BS 7608:2014+A1:2015

BSI Standards Publication

Guide to fatigue design and assessment of steel products

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Contents

Foreword *iv*

1 Scope *1*
2 Normative references *2*
3 Terms and definitions *3*
4 Symbols and units *6*
5 Fatigue assessment procedure *8*
6 Design life *9*
7 Fatigue loading *9*
8 Environmental considerations *10*
9 Factors on fatigue life *11*
10 Features influencing fatigue behaviour *11*
11 Fracture mechanics *12*
12 Classification of details *12*
13 Unclassified details *32*
14 Workmanship and Inspection *32*
15 Stress calculations *42*
16 Allowable fatigue stresses *53*

Annexes
Annex A (normative) Fatigue design *69*
Annex B (normative) Explanatory notes on detail classification *71*
Annex C (normative) Guidance on stress analysis *83*
Annex D (normative) Guidance on the use of fracture mechanics *108*
Annex E (normative) Fatigue testing and the use of test data to define design stresses *117*
Annex F (normative) Weld toe improvement techniques *120*
Annex G (normative) Assessment of tubular node joints *131*
Annex H (normative) Cycle counting by the reservoir method *137*

Bibliography *139*

List of figures
Figure 1 – Definition of length *L* for use in thickness-bending correction *8*
Figure 2 – Reference stress in parent metal *43*
Figure 3 – Reference stress on weld throat *45*
Figure 4 – Typical example of stress concentrations due to geometrical discontinuity *47*
Figure 5 – Typical example of stress concentration caused by a geometric hard spot *48*
Figure 6 – Fatigue stress concentration factors *49*
Figure 7 – Comparison of nominal, structural and hot-spot stresses in a beam with a welded cover plate *50*
Figure 8 – Relative stiffness effects on the fluctuating load in a bolt in a concentrically clamped and concentrically loaded bolted joint *52*
Figure 9 – Mean S_r-N curves *54*
Figure 10 – Standard basic design S_r-N curves *56*
Figure 11 – S_r-N curves for bolts with threads under direct loading (class X) *58*
Figure 12 – Modifications made to S_r-N curves for welded joints in sea water *63*
Figure 13 – Typical S_r-N relationship *64*
Figure B.1 – Welds at plate edges *72*
Figure B.2 – Failure modes at weld ends and weld toes of welded attachments *73*
Figure B.3 – Failure modes in cruciform and T-joints for joint types indicated *74*
Figure B.4 – Failure modes in transverse butt welds for joint types indicated *74*
Figure B.5 – T-junction of two flange plates *76*
Figure B.6 – Cruciform junction between flange plates *77*
Figure B.7 – Alternative method for joining two flange plates *77*
Figure B.8 – Local grinding adjacent to cope hole in type 6.2 joint *78*

