

PD 6705-2:2010+A1:2013



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PUBLISHED DOCUMENT

Structural use of steel and aluminium

Part 2: Recommendations for the execution
of steel bridges to BS EN 1090-2

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Foreword

Publishing information

This part of PD 6705 is published by BSI Standards Limited, under licence from The British Standards Institution, and came into effect on 31 December 2010. It was prepared by Subcommittee B/525/10, *Bridges*, under the authority of Technical Committee B/525, *Building and civil engineering structures*. A list of organizations represented on this committee can be obtained on request to its secretary.

Supersession

PD 6705-2:2010+A1:2013 supersedes PD 6705:2010, which is withdrawn. The start and finish of text introduced or altered by Amendment No. 1 is indicated in the text by tags A1 and A1. Minor editorial changes are not tagged.

Relationship with other publications

This Published Document gives guidance on the use of BS EN 1090-2:2008+A1:2011 for the execution of steel bridges in the UK.

Information about this document

BS EN 1090-2 superseded BS 5400-6 in March 2010 following a period of coexistence. The replacement of BS 5400-6 with BS EN 1090-2 represents a substantial change in construction practice in the UK. The purpose of this Published Document is to ensure that steel bridges are executed with the same level of assurance of reliability as that implicit in BS 5400-6.

BS EN 1993, *Design of steel structures*, calls up BS EN 1090 as the key reference standard for execution and erection which is necessary for the design assumptions in BS EN 1993 to be valid.

The guidance given in this Published Document consists of non-contradictory complementary information (NCCI) to enable the user to apply BS EN 1090-2:2008+A1:2011 in a safe and cost-effective manner, with particular reference to the following:

- selection of options where they are defined in BS EN 1090-2:2008+A1:2011;
- selection of service categories in terms of quantified performance requirements, for use in choosing execution requirements, where applicable;
- alternative information where permitted in BS EN 1090-2:2008+A1:2011.

Explanatory notes are provided in Annex C, giving the background to selected recommendations for additional specification material, selection of options and choice of execution class, where the issues involved are of a specialist nature.

The main differences in the scope and technical bases of BS 5400-6 compared to BS EN 1090-2:2008+A1:2011 are identified in Annex A, to assist the user in adapting to the changes in practice necessary when using BS EN 1090-2:2008+A1:2011.

The amendment A1:2013 updates this Published Document to take account of Amendment A1:2011 of BS EN 1090-2:2008. It also takes account of comments arising from the application of this Published Document in the drafting and use of specifications based on BS EN 1090-2:2008+A1:2011.

Presentational conventions

The provisions in this Published Document are presented in roman (i.e. upright) type. Its recommendations are expressed in sentences in which the principal auxiliary verb is "should".

Commentary, explanation and general informative material is presented in smaller italic type, and does not constitute a normative element.

Contractual and legal considerations

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a Published Document cannot confer immunity from legal obligations.

1 Scope

This part of PD 6705 gives guidance on the use of BS EN 1090-2:2008+A1:2011 for the execution of all types of steel bridges designed to BS EN 1993.

It is applicable to the same scope of application as BS EN 1090-2:2008+A1:2011 with the following exceptions:

- stainless steels;
- sheeting;
- resistance welding;
- riveting; and
- matters not related to structural integrity, e.g. visual appearance.

The recommendations given in this Published Document are only applicable when the design requirements and recommendations in the following documents have been adopted, where relevant:

- BS EN 1990, Eurocode – Basis of structural design;
- BS EN 1991, Eurocode 1: Actions on structures;
- BS EN 1993-2, Eurocode 3: Design of steel structures – Part 2: Steel bridges;
- BS EN 1994-2, Eurocode 4: Design of composite steel and concrete structures – Part 2: General rules and rules for bridges;
- any UK National Annexes and Published Documents referenced normatively or informatively in the above standards.

