of EXC2 as the default class will provide adequate reliability for most elements of ordinary buildings. For some structures, a greater scope of inspection and testing and/or higher quality level acceptance criteria may be required, either generally or for particular details. Particular details where this is required, such as where special inspection and testing is required, should be indicated on the drawings.* *Table A.3 of EN 1090-2 gives a list of requirements related to execution classes;* *Annex B of EN 1090-2 gives guidance for the choice of execution classes;* *The choice of execution classes is related to production categories and service categories, with links to consequence classes as defined in Annex B of EN 1990.*

Proposed Clauses		Commentary
6.3	**Preparation grades**	
6.3.1	The preparation grade of all surfaces to which paints and related products are to be applied shall be ... *Otherwise,* The expected life of the corrosion protection shall be ... years *or* corrosivity category shall be ...	*Preparation grades (P1 to P3 according to ISO 8501-3) are related to the expected life of the corrosion protection and corrosivity category as defined in § 10 of EN 1090-2.*
6.4	**Geometrical tolerances**	
6.4.1	For essential tolerances, the tabulated values in Annex D.1 of EN 1090-2 shall apply. If the steelwork is not within tolerance, it shall be reported to the designer of the permanent works and shall be adjusted, if necessary, to maintain the structural adequacy in accordance with the design rules.	*Manufacturing tolerances are described in § 11.2.2 of EN 1090-2;* *Erection tolerances are described in § 11.2.3 of EN 1090-2;*
6.4.2	For functional tolerances (in terms of accepted geometrical deviations), *either* the tabulated values in § 11.3.2 and Annex D.2 of EN 1090-2 shall apply, *or*, the alternative criteria defined in § 11.3.3 of EN 1090-2 shall apply.	
7.	**CONSTITUENT STEEL PRODUCTS**	
7.1	**Identification, inspection documents and traceability**	
7.1.1	Properties for (...) shall comply with the requirements given in (...).	*§ 5.1 of EN 1090-2* *Insert details for any constituent product not covered by the European Standards listed in Table 2 of EN 1090-2.*
7.1.2	The inspection documents (according to EN 10204) shall be as listed in Table 1 of EN 1090-2.	*§ 5.2 of EN 1090-2.*
(Optional clause) 7.1.3	For Execution Classes EXC3 and EXC4, constituent products shall be traceable at all stages from receipt to hand over after incorporation in the works.	*§ 5.2 of EN 1090-2.*
7.1.4	For Execution Classes EXC2, EXC3 and EXC4, if different grades and/or qualities of constituent products are in circulation together, each item shall be designated with a mark that identifies its grade.	*§ 5.2 of EN 1090-2.* *Methods of marking should be in accordance with that for components given in § 6.2 of EN 1090-2.* *If marking is required, unmarked constituent products should be treated as non conforming product.*
7.2	**Structural steel products**	
7.2.1	The grade and quality of structural steel shall be as specified on the drawings.	
7.2.2	For structural steel plates, thickness tolerances class A, in accordance with EN 10029, shall be used.	*§ 5.3.2 of EN 1090-2.* *Class A is usually sufficient, even where EXC4 is specified, but if class C is required by the technical authority or for other reasons, that class should be specified instead.*

