THE HIGHWAYS AGENCY

BD 16/82
Amendment No.1, dated
10 December 1987

THE SCOTTISH OFFICE DEVELOPMENT DEPARTMENT

THE WELSH OFFICE
Y SWYDDFA GYMREIG

THE DEPARTMENT OF
THE ENVIRONMENT FOR NORTHERN IRELAND

Design of Composite Bridges Use of BS 5400: Part 5: 1979

Summary: This Departmental Standard covers the use of BS 5400: Part 5 for the design of composite highway bridges.

VOLUME 1	HIGHWAY STRUCTURES: APPROVAL PROCEDURES AND GENERAL DESIGN
SECTION 3	GENERAL DESIGN

BD 16/82

DESIGN OF COMPOSITE BRIDGES USE OF BS 5400: PART 5: 1979

Contents

1. INTRODUCTION

1.1 Appendix A of BD 16/82 sets out the Amendments to Part 5 of BS 5400 which are necessary to meet the Department's requirements. The purpose of this Amendment is to amend Appendix A. These further amendments are the result of a review of Part 5 (as previously implemented by the Department) by the BSI Committee CSB 59/2 as an interim revision, pending a long-term revision of Part 5.

A composite document, combining BS 5400: Part 5: 1979 (as amended by AMD 3998 dated 31 May 1982) and Appendix A of BD 16/82 (as amended by this amendment), has been produced by the Department for the convenience of users of these documents.

2. SCOPE

2.1 This Departmental Standard covers the use of BS 5400: Part 5 for the design of composite construction in bridges and other highway structure. It sets out the Department's particular requirements where these differ from or are more comprehensive than those given in the British Standard.

3. USE OF THE BRITISH STANDARD

3.1 The design of composite bridges and other composite highway structures belonging to the Department of Transport shall be carried out in accordance with BS 5400: Part 5: 1979 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 The amendments to Part 5 which are necessary to meet the Department's requirements are given in Appendix A to this Departmental Standard. The amendments are listed under the relevant clause numbers of BS 5400: Part 5.

3.3 BS 5400: Part 5, as amended by this Departmental Standard, supersedes the British Standard Code of Practice CP 117: Part 2: 1967 and those parts of the Interim Design and Workmanship Rules for Steel Box Girder Bridges that deal with composite construction. However, until BS 5400: Part 4 is implemented by the Department, the concrete components shall continue to be designed to the current Departmental requirements, ie Tech Memos BE 1/73 and BE 2/73 as appropriate.

4. ADDITIONAL DEPARTMENTAL REQUIREMENTS

4.1 The clauses in BS 5400: Part 5 that are expressed in the form of recommendations using the word 'should' are considered as mandatory; any deviation there from shall be treated in accordance with Departmental Standard BD 2/79 as a departure from Standard.

5. REFERENCES

The following documents are referred to in this Departmental Standard:

1. BS 5400 Steel, Concrete and Composite Bridges:

   Part 2: 1978: Specification for Loads
   Part 3: 1982: Code of Practice for Design of Steel Bridges, including Amendment No 1
   Part 4: 1978: Code of Practice for Design of Concrete Bridges
   Part 5: 1979: Code of Practice for Design of Composite Bridges, including Amendment No 1

2. CP 117: Part 2: 1967 Composite Construction in Structural Steel and Concrete. Part 2: Beams for Bridges.

3. 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. 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:-

Assistant Chief Engineer
Bridges Engineering Standards Division
Department of Transport
St Christopher House
Southwark Street
LONDON SE1 0TE

All enquiries concerning the distribution of the Departmental Standard should be addressed to:

Administration of Road Construction 1
Department of Transport
Room S7/23
2 Marsham Street
LONDON SW1 3EB
Telephone number: 01-212 4944

AMENDMENTS TO BS 5400: PART 5: 1979

Contents of BS 5400 part 5

4.1.4 Insert "4.1.4 Verification of structural adequacy"

6.2.2 Delete title, insert "Bending resistance of compact sections"

6.2.3 Delete title, insert "Bending resistance of non-compact sections"

6.2.4 Delete clause

Appendix A Delete Appendix

Appendix A Delete Appendix

Tables 1, 2, 3, 4, 5, 6, 8, 10, 11, 13, 13.1, 13.2, 13.3 and 14 Delete tables

Figure 1 Delete Figure 1

Foreword of BS 5400 Part 5

Para 2 Delete “Part 3*”, insert “Part 3”.
Delete “Part 9*”, insert “Part 9”.

Footnote Delete footnote (ie “*In course of preparation”).

AMD 3998 Para 4 (ie starting “Part 5 also contains ...”)
Delete para.

AMD 3998 Para 6 (ie starting “The method given in ...”)
Delete para.