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Figure B.9 – Use of continuity plating to reduce stress concentrations in type 7.1 and 7.2 joints *80*
Figure B.10 – Example of type 7.3 or 7.4 T-joint *81*
Figure B.11 – Single fillet corner weld in bending (type 7.9) *81*
Figure B.12 – Example of a third member slotted through a main member *82*
Figure C.1 – I beam with cover plate showing distribution of structural stress and definition of hot-spot stress *85*
Figure C.2 – Types of hot-spot *87*
Figure C.3 – Possible brick element model of an I beam with a cover plate *88*
Figure C.4 – Node numbers superimposed upon the weld mesh section in Figure C.3c) *89*
Figure C.5 – Node numbers superimposed upon the weld mesh section in Figure C.3e) *89*
Figure C.6 – Element numbers superimposed upon the weld mesh section in Figure C.3c) *90*
Figure C.7 – Element numbers superimposed upon the weld mesh section in Figure C.3e) *90*
Figure C.8 – Calculation of the SSE stress at node n2 of the brick mesh shown in Figure C.3 to Figure C.5 *91*
Figure C.9 – Possible shell element model of an I beam with a cover plate *92*
Figure C.10 – Node numbers superimposed upon the shell element weld mesh section in Figure C.9c) *93*
Figure C.11 – Node numbers superimposed upon the shell element weld mesh section in Figure C.9f) *93*
Figure C.12 – Element numbers superimposed upon the shell element weld mesh section in Figure C.9c) and d) *94*
Figure C.13 – Element numbers superimposed upon the shell element weld mesh section in Figure C.9f) *94*
Figure C.14 – Calculation of the SSE stress at node n2 of the shell mesh shown in Figure C.9 to Figure C.12 *95*
Figure C.15 – Stress distributions across sections of an I-beam with a cover plate *96*
Figure C.16 – Region of TTI or NF integration for an edge attachment *97*
Figure C.17 – Stress distribution through I beam flange underneath node n2 for solid mesh shown in Figure C.4, Figure C.5 and Figure C.7 *97*
Figure C.18 – Distribution of correctly averaged stresses plotted against distance y *98*
Figure C.19 – Distribution of correctly averaged nodal forces plotted against distance y *101*
Figure C.20 – Brick element mesh with definition of weld toe element size (f) and plate thickness (t) *102*
Figure C.21 – Brick element model of an I beam showing the region of connection between the connectivity representing the joining surface (shaded) to a cover plate when the weld overfill is not modelled *102*
Figure C.22 – Dimensions used for inclined element representation of a fillet weld *103*
Figure C.23 – Dimensions used for thicker element representation of a fillet weld *104*
Figure C.24 – Example of symmetrical welded joint for which hot-spot stress is underestimated using methods in this annex *106*
Figure C.25 – Types of misalignment and distortion *107*
Figure D.1 – Flaw dimensions *110*
Figure D.2 – Transverse load-carrying cruciform joint *111*
Figure D.3 – Crack opening modes *112*
Figure F.1 – Multi-run weld in tubular nodal joint requiring improvement of every weld toe *121*
Figure F.2 – Recommendations for weld toe grinding *123*
Figure F.3 – Toe grinding to improve fatigue strength *123*
Figure F.4 – Effect of TIG or plasma torch position on resulting weld profile *124*

This is a preview. Click here to purchase the full publication.

Figure F.5 – Modification to design *S-N* curve for untreated weld resulting from weld toe dressing *125*
Figure F.6 – Weld toe peening methods *126*
Figure F.7 – Weld toe peening *127*
Figure F.8 – Modification to design *S-N* curve for untreated weld resulting from weld toe peening *131*
Figure G.1 – Example of hot-spot stresses in a tubular node joint *132*
Figure G.2 – Locations A and B of stresses used for linear extrapolation to weld toes to determine hot-spot stresses in tubular joints *135*
Figure H.1 – Example of cycle counting by reservoir method *137*

List of tables

Table 1 – Classification of details: plain material free from welding *14*
Table 2 – Classification of details: bolted and riveted connections *15*
Table 3 – Classification of details: butt welds and continuous welded attachments essentially parallel to the direction of applied stress *16*
Table 4 – Classification of details: welded attachments on the surface or edge of a stressed member *18*
Table 5 – Classification of details: full penetration butt welds between co-planar plates *20*
Table 6 – Classification of details: transverse butt welds in sections, tubes and pipes *22*
Table 7 – Classification of details: load carrying fillet and T-butt joints between plates *25*
Table 8 – Classification of details: slotted connections and penetrations through stressed members *28*
Table 9 – Classification of details: circular tubular members *29*
Table 10 – Classification of details: branch connections in pressurized containers *31*
Table 11 – Guidance on non-destructive testing of planar imperfections in welds *39*
Table 12 – Fatigue based acceptance levels for embedded non-planar imperfections in butt welds *40*
Table 13 – Fatigue based acceptance levels for undercut in transversely stressed welds *40*
Table 14 – Effect of misalignment on the fatigue strength of transverse butt welded joints *41*
Table 15 – Effect of misalignment on the fatigue strength of cruciform welded joints *41*
Table 16 – Effect of misalignment on the fatigue strength of transverse butt or cruciform welded joints being assessed in terms of hot-spot stress *41*
Table 17 – Stresses used in fatigue assessments involving applied shear stresses *42*
Table 18 – Details of basic *S-N* curves *59*
Table 19 – Nominal probability factors *60*
Table 20 – Details of design *S-N* curves for steel in sea water *62*
Table 21 – Design *S-N* curves for weld toe improved welded joints *65*
Table C.1 – The performance of structural stress calculation procedures SSE, TTI and NF for assessing hot-spot type "a" weld toes or ends *108*
Table D.1 – Use of stress intensity corrections with nominal or hot-spot stress *116*
Table E.1 – Fatigue test factor, *F* *120*
Table F.1 – Summary of weld toe peening methods *129*
Table F.2 – Improvement in fatigue strength due to weld toe peening *130*

