THE HIGHWAYS AGENCY BD 13/90

THE SCOTTISH OFFICE DEVELOPMENT DEPARTMENT

THE WELSH OFFICE
Y SWYDDFA GYMREIG

THE DEPARTMENT OF
THE ENVIRONMENT FOR NORTHERN IRELAND

Design of Steel Bridges
Use of BS 5400: Part 3: 1982

Summary: This Departmental Standard covers the use of BS 5400: Part 3 for the design of steel highway bridges.

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VOLUME 1 HIGHWAY STRUCTURES: APPROVAL PROCEDURES AND GENERAL DESIGN

SECTION 3 GENERAL DESIGN

BD 13/90

DESIGN OF STEEL BRIDGES USE OF BS 5400: PART 3: 1982

Contents

1. INTRODUCTION

1.1 This Departmental Standard replaces BD 13/82 and it contains a number of amendments to BS 5400: Part 3: 1982 which are either replacement clauses or additional to the requirements given in BD 13/82. Changes in steel grades resulting from the introduction of the new British Standard BS EN 10 025 have also been included.

1.2 The main purpose of this new Departmental Standard is to clarify a number of clauses in BS 5400: Part 3 which are either ambiguous or are creating difficulties for designers. There has been full consultation with the BSI committee CSB 59 in producing these amendments. The Department is sponsoring a study to review a number of clauses in Part 3 where changes of a more substantial technical nature may be needed. These include the $D/2y_t$ factor, patch loading on webs, bracing systems and U-frame restraints etc. It is intended that any proposed changes arising from this study would be taken on board by BSI and published as a revision to BS 5400: Part 3.

2. SCOPE

2.1 This Departmental Standard covers the use of BS 5400: Part 3: 1982 for the design of steel bridges and other highway structures in steel. It sets out the Department's particular requirements where they are either more comprehensive or different compared to those given in the British Standard.

3. USE OF THE BRITISH STANDARD

3.1 The design of steel bridges and other highway structures in steel belonging to the Department of Transport shall be carried out in accordance with BS 5400: Part 3 as amended by this Departmental Standard. Where reference is made to any Part of BS 5400, this shall be taken as a reference to that part as implemented by this Department.

3.2 A list of amendments to BS 5400: Part 3 is given in Appendix A.

3.3 BS 5400: Part 3 as amended by this Departmental Standard supersedes the following:

a) BS 153: Parts 3B and 4: 1972: Specification for Steel Girder Bridges.

b) Inquiry into the Basis of Design and Method of Erection of Steel Box Girder Bridges: Interim Design and Workmanship Rules, Parts I, II, III and IV.

c) Technical Memorandum (Bridges) No BE 6/73: Application of the Merrison Committee's Interim Design and Workmanship Rules for Steel Box Girder Bridges.

d) Technical Memorandum (Bridges) No. BE 3/76: Interim Rules for the Design and Construction of Plate Girders and Rolled Section Beams in Bridges.

e) Departmental Standard BD 13/82: Design of Steel Bridges: Use of BS 5400: Part 2: 1982

3.4 The design of wires, cables, anchorages and saddles in suspension and cable stayed bridges and the design of the deck plate in orthotropic construction are not covered in BS 5400: Part 3.

4. ADDITIONAL DEPARTMENTAL REQUIREMENTS

4.1 Some clauses in BS 5400: Part 3 are expressed in a mandatory form using the word "shall", whereas some other clauses are expressed in the form of recommendations using the word "should". However, even the latter requirements shall be considered as mandatory.

4.2 Weathering Steel

4.2.1 The use of weathering steel in highway structures is covered in Departmental Standard BD 7/81. The design of structures in weathering steel shall be carried out in accordance with Part 3 and the following clauses.

4.2.2 The sectional properties to be used for global analysis (Part 3, Clause 7) shall be calculated assuming either the specified sizes or specified sizes less the allowance for any loss of thickness in accordance with BD 7/81.

4.2.3 All dimensions for checking the adequacy of sections shall be taken as the specified dimensions less the allowance for the loss of thickness in accordance with BD 7/81.

4.3 Strength of Fasteners

4.3.1 For the application of Clause 14.5.3.1, all connections which are subjected to live or wind load effects shall be considered to be "permanent main structural connections".

4.3.2 HSFG bolts to BS 4395: Part 2 shall not be used to resist applied axial tension.

4.4 Patch Loading on Webs

The formulae given in Appendix D of BS 5400: Part 3 are known to give unsafe results in some cases. In applying the code provisions for patch loading on webs, designers are advised to consult Bridges Engineering Division.

5. REFERENCES

5.1 The following documents are referred to in this Departmental Standard:

1. BS 5400: Steel, Concrete and Composite Bridges

   Part 3: 1982: Code of Practice for Design of Steel Bridges, including amendment No 1

2. BS 153: Specification for Steel Girder Bridges

   Part 3B: 1972: Stresses

   Part 4: 1972: Design and Construction

3. BS 4395: Specification for High Strength Friction Grip Bolts

   Part 2: 1969: Higher Grade Bolts and Nuts and General Grade Washers.