This Published Document is prepared for personnel involved in the regulation, design, procurement, fabrication, erection and certification of steel bridges when BS EN 1090-2:2008+A1:2011 is used as the basis for specifying the execution.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

BS EN 1090-2:2008+A1:2011, *Execution of steel structures and aluminium structures – Part 2: Technical requirements for steel structures*

BS EN 1435, *Non-destructive examination of welds – Radiographic examination of welded joints*

BS EN 1593, *Non-destructive testing – Leak testing – Bubble emission techniques*

BS EN 1714, *Non destructive testing of welded joints – Ultrasonic testing of welded joints*

BS EN 1990, *Eurocode – Basis of structural design*

BS EN 1991, *Eurocode 1: Actions on structures*

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

BS EN 1993-2, *Eurocode 3: Design of steel structures – Part 2: Steel bridges*

BS EN 1994-2, *Eurocode 4: Design of composite steel and concrete structures – Part 2: General rules and rules for bridges*

BS EN 10025-1:2004, *Hot rolled products of structural steels – Part 1: General technical delivery conditions*

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

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

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

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

BS EN 10163-2, *Delivery requirements for surface condition of hot-rolled steel plates, wide flats and sections – Part 2: Plate and wide flats*

BS EN 10163-3, *Delivery requirements for surface condition of hot-rolled steel plates, wide flats and sections – Part 3: Sections*

BS EN 14399, *High-strength structural bolting assemblies for preloading*

BS EN 14399-3, *High-strength structural bolting assemblies for preloading – Part 3: System HR – Hexagon bolt and nut assemblies*

BS EN ISO 3834-2, *Quality requirements for fusion welding of metallic materials – Part 2: Comprehensive quality requirements*

BS EN ISO 5817:2007, *Welding – Fusion-welded joints in steel, nickel, titanium and their alloys (beam welding excluded) – Quality levels for imperfections*

BS EN ISO 6520-1, *Welding and allied processes – Classification of geometric imperfections in metallic materials – Part 1: Fusion welding*

BS EN ISO 14555:2006, *Welding – Arc stud welding of metallic materials*

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

BS 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*

BS EN ISO 23277, *Non-destructive testing of welds – Penetrant testing of welds – Acceptance levels*

BS EN ISO 23278, *Non-destructive testing of welds – Magnetic particle testing of welds – Acceptance levels*

PD 6695-1-9, *Recommendations for the design of structures to BS EN 1993-1-9*

PD 6695-1-10, *Recommendations for the design of structures to BS EN 1993-1-10*

3 Terms and definitions

For the purposes of this part of PD 6705, the terms and definitions given in BS EN 1090-2:2008+A1:2011 and the following applies.

3.1 quantified service category

category that characterizes a component or structure (or part thereof), in terms of the circumstances of its use within specified limits of static and cyclic stressing

NOTE See Annex B.

4 General

BS EN 1090-2:2008+A1:2011 represents a major change in practice for specifying the execution of steelwork applied to bridges compared to its predecessor BS 5400-6. The background to the main developments in its preparation and a comparison of the main features of the two standards are given in Annex A.

As BS EN 1090-2:2008+A1:2011 has a wider scope covering all structural steelwork, it contains many clauses where the user either has to make a selection between options or has to provide additional information. Around a third of these clauses have been identified as having a significant influence on the level of design resistance realized in the executed structure.

BS EN 1090-2:2008+A1:2011 enables persons responsible for preparing the execution specification for steel bridges to incorporate appropriate requirements relating to those clauses in order to conform to BS EN 1993-2. This applies whether the specification is intended to cover steel bridges in general, particular types of steel bridge, parts of a steel bridge, or a bridge for an individual project.

The recommendations given in this Published Document represent the minimum requirements needed to ensure that the design conforms to BS EN 1993-2. Compliance with additional requirements does not invalidate this, although there might be a cost penalty. Not all recommendations given in this Published Document are relevant if the scope of the execution specification is limited. The recommendations do not preclude the addition of further requirements in an execution specification, provided they do not lower the level of a recommended minimum requirement.