Summary of pages

This document comprises a front cover, an inside front cover, pages i to vi, pages 1 to 142, an inside back cover and a back cover.

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Foreword

Publishing information

This British Standard is published by BSI Standards Limited, under licence from The British Standards Institution, and came into effect on 31 March 2014. It was prepared by Technical Committee WEE/37, *Acceptance levels for flaws in welds*. A list of organizations represented on this committee can be obtained on request to its secretary.

Supersession

BS 7608:2014+A1:2015 supersedes BS 7608:2014, which is withdrawn.

Information about this document

Guidance on general fatigue design philosophy is given in Annex A, which also contains a brief description of the method of using this British Standard. A more general method for assessing welded joints using the hot-spot stress, only included previously for assessing tubular joints, is also included.

The relevant application standard or specification for the particular product being assessed specifies the following:

a) the loading to be assumed for design purposes, including its magnitude and frequency;

b) the required life of the structure;

c) the environmental conditions;

d) the required nominal probability of failure.

BS 7608:2014 was a full revision of the standard, and introduced the following principal changes [1]:

- Introduction of the hot-spot stress method with guidance on finite element stress analysis (FEA).
- New correction for both plate thickness and applied bending with allowance for welded joint proportions.
- Additional weld details; some have been reclassified.
- Weld quality requirements based on fitness for purpose.
- Revised sea water corrosion fatigue data.
- New rules for bolts.
- Design data to resist shear fatigue failure.
- Guidance on stress calculation for combined loading.
- Revised cumulative damage rules.
- Comprehensive guidance on use of weld toe improvement methods.
- New guidance on acceptance fatigue testing and statistical analysis of results.

European standards containing fatigue rules for steel structures and pressure vessels have been published since the 1993 edition of this British Standard. It is therefore not applicable to product areas covered by them. It is applicable to a wide range of other steel product areas that do not have specific fatigue rules.

Text introduced or altered by Amendment No. 1 is indicated in the text by tags A1 A1. Minor editorial changes are not tagged. The principal changes are to Table 4 to Table 10, Clause **14**, Clause **16**, Table 18, new Table 21, Annex C and Annex F.

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Use of this document

As a guide, this British Standard takes the form of guidance and recommendations. It should not be quoted as if it were a specification or a code of practice and claims of compliance cannot be made to it.

Presentational conventions

The guidance in this standard is presented in roman (i.e. upright) type. Any 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 British Standard cannot confer immunity from legal obligations.

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1 Scope

1.1 General

This British Standard gives methods for assessing the fatigue life of parts of steel products that are subject to repeated fluctuations of stress. It is applicable to all areas of industrial application that are not covered by other British Standards containing fatigue assessment rules.

NOTE Some British Standards have specific product acceptance tests for fatigue life, but do not have assessment rules. In such cases the guidance in this British Standard might be applicable for product development purposes.

1.2 Applications not covered

This British Standard is not applicable to the following application areas;

a) lighting columns (see BS EN 40);

b) concrete building and civil engineering structures (see BS EN 1992);

c) steel building and civil engineering structures [see BS EN 1993 (all parts)];

d) composite steel and concrete building and civil engineering structures [see BS EN 1994 (all parts)];

e) unfired pressure vessels (see BS EN 13445); and

f) fixed offshore structures (see BS EN ISO 19902).

1.3 Materials

This British Standard covers:

a) wrought steel material products;

b) welds in fully machined areas of steel casting;

c) ferritic alloy and low alloy steels;

d) austenitic and duplex stainless steels;

e) unprotected weathering steels; and

f) threaded fasteners.