Proposed Clauses		Commentary
7.2.3	Structural carbon steels shall conform to the requirements of the relevant European product standards as listed in Table 2 of EN 1090-2, unless otherwise specified on the drawings. Grades, qualities and, if appropriate, coating weights and finishes, together with any required options permitted by the product standard, including those related to suitability for hot dip zinc-coating, if relevant, shall be as specified on the drawings.	§ *5.3.1 of EN 1090-2.*
7.2.4	For carbon steels, surface condition shall be as follows: Class A2, for plates in accordance with the requirements of EN 10163-2; Class C1, for sections in accordance with the requirements of EN 10163-3. If relevant, surface imperfections (such as cracks, shell or seams) or repair of surface defects by grinding in accordance with EN 10163, shall comply with the following restrictions : *(insert list of special restrictions)*	§ *5.3.3 of EN 1090-2.*
(Optional clause) 7.2.5	For EXC3 and EXC4, the locations (and width) where internal discontinuity quality class S1 of EN 10160 is required, are specified on the relevant drawings.	§ *5.3.4 of EN 1090-2.* *Especially for welded cruciform joints transmitting primary tensile stresses through the plate thickness, and for areas close to bearing diaphragms or stiffeners.*
7.2.6	Areas where material shall comply with requirements for improved deformation properties perpendicular to the surface (according to EN 10164) are specified on the drawings.	§ *5.3.4 of EN 1090-2.* *Consideration should be given to specifying such material for cruciform, T and corner joints. Should only be invoked where necessary; specify only those parts of the structure which need these properties.*
7.3	**Welding consumables**	
7.3.1	All welding consumables shall conform to the requirements of EN 13479 and the appropriate product standard, as listed in Table 5 of EN 1090-2. The type of welding consumables shall be appropriate to the welding process (defined in § 7.3 of EN 1090-2), the material to be welded and the welding procedure.	§ *5.5 of EN 1090-2.*
7.4	**Mechanical fasteners**	
7.4.1	All mechanical fasteners (connectors, bolts, fasteners) shall conform to the requirements of § 5.6 of EN 1090-2. Studs for arc stud welding including shear connectors for steel/concrete composite construction shall comply with the requirements of EN ISO 13918.	
7.4.2	The property classes of non-preloaded bolts and nuts, and surface finishes, shall be as specified on the drawings.	
7.4.3	The property classes of preloaded bolts and nuts, and surface finishes, shall be as specified on the drawings.	*HV bolts are sensitive to over-tightening, so they require a greater level of site control. It is not advisable to use both HR and HV assemblies on the same project.*

Proposed Clauses		Commentary
7.4.4	The chemical composition of weather resistant assemblies shall comply with the requirements for Type 3 Grade A fasteners to ASTM standard A325, or equivalent.	
7.4.5	Reinforcing steels may be used for foundation bolts. In this case, they shall conform to EN 10080 and the steel grade shall be as specified on the drawings.	
(Optional clause) 7.4.6	Where locking devices are specified on the drawings, they shall comply with the relevant standards listed in § 5.6.8 of EN 1090-2, and additionally ... (*Insert any particular requirements for locking devices*).	
7.5	**Grouting materials**	
7.5.1	Grouting materials to be used shall be as specified on the relevant drawings.	
8.	**PREPARATION AND ASSEMBLY**	
8.1	**Identification**	
8.1.1	Soft or low stress stamps may be used, except in any areas specified on the drawings.	*Soft or low stress stamp marks can easily be obliterated by the protective system. The fabricator will usually mask the stamped area after application of primer and complete the coating locally after erection.*
8.1.2	Areas where identification marks are not permitted or shall not be visible after completion are specified on the drawings.	
8.2	**Handling and storage**	
8.2.1	Structural steel components shall be packed, handled and transported in a safe manner, so that permanent deformation does not occur and surface damage is minimized. Handling and storage preventive measures specified in Table 8 of EN 1090-2 shall be applied as appropriate.	
8.3	**Cutting**	
8.3.1	Hand thermal cutting shall be used only if it is not practical to use machine thermal cutting. Cutting shall be carried out in such a way that the requirements for geometrical tolerances, maximum hardness and smoothness of free edges, as specified in § 6.4 of EN 1090-2, are met.	
8.4	**Shaping**	
8.4.1	Requirements of § 6.5 of EN 1090-2 shall be applied as appropriate.	