5 Basis for the recommended selections of choice permitted by BS EN 1090-2:2008+A1:2011

5.1 Objectives

The prime objective of the recommendations given in this Published Document is to ensure that, when using BS EN 1090-2:2008+A1:2011 for specifying the execution of steelwork in bridges, the design resistance values assumed in BS EN 1993 and its associated documents are realized in the final bridge construction to the level of reliability implicit in BS EN 1990 and BS EN 1993. This is achieved by specifying appropriate controls on management systems, procedure approval, personnel qualification, process selection, quality of materials and workmanship, inspection, testing and recording.

BS EN 1090-2:2008+A1:2011 contains multiple options and requirements for further information. Many of these involve decisions on specialist technical matters which users might not feel qualified to make. Use of this Published Document should ensure that technically sound choices are made, resulting in bridges being $\boxed{A_1}$ executed $\boxed{A_1}$ as economically as possible, whilst maintaining the level of reliability defined above.

5.2 Reliability level

The partial factors for actions and material properties chosen by the UK and specified in the National Annexes (NA) to BS EN 1990 and BS EN 1993-2 are based on achieving the same notional safety margins used for general structural applications.

NOTE In BS EN 1990 this generally aligns with reliability class (RC) 2 which is consistent with the basis of the safety factors used for most British Standard limit state structural design codes. BS EN 1990, Annex B recommends that RC2 may be associated with consequence class (CC) 2.

The partial factor γ_M is necessary to allow for inherent deviations in chemical, mechanical and geometrical properties of the members and joints in the final structure, including $\boxed{A_1}$ execution $\boxed{A_1}$ induced stresses and notch-like imperfections. The recommendations in this Published Document control these deviations so that the values of γ_M assumed by the UK are valid for all steel bridge applications.

In cases where a higher level of reliability is deemed to be necessary (e.g. class RC3 in BS EN 1990, Annex B), it might be appropriate to increase the scope of testing and inspection to levels above that recommended in this Published Document.

5.3 Types of choice in BS EN 1090-2:2008+A1:2011

There are three types of choice available to the user of BS EN 1090-2:2008+A1:2011.

- Execution class: BS EN 1090-2:2008+A1:2011, **A.3** lists 36 technical requirements where choices can be made by selection of execution class. Twenty-one of these are related to assurance matters, e.g. extent of inspection and testing, qualification of personnel and procedures, traceability, documentation. The remaining fifteen relate to the physical quality required for the structure and its components and joints, e.g. geometrical tolerances, surface finish, attachments, weld acceptance criteria.
- Options: BS EN 1090-2:2008+A1:2011, **A.2** lists over ninety requirements which can be subject to variation by the specifier.
- Additional information: BS EN 1090-2:2008+A1:2011, **A.1** lists around seventy requirements which, if relevant to the structure, require further information to be provided by the specifier.

5.4 Selection of execution class (EXC)

The guidelines for selection of execution class given in BS EN 1090-2:2008+A1:2011, Annex B are not recommended for the following reasons.

- Execution class is dependent on the choice between service category 1 (SC1) and service category 2 (SC2), which are not defined in quantitative terms.
- The main unresolved issue resulting in the UK's negative vote on prEN 1090-2 was the technical basis of the guidelines and

their perceived incompatibility with BS EN 1990. This particularly applied to the quality related items, as opposed to the assurance related items (see 5.3), which in BS EN 1090-2:2008+A1:2011 are still allied directly to the reliability level instead of quantitatively defined service categories. The UK was able to implement BS EN 1090-2:2008+A1:2011 due to the flexibility allowed in BS EN 1090-2:2008+A1:2011, 4.1.2 and the fact that Annex B is informative.

In BS EN 1090-2:2008+A1:2011, where there is a choice of execution class in a particular clause, this Published Document considers each case separately. In certain clauses the requirements can be the same for more than one execution class. In these cases, the recommendation is given by the execution class number(s). For example, if the preferred option is the same for execution class 2, 3 and 4, the choice is indicated as EXC2/3/4.

The recommendation for selecting a particular execution class (or classes) does not imply any change in reliability level (see 5.2). For this reason the recommendations in this Published Document might not accord with those given in BS EN 1090-2:2008+A1:2011, Annex B.

NOTE Where the execution class has been used to differentiate a quality requirement, there might be more than one recommendation, the distinction being made on the basis of a quantified service category (see 5.5).