4. BS EN 10 025: Hot Rolled Products of Non-alloy Structural Steels and Their Technical Delivery Conditions.

5. Inquiry into the Basis of Design and Method of Erection of Steel Box Girder Bridges: Interim Design and Workmanship Rules, Parts I, II, III and IV.

6. Technical Memorandum (Bridges) No BE 6/73: Application of the Merrison Committee's Interim Design and Workmanship Rules for Steel Box Girder Bridges.

7. Technical Memorandum (Bridges) No BE 3/76: Interim Rules for Design and Construction of Plate Girders and Rolled Section Beams in Bridges.

8. Departmental Standard BD 7/81: Weathering Steel for Highway Structures.

9. Departmental Standard BD 13/82: Design of Steel Bridges: Use of BS 5400: Part 3: 1982.

6. ENQUIRIES

Technical enquiries arising from the application of this Departmental Standard to a particular project should be addressed to the appropriate Technical Approval Authority.

All other technical enquiries or comments should be addressed to:-

Head of Division
Bridges Engineering Division
Department of Transport
St Christopher House
Southwark Street
LONDON SE1 0TE

Quoting Reference:
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AMENDMENTS TO BS 5400: PART 3: 1982

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Clause 3.2.2 Main Symbols

In line 7, insert "of" between "spacing" and "longitudinal"

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Table 2 Partial safety factors

Delete the last line of Table 2(a) beginning "welds - etc" and substitute the following:

welds	14.6.3.11.1, 14.6.3.11.2, 14.6.3.11.3	1.20

Table 2(a), Column 2, Line 3, delete "9.9.5.2 (a)" and insert "9.9.5.3 (a)"

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Clause 5.7 Camber

In line 4, delete "in excess".

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Clause 6.2 Nominal yield stress

Delete the whole clause and substitute the following:

"The nominal yield stress σ_y, for steel supplied to a standard grade complying with the requirements of BS EN 10 025 or BS 4360 and tested in accordance with those standards, should be taken as:

Steel grade in		Yield strength σ_y, for thickness (in mm)		
BS EN 10 025	BS 4360	up to and including 63	over 63 up to and including 100	over 100 up to and including 150
		N/mm^2	N/mm^2	N/mm^2
Fe 360	40	225	215	195
Fe 430	43	265	245	225
Fe 510	50	355	325	295
	55	450	400	-
	WR 50	345	-	-

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When steel to specifications other than BS EN 10 025 or BS 4360 is used the nominal yield stress should be taken as:

$$(1 - \frac{\rho_t}{100}) \quad (\sigma_{ym} - k_2 \times \text{standard deviations from } \sigma_{ym})$$

where

ρ_t is the percentage tolerance below the specified thickness permitted by the relevant British Standard for material for the relevant thickness.

σ_{ym} is the mean yield stress of material of the relevant thickness.

k_2 is the coefficient as given in Table 7 of BS 2846: Part 3: 1975, using the confidence level $(1 - \alpha) - 0.95$ and the proportion of the population P = 0.95."

Clause 6.3 Ultimate tensile stress

In line 3, insert "BS EN 10 025 or" immediately before "BS 4360".

Clause 6.4 Ductility

In line 5 of para 1 and line 4 of para 3, insert "BS EN 10 025 or" immediately before "BS 4360".

Clause 6.5.4 Simple provisions

In line 3 of para 1 and line 3 of para (b), insert "BS EN 10 025 or" immediately before "BS 4360".

Clause 6.5.5 Energy absorption

Delete the whole clause and substitute the following:

"Unless the simple provisions of 6.5.4 are adopted, the energy value C_v for steel used to resist applied tensile stress should not be less than:

(a) 18 joules or

(b) for type 1, $(\frac{\sigma_y}{355})(\frac{t}{2})$ (in joules) when $\sigma_y \leq 355$ N/mm^2

$(\frac{\sigma_y}{355})^2(\frac{t}{2})$ (in joules) when $\sigma_y > 355$ N/mm^2

for type 2, $(\frac{\sigma_y}{355})(\frac{t}{4})$ (in joules) when $\sigma_y \leq 355$ N/mm^2

$(\frac{\sigma_y}{355})^2(\frac{t}{4})$ (in joules) when $\sigma_y > 355$ N/mm^2

whichever is the greater
where

C_v is the energy value in impact tests carried out at the design minimum temperature U (see 6.5.2) in accordance with BS EN 10 025 or BS 4360.

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σ_y is the nominal yield stress appropriate to the thickness.

t is the thickness of the part (in mm).

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Clause 6.5.6 Stress concentrations

Delete the expression for C and substitute the following:

'$C_v \geq \frac{\sigma_y}{1000} (0.75 + \frac{\sigma}{\sigma_y} k) t$, but not less than 18 joules'

Add the following new definition:

"σ is the applied mean principal tensile stress at the ultimate limit state."

In the last sentence of NOTE, insert the following between "concentrations" and "around":

"inherent in the make-up of welded joints, those"

Pages 12 and 13

Table 3 Limiting thickness

Delete tables and notes and substitute the following tables and notes:

"Table 3. Limiting thickness of certain steels, complying with the requirements of BS EN 10 025 or BS 4360, for parts in tension.

(a) Plates, strip and wide flats.