Proposed Clauses		Commentary
8.5	**Holing**	
8.5.1	Dimensions of holes, tolerances on hole-diameters and execution of holing shall comply with the requirements of § 6.6 of EN 1090-2.	
8.5.2	Where specified on the drawings, holes with special dimensions shall be provided for connections of movement joints.	
8.5.3	Special tolerances on hole diameters shall be as specified on the drawings.	*Special tolerances would only be needed in exceptional conditions.* *If pins are used, tolerances should be specified for both holes and pins.*
8.5.4	Holes for fasteners shall be formed by drilling or by punching followed by reaming.	
8.5.5	Long slotted holes shall be executed as specified on the drawings.	*This option is only needed for special cases, such as slotted holes for pins in movement joints. Details must then be given on the drawings.*
8.6	**Assembly**	
8.6.1	Requirements of Clauses 6.9 and 6.10 of EN 1090-2 shall be applied as appropriate.	
8.6.2	Holes for which elongation is not permitted are shown on the relevant drawings.	*This option is needed for fit bolts for instance.*
8.6.3	The acceptability of the addition of any welded temporary attachments and the making of any butt welds additional to those specified on the drawings 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.	*If there are any restrictions on positioning of temporary attachments, they should be specified, either in this clause or on the drawings.* *In general, temporary welded attachments are not acceptable within 25 mm of the edges of flange plates.*
9.	**WELDING**	
9.1	**General**	
9.1.1	Welding shall be undertaken in accordance with the requirements of the relevant part of EN ISO 3834 or EN ISO 14554 as applicable.	
9.1.2	A welding plan shall be provided as part of the production planning required by the relevant part of EN ISO 3834.	*The content of a welding plan is described in § 7.2.2 of EN 1090-2.*
9.1.3	Welding may be performed by the welding processes defined in EN ISO 4063.	*Welding processes are listed in § 7.3 of EN 1090-2.*

Proposed Clauses		Commentary
9.2	**Qualification of welding procedures**	
9.2.1	Welding shall be carried out with qualified procedures using a Welding Procedure Specification (WPS) in accordance with the relevant part of EN ISO 15609 or EN ISO 14555 or EN ISO 15620.	*Qualifications of welding procedures, depending on welding processes, are described in Clauses 7.4.1.2 and 7.4.1.3 of EN 1090-2.*
9.3	**Welders and welding operators**	
9.3.1	Welders shall be qualified in accordance with EN 287-1 and welding operators in accordance with EN 1418. Records of all welder and welding operator qualification tests shall be kept available.	
9.4	**Welding coordination**	
9.4.1	Welding coordination shall be maintained during the execution of welding by welding coordination personnel suitably qualified for, and experienced in the welding operations they supervise as specified in EN ISO 14731.	*This option is needed for Execution Class EXC2, EXC3 and EXC4.* *With respect to the welding operations being supervised, and for structural carbon steels, welding coordination personnel should have a technical knowledge according to Table 14 of EN 1090-2.*
9.5	**Preparation and execution of welding**	
9.5.1	Precautions shall be taken to avoid stray arcing, and if stray arc do occur the surface of the steel shall be lightly ground and checked. Visual checking shall be supplemented by penetrant or magnetic particle testing.	
9.5.2	Precautions shall be taken to avoid weld spatter.	*For Execution Class EXC3 and EXC4, weld spatter should be removed.*
9.5.3	Visible imperfections such as cracks, cavities and other not permitted imperfections shall be removed from each run before deposition of further runs.	
9.5.4	All slag shall be removed from the surface of each run before each subsequent run is added and from the surface of the finished weld.	
9.5.5	Particular attention shall be paid to the junctions between the weld and the parent metal.	
9.5.6	Special requirements for grinding and dressing of the surface of completed welds are shown on the relevant drawings.	
9.5.7	Joint preparation shall be free from visible cracks. Visible cracks shall be removed by grinding and the joint geometry corrected as necessary.	
9.5.8	If large notches or other errors in joint geometry are corrected by welding, a qualified procedure shall be used, and the area shall be subsequently ground smooth and feathered into the adjacent surface.	