It is applicable to yield strengths in the range 200 N/mm^2 to 960 N/mm^2 and ultimate tensile strengths in the range 360 to 1 200 N/mm^2 for material thicknesses 3 mm and greater.

This British Standard is not applicable to the following:

1) proprietary fasteners;

2) steel castings;

3) cold drawn products;

4) wire ropes; and

5) steel for reinforcement in concrete.

1.4 Manufacturing processes

This British Standard is applicable to machined products with the following exceptions:

a) rough sawn surfaces;

b) surfaces requiring high quality surface finish (e.g. lapping, polishing, honing, fine grinding); and

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c) machined details with sharp corners (e.g. key ways, un-radiused shoulders).

The following manufacturing processes are also covered:

1) cold formed wrought products;

2) weld toe improvement methods;

3) arc welded joints, with the exclusion of joints between rectangular and square hollow sections;

4) in-line butt welds made by power beam A1 or A1 friction welding;

5) tensioned and un-tensioned bolted joints and hot-driven riveted lap joints loaded in shear; and

6) thermal cutting.

This British Standard is not applicable to the following manufacturing processes:

i) resistance welding processes and brazing;

ii) contact joints under pressure where fretting occurs;

iii) adhesively bonded joints;

iv) shearing and punching; and

v) surface hardening.

1.5 Environment

The fatigue design data in this British Standard are applicable to internal and external air environments. They are applicable to structural steel products exposed to sea water.

They are not applicable to unprotected stainless or weathering steel products in sea water or aggressive corroding environments (e.g. chloride, sulphide, strong acid or alkali).

The data are applicable to products operating at temperatures below the creep range of the steel.

This British Standard is not applicable to products operating in the creep regime.

2 Normative references

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

BS 3643-2, *ISO metric screw threads – Part 2: Specification for selected limits of size*

BS 3692, *ISO metric precision hexagon bolts, screws and nuts – Specification*

BS 4190, *ISO metric black hexagon bolts, screws and nuts – Specification*

BS 4395 (all parts), *Specification for high strength friction grip bolts and associated nuts and washers for structural engineering*

BS 7910, *Guide to methods for assessing the acceptability of flaws in metallic structures*

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

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

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

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

BS EN 1993-1-8, *Eurocode 3 – Design of steel structures – Design of joint*

BS EN ISO 3506, *Mechanical properties of corrosion-resistant stainless steel fasteners – Bolts, screws*

BS EN ISO 4014, *Hexagon head bolts – Product grades A and B*

BS EN ISO 4017, *Hexagon head screws – Product grades A and B*

BS EN ISO 4762, *Hexagon socket head cap screws*

BS EN ISO 9013, *Thermal cutting – Classification of thermal cuts – Geometrical product specification and quality tolerance*

BS ISO 12108, *Metallic materials – Fatigue testing – Fatigue crack growth method*

3 Terms and definitions

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

3.1 cycle counting method
method of counting the numbers of stress cycles of different magnitudes which occur in a service stress history

NOTE The loads applied to the structure, considered in sequence, generate a particular stress history at each detail of interest. This stress history can be broken down into equivalent stress ranges by the operation of cycle counting.

3.2 detail class
rating given to a particular structural detail to indicate which of the fatigue strength (*S-N*) curves should be used in the fatigue assessment

NOTE 1 Also known as joint class.

NOTE 2 The class is denoted by one of the following letters: A, B, C, D, E, F, F2, G, G2, S_1, S_2, TJ, W1 or X. The categorization takes into account the stress being used in the assessment (e.g. nominal, hot-spot or shear stress), the local stress concentration at the detail, the size and shape of the maximum acceptable discontinuity, the stress direction, metallurgical effects, residual stresses and a post-weld improvement method.

3.3 design life
period within which there is a defined nominal probability that failure by fatigue cracking is unlikely to occur

NOTE This can be longer or shorter than the service life (see Annex A).

3.4 design spectrum
tabulation of the number of occurrences of all the stress ranges, S_r, of different magnitudes produced by the load spectrum in the design life of the structure or component, to be used in the fatigue assessment

NOTE 1 Also known as stress spectrum.

NOTE 2 Different components of a product can have different design spectra.

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