Grade in BS EN 10 025 and BS 4360	U= 0 E C	U= -10 E C	U= -20 E C	U= -30 E C	U= -40 E C	U= -50 E C
	Limiting thickness					
	mm	mm	mm	mm	mm	mm
Fe360B, Fe430B	0	0	0	0	0	0
Fe360C, Fe430C	75	45	0	0	0	0
Fe360D1, Fe360D2 Fe430D1, Fe430D2	150	125	75	45	0	0
40EE, 43EE	75*	75*	75*	75*	75*	75*
Fe510B	0	0	0	0	0	0
Fe510C	55	35	0	0	0	0
Fe510D1, Fe510D2	130	85	55	35	0	0
Fe510DD1, Fe510DD2	150	130	85	55	35	0
50EE	75*	75*	75*	75*	75*	75*
50F	40	40	40	40	40	40

55C	25	20	0	0	0	0
55EE	63**	63**	63**	63**	50**	35**
55F	40	40	40	40	40	40
WR50A	12	12	0	0	0	0
WR50B	50	35	0	0	0	0
WR50C	50	50	45	35 (U= -25°C)	0	0

* 50 mm for wide flats
** 30 mm for wide flats

(b) Sections (other than hollow sections)

Grade in BS EN 10 025 and BS 4360	U= 0°C	U= -10°C	U= -20°C	U= -30°C	U= -40°C	U= -50°C
	Limiting thickness					
Fe360B, Fe430B	mm 0	mm 0	mm 0	mm 0	mm 0	mm 0
Fe360C, Fe430C	75	45	0	0	0	0
Fe360D1, Fe360D2 Fe430D1, Fe430D2	100	100	75	45	0	0
40DD, 43DD	100	100	100	75	45	0
Fe510B	0	0	0	0	0	0
Fe510C	55	35	0	0	0	0
Fe510D1, Fe510D2	100	85	55	35	0	0
Fe510DD1, Fe510DD2	100	100	85	55	35	0
50E	100	100	100	85	55	35
55C	19	19	0	0	0	0
WR50A	12	12	0	0	0	0
WR50B	50	35	0	0	0	0
WR50C	50	50	45	35 (U= -25°C)	0	0

(c) Hollow sections

Grade in BS 4360	U= 0°C	U= -10°C	U= -20°C	U= -30°C	U= -40°C	U= -50°C
	Limiting thickness					
	mm	mm	mm	mm	mm	mm
43C	40	40	0	0	0	0
43D	40	40	40	40	0	0
43EE	40	40	40	40	40	40
50C	40	35	0	0	0	0
50D	40	40	40	35	0	0
50EE	40	40	40	40	40	40
55C	25	20	0	0	0	0
55EE	25	25	25	25	25	25
55FF	25	25	25	25	25	25
WR50A	12	12	0	0	0	0
WR50B	40	35	0	0	0	0
WR50C	40	40	40	35 (U= -25°C)	0	0

NOTE 1. All thicknesses given are for type 1 parts. Thicknesses may be doubled for type 2 parts but should not exceed the maximum thickness specified in BS EN 10 025 or BS 4360.

NOTE 2. Interpolation for limiting thicknesses for intermediate temperatures is permitted between data in adjacent columns except where one of the limiting thicknesses is shown as zero, then the use of that grade of material for the intermediate temperature is not permitted.

NOTE 3. Some of the thicknesses given are the limits set by the maximum thickness specified in BS EN 10 025 or BS 4360. In the case of sections, for which the maximum thicknesses for some grades are not specified, they are taken as those for plates. The option in BS 4360 for specifying the impact value for hollow section of grade 43C should be adopted.

NOTE 4. Limiting thicknesses given are derived using 6.5.5 for type 1 parts and the following impact values:

Temperature (°C)	Impact Value (joules)
T + 30	67
T + 20	54
T + 10	40
T	27
T – 10	18

Where T is the test temperature given in BS EN 10 025 or BS 4360 for impact value of 27 joules, except for grades Fe510DD1 and Fe510DD2, where T is taken as –30°C.

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Clause 9.2.1.2 Effects to be considered

In line 1, delete "Stresses" and substitute "The effects".

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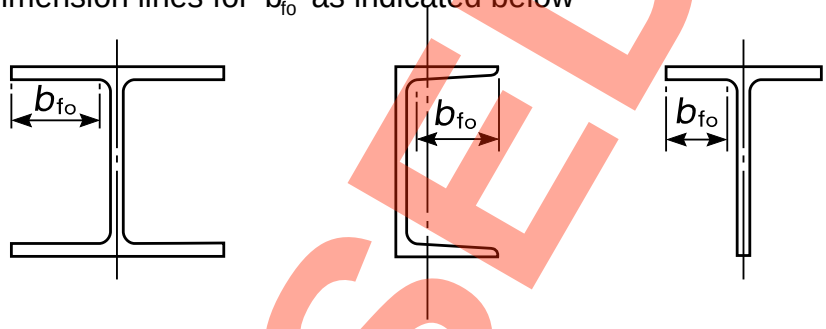
Figure 1. Geometric notation for beams