Proposed Clauses		Commentary
9.5.9	All surfaces to be welded shall be dry and free from material that would adversely affect the quality of the welds or impede the process of welding.	*Such as rust, organic material or galvanizing.*
9.5.10	Requirements of § 7.5.1 to 7.5.16 of EN 1090-2 shall be applied as appropriate.	
9.6	**Acceptance criteria**	
9.6.1	Welded components shall comply with the requirements specified in Clauses 10 and 11 of EN 1090-2.	
9.6.2	The acceptance criteria for weld imperfections shall conform to the requirements of § 7.6 of EN 1090-2.	
10.	**MECHANICAL FASTENING**	
10.1	**General**	
10.1.1	Minimum nominal fastener diameter, bolt length, length of protrusion, length of the unthreaded bolt shaft and clamp length shall comply with the requirements of § 8.2.2 of EN 1090-2.	
10.1.2	Requirements given in § 8.2.3 of EN 1090-2 for washers shall apply.	
10.1.3	Tightening of non-preloaded bolts shall comply with the requirements of § 8.3 of EN 1090-2. The bolt shall protrude from the face of the nut, after tightening, not less than one full thread pitch.	
10.1.4	Precautions and preparation of contact surfaces in slip resistant connections shall comply with the requirements of § 8.4 and Table 18 of EN 1090-2. Slip factor shall be determined by test as specified in Annex G of EN 1090-2.	
10.1.5	Tightening methods of preloaded bolts shall comply with the requirements of § 8.5 of EN 1090-2; special requirements are specified on the relevant documents.	
10.2	**Bolts**	
10.2.1	Bolt sizes for structural bolting shall be as specified on the drawings.	
10.2.2	Where the structure has been designed to utilise the shear resistance of the unthreaded shank of bolts, this is specified on the drawings and the dimensions of the bolts are given.	*The locations and dimensions must be given on the 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.*
10.3	**Nuts**	
10.3.1	Nuts shall be assembled so that their designation markings are visible for inspection after assembly.	

Proposed Clauses	Commentary
10.3.2 Nuts shall run freely on their partnering bolt, which is easily checked during hand assembly.	*Any nut and bolt assembly where the nut does not run freely should be discarded.*
10.4 Washers	
10.4.1 Washers shall be provided under the nut or the bolt head of non-preloaded bolts, whichever is to be rotated.	
10.4.2 For preloaded bolts : - for 8.8 bolts, a washer shall be used under the bolt head or the nut, whichever is to be rotated; - for 10.9 bolts, washers shall be used under both the bolt head and the nut.	
10.5 Preparation of contact surfaces in slip-resistant connections	
10.5.1 The area of contact surfaces in preloaded connections shall be as specified on the drawings. For contact surfaces in slip-resistant connections shown on the relevant drawings, the following particular treatment shall apply: ... *(Insert requirements)*. The treated surfaces shall be adequately protected until they are brought together.	
10.5.2 Preparation of contact surfaces in slip-resistant connections shall comply with the requirements of § 8.4 of EN 1090-2; special requirements are specified on the relevant documents.	
10.6 Tightening of preloaded bolts	
10.6.1 The nominal minimum preloading force $F_{p,C}$ shall be taken as indicated on the relevant drawings.	*Usually, $F_{p,C} = 0,7.f_{ub}.A_s$.*
10.6.2 The following tightening method(s) shall be used: ... *(insert specific tightening methods)*	*The different tightening methods are described in Table 20 of EN 1090-2.*
10.6.3 As an alternative to Table 20 of EN 1090-2, calibration to Annex H of EN 1090-2 may be used: - for all tightening methods; - for all tightening methods, except for the torque method. *(choose one of the above options)*	
10.6.4 When bolts are tightened by rotation of the bolt head, the following special precautions shall be taken: ... *(insert special precautions depending on the tightening method adopted)*.	
10.6.5 For thick surface coatings shown on the relevant drawings, the following measures shall be taken to offset possible subsequent loss of preloading force: ... *(insert specific measures, depending on the tightening method adopted)*.	*If torque method is used, this may be by retightening after a delay of some days.*