5.5 Quantification of service category

The fatigue design rules specified in BS EN 1993-1-9 permit high levels of cyclic stressing for certain categories of detail. These levels are acceptable provided a high quality of **A₁** execution **A₁** can be assured, free from all but very small notches. This demands a high degree of control of **A₁** execution **A₁**, particularly for welding, and careful inspection procedures for detection and assessment. Such stress levels are usually only found in limited parts of certain bridges. However, when they do occur, extra controls should be applied to achieve the correct level of reliability.

BS 5400, ISO 10721, BS 8118, PD 6702-1 and PD 6705-3 provide a simple means of identifying the higher risk areas. Annex B provides means of calculating and designating the various levels of fatigue stressing and static stressing. These are compatible with the design rules in BS EN 1993-1-9 and BS EN 1993-1-10 including their National Annexes, PD 6695-1-9 and PD 6695-1-10. For this purpose, six levels of quantified service category are defined, designated F36, F56, F71, F90, F112 and F140 in increasing severity of quality requirement. Annex B gives guidance on how these can be used in the drafting of an execution specification.

5.6 Options

Guidance on selection of any BS EN 1090-2:2008+A1:2011, **A.2** options which could affect the structural reliability level in a bridge are given in Clause 6 to Clause 14, where relevant. If no guidance is given, the stated requirement should be assumed to be acceptable for UK bridges.

5.7 Additional information

Guidance on any BS EN 1090-2:2008+A1:2011, **A.1** items of required additional information considered necessary to control the structural reliability level of a bridge are given in Clause 6 to Clause 14, where relevant.

6 Specifications and documentation (see BS EN 1090-2:2008+A1:2011, Clause 4)

6.1 Execution class and service category (see BS EN 1090-2:2008+A1:2011, 4.1.2 and Annex B)

Execution class is used in Clause 6 to Clause 14 of this Published Document for the purposes of recommending the appropriate requirement where options based on this parameter are given in BS EN 1090-2:2008+A1:2011 (see 5.4). In some cases, the applicable recommended requirement might depend on the quantified service category (see 5.5).

NOTE Where more than one execution class applies to the same requirement, any one of the recommended classes may be used to select the requirement.

6.2 Quality documentation (BS EN 1090-2:2008+A1:2011, 4.2.1)

Quality documentation should conform to the requirements for EXC2/3/4.

6.3 Quality plan (see BS EN 1090-2:2008+A1:2011, 4.2.2 and Annex C)

A quality plan for execution of the works should be provided and should include the items recommended in BS EN 1090-2:2008+A1:2011, Annex C, if applicable.

7 Constituent steel products (see BS EN 1090-2:2008+A1:2011, 5)

7.1 Identification, inspection documents and traceability (see BS EN 1090-2:2008+A1:2011, 5.2)

7.1.1 Inspection documents for steel grades S355 JR and J0 (BS EN 1090-2:2008+A1:2011, Table 1, note a)

Inspection documents for steel grades S355 JR and J0 should conform to the requirements for EXC2/3/4.

7.1.2 Stages of traceability (BS EN 1090-2:2008+A1:2011, 5.2)

Stages of traceability should conform to the requirements for EXC3/4.

7.1.3 Unique traceability of products (BS EN 1090-2:2008+A1:2011, 5.2)

Specialist proprietary and/or bespoke products incorporating non-standardised features, components or methods of manufacture, e.g. castings, forgings, cables and their terminations, energy absorbing devices, mechanical components such as movement joints and major bearings should be uniquely traceable.

7.1.4 Marking of different grades and/or qualities (BS EN 1090-2:2008+A1:2011, 5.2)

The identification of different grades and/or qualities $\boxed{A_1}$ of constituent products $\boxed{A_1}$ should conform to the requirements for EXC2/3/4.

7.2 Structural steel products (see BS EN 1090-2:2008+A1:2011, 5.3)

7.2.1 Options (see BS EN 1090-2:2008+A1:2011, 5.3.1)

Wrought steel product forms covered by BS EN 1090-2:2008+A1:2011, Table 2, Table 3 and Table 4 should be specified in accordance with the product standards listed in these tables.