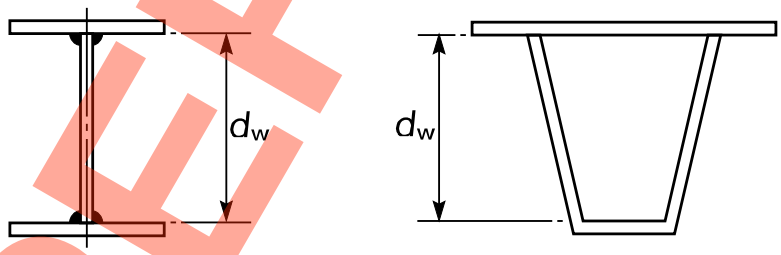
(a) Rolled beam sections

Alter the 3 dimension lines for 'b_{fo}' as indicated below



(b) Fabricated beam sections

Alter the two dimension lines for 'd_w' as indicated below



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Clause 9.4.2.1 General

Add the following new "NOTE" at the end of the clause:

"NOTE. Additional or alternative provisions are given elsewhere for specific elements such as stiffeners."

Clause 9.4.2.4 Effective compression flange

In the definition for "K_c", delete "outstands or stiffeners which are in accordance with 9.3.2 or 9.3.4 respectively" and substitute the following:

"outstands which are in accordance with 9.3.2, and for all stiffeners which are in accordance with 9.3.4".

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Clause 9.5.1 General

In line 3, delete "11.4" and insert "11.3".

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Clause 9.5.5 Redistribution of tension flange stresses in a longitudinally stiffened beam

In item (c), line 2, delete "$1/E\gamma_m\gamma_{f3}$" and substitute "1/E".

In item (c), line 4, delete "$2\sigma_y/E\gamma_m\gamma_{f3}$" and substitute "$2\sigma_y/E$".

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Figure 7 (b) Effect of bending restraint

Delete "k_1" on the right hand ordinate.

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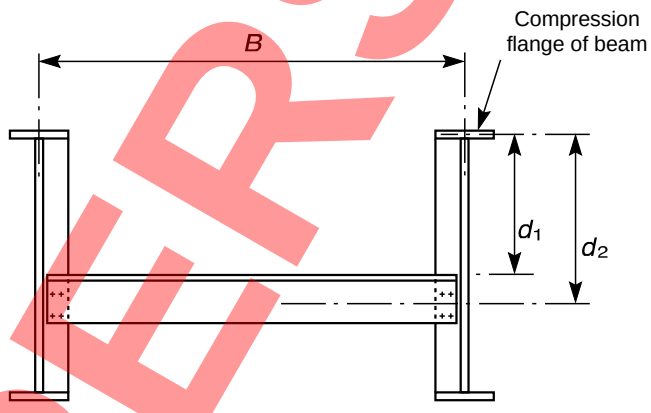
Figure 8 Restraint of compression flange by U-frames or deck

Delete item (a) and substitute the following:



(a) Main beams restrained by U-frames (see 9.6.5)

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Clause 9.7.2 Uniform I, channel, tee or angle sections

In the definition for "r_y", delete "whole beam section" and substitute "gross cross section of the beam".

In the definition for "t_f", line 4, delete "λ_f" and substitute "λ_F".

Clause 9.7.3.1 Uniform rectangular or trapezoidal box sections

In the definition for "A", insert "gross" immediately before "cross".

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In the definition for "I_x and I_y", line 1, insert "gross cross" immediately before "section".

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Clause 9.7.5 Other cases

Delete existing heading and substitute "Other cases and alternative methods".

In line 2, insert "or as an alternative", immediately after "9.7.4".

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Clause 9.9.1.1 General

In lines 9 and 10, delete "not in accordance with 9.9.8" and add at end "in accordance with 9.9.8".

Clause 9.9.1.2 Compact sections

In lines 1 and 3 of paragraph 2 of NOTE, delete "width" and substitute "area"

Add the following to the end of the last sentence of NOTE:

> "but the transformed area of the reinforcement in concrete subject to tension should be included and obtained from:
>
> $$\text{the gross area of reinforcement} \times \frac{0.87 f_y}{\sigma_{yc} / \gamma_m}$$
>
> where f_y is the characteristic strength of the reinforcement in accordance with Part 4."

Clause 9.9.1.3 Non-compact sections

Add the following "NOTE" at the end of the clause:

> "NOTE: For composite sections, Z_{xc} and Z_{xt} should be based on the transformed section. The transformed area of the concrete compression flange should be obtained using either the short-term or the long-term modular ratio of the concrete as appropriate to the type of loading. Concrete in tension should be ignored but the area of the reinforcement in concrete subject to tension should be included."

Clause 9.9.2.2 shear resistance under pure shear

Add the following after the definition of "τ_1"

> "If the value of τ_1/τ_y from figures 11 to 17 is less than the value of the shear coefficient K_q for an unrestrained panel from figure 22, the value of this ratio may be taken as K_q."

In the definition for b_{fe}, para (c), insert "or" immediately before "more".

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Clause 9.9.5.1 General

Delete existing clause and substitute as follows:

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"9.9.5.1 General

When the cross-section of a beam and the applied loading increase by stages, eg a steel section initially carrying self-weight and weight of concrete deck but acting compositely for subsequently applied loads, a check for adequacy should be made for each stage of construction."