Proposed Clauses		Commentary
10.6.6	For the combined method, when using the value $M_{r,1}$ for the first tightening step, the simplified expression of $M_{r,1}$ (in § 8.5.4 of EN 1090-2) may (or may not) be used. *(choose one of the above options)*	
10.6.7	For the combined method, values other than those given in Table 21 of EN 1090-2 shall not be used unless calibrated in accordance with Annex H of EN 1090-2.	
10.6.8	For the HRC method, the first tightening step shall be repeated as necessary if the pre-tightening is relaxed by the subsequent tightening of the remainder of the bolts in the connection.	*This first step should be completed for all bolts in one connection prior to commencement of the second step. Guidance of the equipment manufacturer may give additional information on how to identify if pre-tightening has occurred, e.g. sound of shear wrench changing, or if other methods of pre-tightening are suitable.*
10.7	**Fit bolts**	
10.7.1	Where permitted on the drawings, the length of the threaded portion of the shank of a fit bolt may exceed 1/3 of the thickness of the plate, subject to the following requirements: ... *(Insert details)*	*Insert this clause if such permission is to be given and specify on the drawings for which bolts the longer thread length is permitted.*
11.	**ERECTION**	
11.1	The design is based on the construction method and/or sequences given in the following documents: *(Insert list)*.	*Insert list of relevant drawings and other documents. Information should include, amongst other things, allowances for permanent deformations (pre-camber), settlement of supports, assumptions for temporary stability and assumptions about propped/un-propped conditions in staged construction.* *The designer has the duty to ensure that the permanent works can be built safely. The drawings will show a construction method and/or sequences and will show either in detail or indicatively the nature and positions of temporary bracings compatible with those sequences. These temporary bracings will normally be those required to provide stability in the 'bare steel' and 'wet concrete' conditions. The elements of the temporary bracing would normally be designed by the permanent works designer; if that is not the case, it should be stated in the contract documents (preferably on the drawings) that their design is the constructor's responsibility.*
11.2	Requirements for temporary bracing compatible with the construction method and/or sequences are specified on the following drawings: *(Insert list)*	

Proposed Clauses		Commentary
11.3	The allowances for permanent deformation and other associated dimensions specified on the relevant drawings allow for the quasi-permanent effects of the following actions, using the design basis method of erection: i) after steelwork erection: - Self weight of structural steelwork; ii) after completion of structure: - Self weight of structural steelwork; - Self weight of structural concrete; - Self weight of non-structural parts; - The effects of shrinkage modified by creep.	*It is the designer's responsibility to determine the allowances (i.e. the addition to the nominal profile) required to offset the effects of permanent actions, including shrinkage effects. These allowances have often been termed, somewhat loosely, 'pre-camber'.*
11.4	If the constructor proposes to adopt an alternative construction method and/or sequences to that referred to in 11.1, the constructor shall verify, in accordance with the design rules, that the alternative method and/or sequences can be used without detriment to the permanent works. The constructor shall allow a period of at least ... *(insert number)* weeks for the verification of the erection method in accordance with the design rules, to the satisfaction of the permanent works designer.	*For major multi-storey structures, the design basis method of erection will normally be produced through a close working between the designer and the constructor because the method of erection will often dictate aspects of the design.* *Even for lesser or minor structures, the fundamental issue is that the constructor's erection method must be compatible with the design basis method of erection or, if it is different, for whatever reason, the design of the permanent works must be re-verified, for that erection method.*
11.5	The steelwork dimensions on the drawings are specified for a reference temperature of ... °C *(Insert reference temperature)*	*The steelwork contractor will make adjustments to suit the calibration temperature of his measuring equipment.*
11.6	Compensation for settlement of supports shall be made by the constructor if such settlement differs from the design assumptions.	*The designer should state the range of settlement of the supports (including temporary supports) that was considered in the design.*
11.7	The finished cover to steel packings (comprising a total thickness of grout and any concrete) shall comply with the cover requirements of EN 1992.	*It is normal practice to remove steel packings. Softer packings may be left in place.*
11.8	Packings and levelling nuts may be left in position, provided that it can be verified, in accordance with the design rules, that there is no detriment to the permanent works.	*The implications of introducing a hard spot into the bearing area should be checked with respect to both steel and concrete elements.*
11.9	The treatment of steelwork, bearings and concrete surfaces before grouting shall be as specified on the drawings.	
11.10	Areas where the edges of the base plate are to be sealed, without grouting, are specified on the drawings.	*If grouting is not specified in bearing areas, the perimeter of base plates should be sealed. The locations for sealing must be shown on the drawings.*
11.11	Surfaces that are to be in contact with concrete, including the undersides of baseplates, shall be coated with the protective treatment applied to the steelwork, excluding any cosmetic finishing coat, for the first ...mm *(insert length, minimum 50 mm)* of the embedded length, and the remaining surfaces need not be coated *(or shall be coated, choose one option)*.	*Additional requirements are given in § 10.7 of EN 1090-2.*