The only options usually needed are those covered by 7.2.2 to 7.2.5, below. In particular, caution should be exercised in the use of optional variations to chemical composition. The reason for specifying such an option should be given and it should be verified that no adverse effect on mechanical properties, weldability or other property could result.

Option 3 in BS EN 10025-1:2004, 7.3.2.2 allowing Charpy quality to be verified at a temperature above the lowest test temperature should not be adopted.

7.2.2 Thickness tolerances (see BS EN 1090-2:2008+A1:2011, 5.3.2)

For thickness tolerance, thickness tolerance class A should be used.

NOTE See explanatory note C.1.

7.2.3 Surface conditions (see BS EN 1090-2:2008+A1:2011, 5.3.3)

For plates $\boxed{A_1}$ and wide flats $\boxed{A_1}$, EXC3/4 should apply and more stringent surface conditions should be required as follows. Class A3 and class B3 to BS EN 10163-2 may be applied in all circumstances. Class A2 and class B2 may be applied where:

- steels are not specified to BS EN 10025-6;
- the quantified service category is F90 or less;
- reports on weld repairs are submitted;
- UT and MPI are used for inspection of weld repairs; and
- weld repairs are rechecked on delivery for quantified service categories F71 and above.

For sections, the special restrictions on surface imperfections and repair should conform to BS EN 10163-3 as follows:

- cracks, shells and seams in sections should be repaired in all circumstances;
- class C3 and class D3 require no special restrictions;
- class C2 and class D2 should have the same restrictions in use as for plates to class A2 and class B2, above;
- class C1 and class D1 should be restricted to quantified service category F36.

NOTE 1 There could be cost penalties or availability restrictions for class B and class D.

NOTE 2 See explanatory note C.2.

7.2.4 Special properties (see BS EN 1090-2:2008+A1:2011, 5.3.4)

7.2.4.1 Cross plates in welded cruciform and welded tee joints – transmitting primary stresses through the plate thickness

For quantified service category F56, the internal discontinuity quality class should conform to the requirements for EXC3/4.

For quantified service category F71 and above, BS EN 10160 internal discontinuity quality class S_2 should apply.

NOTE See explanatory note C.3.

7.2.4.2 Flange or web plates close to bearing diaphragms and/or single-sided bearing stiffeners

Flange or web plates close to bearing diaphragms and/or single sided bearing stiffeners, where attached by welding, should be checked for conformance to BS EN 10160 internal discontinuity quality class S_1 in the areas defined in BS EN 1090-2:2008+A1:2011, 5.3.4.

NOTE See explanatory note C.3.

7.2.5 Improved deformation properties (Z testing) perpendicular to the surface (see BS EN 1090-2:2008+A1:2011, 5.3.4)

The precautions necessary to avoid lamellar tearing in tee, cruciform and corner joints should be decided by the A_1 constructor (A_1), whether or not improved deformation properties have been specified for the through plates.

NOTE See explanatory note C.4.

7.3 Steel castings (BS EN 1090-2:2008+A1:2011, 5.4)

The specification of grades and qualities and selection of options permitted by the product standard is beyond the scope of this Published Document and expert advice should be sought.

NOTE See explanatory note C.5.

7.4 Welding consumables for weathering steels (see BS EN 1090-2:2008+A1:2011, Table 6 and 7.5.10)

Options 1, 2 and 3 in BS EN 1090-2:2008+A1:2011, Table 6 are suitable for the purposes of weather resistance. Options 2 and 3 are preferable to option 1 in terms of weldability.

C-Mn consumables may be used, but only for:

- single run fillet welds not exceeding 8 mm leg length using processes 135 and 121;
- butt welds using one run only per side;
- the body of multi-pass butt welds except for the outer 3 mm thick surface zones of the cap, root and ends (excluding any overfill).
The surface zones should be deposited using consumables conforming to options 1, 2 or 3.

NOTE See explanatory note C.6.