Clause 9.9.5.2 Bending resistance of non-compact section

Delete existing clause and substitute as follows:

"9.9.5.2 Compact sections

For beams that are of compact section, as defined in 9.3.7, the entire load at any stage may be assumed to act on the cross-section of the beam appropriate to that stage."

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Clause 9.9.5.3 Bending combined with shear or axial load on non-compact sections

Delete existing clause and substitute as follows:

"9.9.5.3 Non-compact sections

For the beam that is not of compact section, as defined in 9.3.7, the stresses appropriate to the cross-section and the loading at each stage of construction should be calculated. The sum of the stresses at each stage of construction should be calculated separately for bending about each axis and for axial load.

The stress at an extreme fibre due to bending about one axis should not exceed

(a) $\frac{\sigma_{1c}}{\gamma_m \gamma_{f3}}$ if compressive, or

(b) $\frac{\sigma_{yt}}{\gamma_m \gamma_{f3}}$ if tensile.

In the interaction formulae in 9.9.3 and 9.9.4.2, V_D , V_R , M_D , M_R , P_D , M_{DX} and M_{DY} should be taken appropriate to the cross-section at the stage under consideration. The applied moments should be taken as follows:

$\sigma_{xx} Z_x$ for M and M_{xmax}

$\sigma_{yy} Z_y$ for M_{ymax}

The total stresses at all points at all sections should not exceed:

$$\frac{\sigma_y}{\gamma_m \gamma_{f3}}$$

where

"σ_{1c} and σ_{yt} are as defined in 9.9.1.3, appropriate to the cross-section at the stage under consideration.

σ_{xx} and σ_{yy} are the sums to the stage considered of the stresses of the extreme fibres of the section due to bending about the X-X and Y-Y axes respectively.

Z_y and Z_y are the elastic moduli of the effective section for the stage considered about the X-X and Y-Y axes respectively, for the corresponding extreme fibres."

Clause 9.9.7 Differential temperature and concrete shrinkage

Delete existing clause and substitute as follows:

"When, as required by 9.2.1 or 9.2.3, differential temperature and shrinkage effects are to be taken into account, the effects should be separated into the following parts:

(a) Stresses forming the internal stress distribution through the section, ignoring any continuity over supports.

(b) Bending moments and shears due to requirements for continuity over supports in a continuous beam.

For the strength checks contained in 9.9.1 to 9.9.4, the values of bending moments and shears from (b) should be combined with other load effects as appropriate.

For serviceability limit state the stresses calculated from (a) should be added to the stresses due to load effects (including the moments from (b) above at appropriate points on the section). The resultant total stresses should not exceed:

$\frac{\sigma_{1c}}{\gamma_m \gamma_{f3}}$ or $\frac{\sigma_{yt}}{\gamma_m \gamma_{f3}}$ as appropriate."

Clause 9.10 Flanges in longitudinally stiffened beams

Delete the existing clause heading and substitute the following:

"9.10 Flanges in beams with longitudinal stiffeners in the cross-section"

Clause 9.10.1.1 Flanges straight in elevation

In paragraph 1, lines 1 to 3, delete from "The stresses" to "exceed:" and substitute as follows:

"The stresses in the extreme fibres of a beam with longitudinal stiffeners on the web, including any redistribution of stresses from the web, should not exceed:"

Clause 9.10.2.1 Yielding of flange plate

In the definition for "σ_f", line 2, immediately after "plate" insert the following:

"including any re-distribution of stresses from the web,"

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Clause 9.10.2.3 Strength of longitudinal flange stiffeners

In the definition for "σ_a", line 1, immediately after "stress", insert the following:

"including any re-distribution of stresses from the web,"

Clause 9.10.3.3.1 Flange plate

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Delete existing clause and substitute as follows:

"9.10.3.3.1 Flange plate

The design of the flange plate should satisfy the following yield criterion at all sections:

$$(\sigma_{fz} + \sigma_f)^2 + (\sigma_2 + \sigma_{2b})^2 - (\sigma_{fz} + \sigma_f)(\sigma_2 + \sigma_{2b}) + 3 \tau^2 \leq \left(\frac{\sigma_{yf}}{\gamma_m \gamma_{f3}} \right)^2$$

where

σ_f, σ_2 and τ are as defined in 9.10.2.1 due to global effects

σ_{fz} is the stress at the mid-plane of the flange plate due to local bending of the effective stiffener section spanning between transverse members

σ_{2b} is the stress due to local bending at the extreme fibre of the flange plate spanning between longitudinal stiffeners and transverse membrane action."

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Clause 9.11 Webs in longitudinally stiffened beams

Delete existing clause heading and substitute the following:

"9.11 Webs in beams with longitudinal stiffeners in the cross-section."

Clause 9.11.3 Yielding of web panels

In item (b), line 1, immediately after "stresses" insert "σ_2".

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Clause 9.11.4.2.2 Restraint for derivation of K_1, K_q and K_b

In item (b), definition for "σ_f", immediately after "flange" delete "full stop" and insert the following:

"plate, including any re-distribution of stresses."

Clause 9.11.4.3.5 Transverse coefficient K_2

In lines 4 and 7, delete "either" and "or" respectively.

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Clause 9.12.2.3 U frames with cross members subjected to live loading

In clause heading, delete "live" and substitute "vertical".

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Clause 9.12.4.1 Restraining forces

In item (4), 3rd line, delete "9.6.6" and insert "9.6.6.2"

Clause 9.12.4.2 Stiffness

In item (a), definition for "I_x", line 2, delete "(see figure 1)" and substitute the following:

"determined in accordance with 9.14.2 (see figure 27)".

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Clause 9.13.3.3 Axial force representing the destabilising influence of the web

In paragraph 2 "For a longitudinally stiffened etc", line 1, delete "may be" and substitute "should be".

In paragraph 2 (as above) definition for "ΣI_s", line 3, immediately after "1_s" insert "derived in accordance with 9.11.5.1".

Clause 9.13.5.1 Yielding of web plate

Equation for "σ_e", Delete existing equation and substitute as follows:

$$\sigma_e = \sqrt{(\sigma_1 + K\sigma_b)^2 + \sigma_{es2}^2 - \sigma_{es2}(\sigma_1 + K\sigma_b) + 3r_R^2}$$

Definition for "σ_a". Delete existing definition and add new definition for "σ_1" as follows:

"σ_1 is as defined in 9.13.3.3"

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Clause 9.13.6 Transverse web stiffeners without applied loading

Delete existing expression and substitute the following:

$$\sigma_R \leq \frac{A_{se} a_{max} \sigma_{1s}}{\eta_s K_s t_w 1_s^2 \gamma_m \gamma_{f3}}$$

New definition "η_s". Add new definition at end of clause as follows:

"η_s = 1 for webs without longitudinal stiffeners and is defined in 9.13.3.3 for longitudinally stiffened webs".

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Figure 27 Bearing Stiffeners

(b) Effective section

In all four items, delete the phrase "Minimum of" from all notes and substitute "Lesser of".

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Clause 9.14.4.3 Buckling of effective stiffener section

In the definition for "P", immediately after "stiffener" insert "within the middle third of its length".

Definitions for "A_{se}" and "σ_{ls}". Delete existing definitions and substitute the following:

"A_{se} is the area of the effective stiffener section

σ_{ls} is as defined in 9.13.5.3"

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Clause 9.15.3.2 Stiffness of transverse members

In NOTE 1, add the following new last sentence:

"Where there are longitudinal stiffeners, A_f and I_f should be calculated on the basis of the effective section of the member derived in accordance with 9.4.2".

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Clause 9.17.5.4 Yielding of diaphragm plate

In the last line of page 66, in the expression amend symbols "t^3_d" to read "$t_d{}^3$".

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Clause 9.17.6.2.3 Horizontal Stresses

In the expression for the primary moment M in item (a), insert a minus sign between "$\Sigma_{i-1,n}\ (P_i X_i)$" and "$R_v X_b$".

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Clause 9.17.6.3.4 Equivalent stress for buckling check

In the definition for "r_{se}", line 3, immediately after "diaphragm" insert the following:

"derived in accordance with 9.17.4.4".

In the definition for "ΣA_s", line 3, immediately after "l_s" insert the following:

"not including any adjacent diaphragm plate".

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Clause 9.17.6.7 Buckling of diaphragm stiffeners

In the definition for "r_{se}" line 3, immediately after "diaphragm" insert the following:

"derived in accordance with 9.17.4.4".

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Clause 9.17.7.3.2

Definition for "r_{se}", immediately after "web" insert the following:

"derived in accordance with 9.17.4.5".

Clause 9.17.7.4 Junction restraint provided by diaphragm stiffeners

In the definition for "A_{se}", immediately after "stiffeners", delete "full stop" and substitute the following:

"derived in accordance with 9.17.4.4".

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Clause 10.3.2 Stiffened outstand

In the expression in line 6, delete "σ_y" and substitute "σ_y" ".

In the definition for "σ_y", delete "σ_y" and substitute "σ_y" ".

Clause 10.3.3 Circular hollow sections

In the expression in line 4, delete "σ_y" and substitute "σ_y" ".

In the definition for "σ_y", delete "σ_y" and substitute "σ_y" ".

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Clause 10.5.2.2 Circular hollow sections

In item (b), delete "when $> 50 \frac{D}{t}\sqrt{\frac{\sigma_y}{355}}$" and substitute " when $\frac{D}{t}\sqrt{\frac{\sigma_y}{355}} > 50$"

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Figure 38 Battened members

Delete "Q_s/N_b" in the figure on the left side (single plane of battens) and substitute "Qs/nb".

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Clause 10.8.3 Spacing of battens

In the definition for "l_x/r_x and l_y/r_y", add the following at the end:

"; r_x and r_y should be calculated on the basis of the gross cross-section of the member".

In the definition for "r_{b1}", line 1, immediately before "component" insert "gross cross-section of the".

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In the definition for "r_{b2}", line 1, immediately before "component" insert "gross cross-section of the".

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Clause 10.9.3 Spacing of lacing bars

In the definition for "r_{p1}", line 3, immediately after "lacing" insert "based on the gross cross-section of the member".

In the definition for "r_{p2}", line 3, immediately after "member" insert "based on the gross cross-section of the member".