7.5 Bolt assemblies (see BS EN 1090-2:2008+A1:2011, 5.6)

7.5.1 Preloaded bolting assemblies (see BS EN 1090-2:2008+A1:2011, 5.6.4)

The following products should be used for preloaded bolt assemblies using all tightening methods, except the HRC method:

- bolt assemblies conforming to BS EN 14399-3 (HR type);
- nuts lubricated by the manufacturer after the nuts have been tapped (and, if relevant, after any coating passivation process has been completed).

A1 Bolts of property class 10.9 should not be used for assemblies tightened by the part turn method. See 10.2.6. **A1**

Electroplated **A1** property class **A1** 10.9 bolt assemblies should not be used.

Cleaning of **A1** property class **A1** 10.9 bolts prior to hot dip galvanising should be by blast cleaning and not by pickling.

Nuts of property class 10 may be used with bolts of property class 8.8.

NOTE See explanatory note C.7.

7.5.2 Foundation bolts (see BS EN 1090-2:2008+A1:2011, 5.6.7)

Reinforcing steels should not be used for foundation bolts carrying applied tension forces.

7.5.3 Locking devices (see BS EN 1090-2:2008+A1:2011, 5.6.8 and 8.2.1)

Prevailing torque type nuts should not be used as a substitute for nuts conforming to BS EN 14399 when used with bolts conforming to BS EN 14399 in pre-loaded joints.

NOTE Preloaded assemblies installed and tightened in accordance with BS EN 1090-2:2008+A1:2011 are resistant to loosening.

8 Preparation and assembly (see BS EN 1090-2: 2008+A1:2011, Clause 6)

8.1 Identification of components (BS EN 1090-2:2008+A1:2011, 6.2)

Identification of components should conform to the requirements for EXC3/4.

8.2 Marking methods (see BS EN 1090-2:2008+A1:2011, 6.2)

Hard stamps, punched or drilled marks **A1** may only **A1** be used for zones with a quantified service category of **A1** F56 and below **A1**.

A1 Soft or low stress stamps may be used for zones with a quantified service category of F90 and below. **A1**

No type of **A1** marking process involving deformation of or removal of metal from the surface **A1** should be used for zones with a quantified service category of F112 and above.

8.3 Quality of thermally cut surfaces (BS EN 1090-2:2008+A1:2011, 6.4.3)

The quality of cut surfaces should conform to the requirements for EXC2/3.

8.4 Hardness of free edge surfaces (see BS EN 1090-2:2008+A1:2011, 6.4.4)

Free edge surfaces with hardnesses exceeding 380HV10 values should be ground, finished or machined until sufficient material has been removed such that the 380HV10 limit is not exceeded, subject to the following exceptions.

The above hardness limit need not apply to machine plasma cut edges where:

- a) the steel grade does not exceed S420;
- b) plain edge surfaces are not subject to a quantified service category exceeding F71 [subject to c)];
- c) edge surfaces within 25 mm of stress raising features such as re-entrant corners, openings, weld terminations on the edge that are not subject to a quantified service category exceeding F36; and
- d) edge surfaces are not subject to subsequent cold forming (unless fully fused over the full length and width by subsequent welding).

NOTE See explanatory note C.8.

8.5 Flame straightening (see BS EN 1090-2:2008+A1:2011, 6.5.3)

A suitable procedure should be developed in accordance with the requirements for EXC3/4 and should include the following recommendations:

- the materials being used for procedure approval purposes should be of a higher grade and subgrade than that used in the component being straightened;
- for destructive tests, any reduction in tensile strength should not exceed 5% of the original value and any reduction in Charpy energy should not exceed 10% of the original value at the same test temperature.

8.6 Execution of holing (see BS EN 1090-2:2008+A1:2011, 6.6.3)

8.6.1 Round holes for fasteners or pins

A1 For material 3 mm thick or less with a quantified service category of less than F71, round holes for fasteners or pins may be formed by punching without reaming as permitted for EXC1/2. For material 3 mm thick or less with a quantified service category of F71 and above, round holes for fasteners or pins should be drilled or be punched at least 2 mm undersize in diameter, and reamed after punching. **A1**

For A_1 materials thicker than 3 mm A_1 , round holes should be drilled or be punched at least 2 mm undersize in diameter and reamed after punching in accordance with the requirements for EXC3/4.