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Clause 10.11.2 Slenderness of components

In the definition for "r_p", line 3, immediately after "connections" insert "based on the gross cross-section of the member".

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Clause 14.4.3.2 Design stresses

In line 4, delete "k_2" from the expression.

Delete the existing definition for "σ_a" and substitute the following new definition:

> "σ_a is the axial stress or, where shear is present, the equivalent stress, based on the effective section determined in accordance with 11.3 or 0.8 times the effective section for outer plies in connections made with HSFG bolts acting in friction".

Delete the definition for "k_2".

Clause 14.4.4 Parts in shear

Delete existing clause and substitute the following:

> "14.4.4 Members in bending
>
> 14.4.4.1 General. A splice in a member or part subjected to bending and axial load effects should satisfy the requirements of 14.4.4.2 to 14.4.4.4 and 14.4.2 or 14.4.3 as appropriate.
>
> 14.4.4.2 Compression flanges. Compression flanges should be treated as compression members and spliced in accordance with 14.4.2. In determining the load to be transmitted at a splice that is not effectively braced, the following definitions should be adopted:
>
> P is the force in the compression flange at the splice position
>
> P_D is the flange compression calculated from the bending resistance of the beam at the position of the maximum bending moment
>
> P_{DK} is the flange compression calculated from the bending resistance of the beam at the position of the maximum bending amount, assuming that the slenderness parameters λ_{LT} is equal to zero.

In applying 14.4.2.2, the value of γ_m should be taken as that used for the compression flange being spliced.

14.4.4.3 Tension flanges. Tension flanges should be treated as tension members and spliced in accordance with 14.4.3.

14.4.4.4 Parts subject to shear. A splice in a web or other part subjected to shear should be designed to transmit at least the total of

(a) the shear force at the splice;

(b) the moment resulting from the eccentricity, if any, of the centroids of the groups of fasteners on each side of the splice;

(c) the proportion of moment carried by the web or part, irrespective of any shedding of stresses into adjoining parts assumed in the design of the member or part."

Clause 14.4.5 Parts in shear and bending

Delete the entire clause.

Clause 14.4.6 Parts in tension or compression and bending

Delete the entire clause.

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Clause 14.5.4 Strength of HSFG bolts acting in friction

At the end of the clause, add new note as follows:

"NOTE. The recommendations given in 14.5.4 apply only to bolts tightened in accordance with the requirement of BS 4604: Parts 1, 2 and 3".

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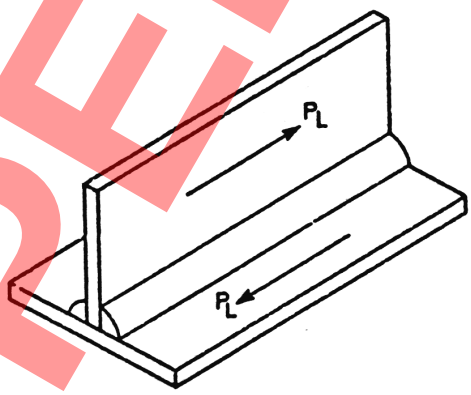
14.6.3.11.1 Simple method of assessment

Delete the existing clause and substitute a new clause as follows:

"14.6.3.11.1 Weld subject to longitudinal shear ie shear in the direction of its length (see figure 55(a))



The stress in a weld, calculated as the longitudinal shear force per unit length P_L divided by the effective throat g, shall not exceed

$$\frac{\sigma_w}{\gamma_{f3}\,\gamma_m\,\sqrt{3}}$$

Where σ_w is the yield stress of the deposited weld metal and may be taken as

$\frac{1}{2}(\sigma_y + 455)$ N/mm^2

σ_y is the smaller nominal yield stress of the two parts joined."

14.6.3.11.2 Alternative method of assessment

Delete the existing clause and substitute a new clause as follows:

"14.6.3.11.2 Weld subject to transverse force ie force at right angles to its length (see figure 55(b)

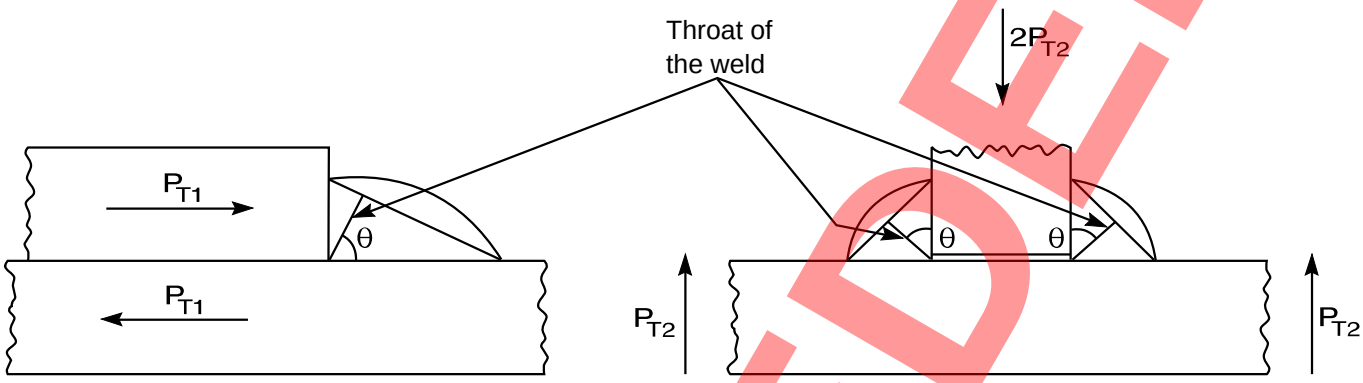


Figure 55(b) Weld subjected to transverse force

The stress in a weld, calculated as the transverse force per unit length P_{T1} (or P_{T2}) divided by the effective throat g, shall not exceed

$$\frac{K\sigma_w}{\gamma_{f3}\ \gamma_m\ \sqrt{3}}$$

Where σ_w is as defined in 14.6.3.11.1

K depends on the angle θ between the direction of the applied force and the throat and is given by

$$K = \left[\ \frac{3}{1 + 2\cos^2\theta}\ \right]^{1/2}$$ but not greater than 1.4

For equal leg fillets between components at right angles $\theta = 45°$ and K = 1.225."

New clause 14.6.3.11.3

Add the following new clause:

"14.6.3.11.3. Weld subject to forces in both transverse and longitudinal directions

The following condition should be satisfied:-

$$\frac{1}{g}\left[\ P_L^2 + \frac{P_T^2}{K^2}\ \right]^{½} \leq \frac{\sigma_w}{\gamma_{f3}\ \gamma_m\ \sqrt{3}}$$

where

P_L is the longitudinal shear force per unit length of the weld

P_T is the resultant of transverse forces per unit length of the weld (see Fig 55(c))

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g is the effective throat of the weld

$K = \left[\frac{3}{1 + 2\cos^2 \theta} \right]^{1/2}$ but not greater than 1.4

θ is the angle between the resultant transverse force and the throat

σ_w is as defined in 14.6.3.11.1"

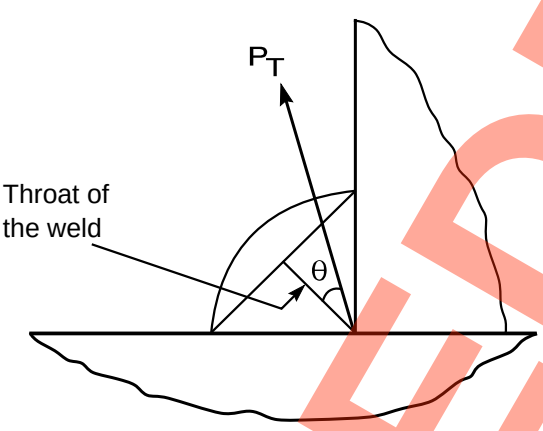

Figure 55(c) Resultant transverse force at weld

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Appendix A6. Transverse distribution of stress

In the definition for "k", delete the existing definition and substitute the following new definition:

"k = 0.25 (5ψ - 1) for portions between web centrelines, or

$= 0.25 \left[5\left(1 - 0.15 - \frac{b}{L}\right)\psi - 1\right]$ for portions projecting beyond an outer web'

Definitions for "ψ and b". Delete existing definitions and substitute the following:

"ψ, b and L are as defined in 8.2."

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Figure 58 Distortional warping stress parameters

In the left-hand ordinate of item (c), replace "0.001, 0.01, 0.1, 1.0" by "0.01, 0.1, 1.0, 10.0" respectively.

In the left-hand ordinate of item (d), replace "0.001, 0.01, 0.1, 1.0" by "0.1, 1.0, 10.0, 100.0" respectively.

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Figure 62 Coefficients for torsional buckling

In the left-hand ordinate of item (c), replace "0.5, 1.0" by "1.0, 2.0" respectively.

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Clause G8 Figures 11 to 17. Limiting shear strength τ_1

In item (a) delete " ß = $\dfrac{\lambda}{\sqrt{5 + \frac{5}{\Phi^2}}}$ " and substitute the following:

" ß = $\dfrac{\lambda}{\sqrt{5.34 + \frac{4}{\Phi^2}}}$ when $\Phi \geq 1$

" ß = $\dfrac{\lambda}{\sqrt{\frac{5.34}{\Phi^2} + 4}}$ when $\Phi < 1$

In item (e) delete the expression for " $\frac{\tau_u}{\tau_y}$ " and insert as follows:

$$\text{"}\frac{\tau_u}{\tau_y} = f\left[\frac{\tau_c}{\tau_y} + 5.264\sqrt{m_{fw}\frac{\sigma_t}{\tau}}\sin\theta + \frac{\sigma_t}{\tau_y}(\cot\theta - \Phi)\sin^2\theta\right]$$

$$\text{when } m_{fw} \leq \frac{\Phi^2}{4\sqrt{3}}\frac{\sigma_t}{\tau_y}\sin^2\theta$$

$$\frac{\tau_u}{\tau_y} = f\left[\frac{4\sqrt{3}\, m_{fw}}{\Phi} + \frac{\sigma_t \sin^2\theta}{2\tau_y} + \frac{\tau_u}{\tau_y}\right] \text{ when } m_{fw} > \frac{\Phi^2}{4\sqrt{3}}\frac{\sigma_t}{\tau_y}\sin^2\theta \text{ "}$$