NOTE See explanatory note C.9.

8.6.2 Slotted holes

The methods given in Table 1 may be used up to the maximum quantified service categories and thicknesses given in Table 1.

Table 1 Method for slotted holes

Method	Maximum quantified service category	Maximum thickness, mm
Punching and hand thermal cutting	F36	—
Punching in a single operation	F56	15
Thermal cutting by machine		
Drilling and/or milling	F112	—

8.7 Cut outs (see BS EN 1090-2:2008+A1:2011, 6.7)

8.7.1 Minimum radii

The minimum radius for re-entrant corners and notches should conform to the requirements for EXC2/3, except for quantified service category F71 or above when the requirement for EXC4 should apply A_1 (when the stress direction is in the plane of the radius) A_1 , subject to a smaller radius not being specified. A_1 If Form B in BS EN 1090-2:2008+A1:2011, 6.7 is to be used, the design should be checked for the loss of section. A_1

8.7.2 Punch cut outs

The restriction on use of punched cut outs required for EXC4 should apply where:

- quantified service categories F56 and above are required;
- materials conforming to BS EN 10025-6 are used.

8.8 Assembly (see BS EN 1090-2:2008+A1:2011, 6.9)

8.8.1 Elongation of holes by drifting

The tolerance class for EXC1/2 should be applied to non-preloaded connected parts. The tolerance class for EXC3/4 should be applied to preloaded connected parts.

NOTE See explanatory note C.10.

8.8.2 Connections for temporary assembly components

A_1 Connections for temporary components A_1 which can affect the works in service, including the reinstatement or sealing of holes and the removal or otherwise of welded attachments, should be agreed with the designer before A_1 execution A_1 starts (see 9.4.3).

8.9 Trial assembly (see BS EN 1090-2:2008+A1:2011, 6.10)

A1 A full or staged trial assembly should be required, where it is necessary to prove fit up between components and critical dimensions especially where tolerances on overall geometry or joint fit-up are small. This applies particularly to bolted joints with butting faces. **A1**

A full or staged trial assembly of the superstructure should be undertaken where:

- A1** a) erection operations are to be undertaken within restricted possession times; and/or **A1**
- b) the vertical camber is critical to the correct dead weight stress distribution in continuous main girders, particularly in cable stayed or suspension bridges; and/or
- c) fit-up tolerances are small in latticed structures which contain heavy members and rigid joints.

The correction of hole alignment by reaming of bolted splices, selection of pack thicknesses, correction of weld preparation fit-up and correct positioning of temporary alignment cleats can be carried out during trial assembly.

The following factors should be taken into account:

- 1) support of the assembly parts to minimize dead weight deflections;
- 2) correct re-establishment of the alignment of assembly parts in staged trial assembly;
- 3) control of, or allowance for, differential temperature distributions throughout the steelwork if exposed to direct sunlight when surveys are made;
- 4) unique marking for identification and orientation of individual members.

The above measures ensure that long range locked-in forces, beyond those allowed for in the design, are controlled within acceptable limits, e.g. incorrect dead load bending moment distribution in continuous girders.

9 Welding (BS EN 1090-2:2008+A1:2011, Clause 7)

9.1 Quality management (see BS EN 1090-2:2008+A1:2011, 7.1)

The BS EN ISO 3834 quality requirements should conform to the requirements for EXC3/4, except where the quality requirements for EXC2 might be suitable for simple bridges of limited span using steel grades of S355 or below and those requiring a quantified service category of no more than F56. The BS EN ISO 3834 quality requirements for EXC1 should not be applied to bridges.

The **A1** constructor **A1** should always ensure that the range of bridge types for which their welding management systems have been approved are clearly defined on a schedule. The schedule should support any certification in terms of type and size of construction, material grades, product forms and thicknesses, **A1** execution **A1** processes and quantified service categories.

NOTE See explanatory note C.11.