Page 2 of BS 5400 Part 5

3.1.11.1 Line 1
Delete “no slip”, insert “no significant slip”.

3.2 Line 2
Delete “have been derived in accordance with appendix F of CP 110 : Part 1 : 1972 and".

Page 3 of BS 5400 Part 5

Symbol 1 Last line
Delete “of end restraints*”, insert “of end restraints”

Symbol ρ Last line
Delete “0.91 f_y“, insert “0.95 f_y“

Footnote Delete footnote (ie starting “* In Appendix A....”)

New Symbols Insert the following new symbols.

"1_w Length of wheel patch

R* Design resistance as defined in Part 1

v_1 Ultimate longitudinal shear stress of concrete v

z_{pe} Plastic section modulus of beams as defined in Part 3".

σ Stress of steel members (with appropriate subscripts) as defined in Part 3".

Page 3

4.1.3 Para 1, lines 4, 5 and 6
Delete lines, insert the following:

"in accordance with Part 1."

4.1.3 Para 3 (ie beginning "Where the relationship...")
Delete para (continues on Page 4).

Page 4

4.1.4 New Clause
Insert the following new clause:

"4.1.4 Verification of structural adequacy. For a satisfactory design the following relation should be satisfied:-

$$R^* \geq S^* \quad (1)$$

where R* is the design resistance

$$\text{ie function} \left(\frac{f_k}{\gamma_m} \right) \geq \gamma_{f3} (\text{effects of } \gamma_{fL} . Q_k) \quad (2a)$$

where f_k, γ_m, γ_{fL} and Q_k are defined in Part 1.

When the resistance function is linear, and a single value of γ_m is involved, this relation may be rearranged as:

$$\frac{1}{\gamma_{f3}} . \frac{1}{\gamma_m} \text{ function } (f_k) \geq (\text{effects of } \gamma_{fL} . Q_k) \quad (2b)$$

It should be noted that the format of equation 2a is used in Part 4 whereas the format given in equation 2b is used in Part 3. Therefore when using this Part in conjunction with either Part 3 or Part 4 care must be taken to ensure that γ_{f3} is applied correctly."

4.2.1 Para 1, lines 8-11 (inc)
Delete lines, insert the following:

"materials and limit state. It should be noted that the stress limitations given in Part 4 allow for γ_m. For shear connectors the appropriate values of γ_m are explicitly given in the expressions for design resistance in this Part. For the longitudinal shear resistance of reinforced concrete slabs over steel beams the appropriate values of γ_m for the concrete and reinforcement are already incorporated in the expressions given in this Part."

4.2.1 Table 1 Delete Table

4.3.1 Delete clause and insert the following:

"4.3.1 General. All structural steelwork in composite beams should be checked for compliance with the requirements of Part 3 in relation to both limit states. Where required by Part 3 the effects of creep, shrinkage and temperature should be calculated in accordance with the recommendations of this Part, for the relevant limit state.

The concrete and reinforcement in concrete slabs should satisfy the limit state requirements of Part 4 including the serviceability limit state stress limitations given in 4.1.1.3 of Part 4; where they are part of a composite beam section they should also satisfy the limit state requirements of this Part. The method of calculating crack widths at the serviceability limit state should follow the recommendations of this Part.

Shear connectors should be designed to meet the requirements of the serviceability limit state given in this Part and, where specified in this Part, the requirements of the ultimate limit state.

Both shear connectors and structural steelwork should satisfy the fatigue requirements of Part 10."

4.3.2 Para 1, (a)
Delete para and insert the following:

"(a) the stress or deformation in structural steel reaches the levels indicated in Part 3;"

Para 1, (b)
Insert "or" after concrete, delete "or prestressing tendons".

4.3.3 Para 1, line 1
Delete "recommendations" insert "requirements".

5.1.1.2 Line 3
Delete “maximum”, insert “greatest”.

5.2.1 Delete clause and insert the following:

"5.2.1 General. The stresses in composite sections should be determined in accordance with 5.2.2 - 5.2.5. Crack widths should be checked in accordance with 5.2.6".

5.2.2 Para 2 (new para)
Insert the following new para:

When the cross section of a beam and the applied loading increase by stages, a check for adequacy should be made for each stage of construction in accordance with 6.2.3 treating all sections as non-compact. The bending stresses should not exceed the appropriate limits given in 6.2.3 using the appropriate values of γm and γf_3 for the serviceability limit state except that the limiting tensile stress in the reinforcement should be replaced by o.75 $f_{ry}/\gamma f_3$".

5.2.3 (continues on Pages 5 and 6)
Delete clause (up to and including 5.2.3.8 and Tables 2, 3 and 4) and insert the following:

"5.2.3 Effective breadth of concrete flange.

5.2.3.1 General. In calculating the stresses in a flange, and in the absence of rigorous analysis, the effect of in-plane shear flexibility (ie shear lag) should be allowed for by assuming an effective breadth of flange in accordance with 5.2.3.2, 5.2.3.3 and Part 3.

5.2.3.2 Effective breadth of cracked flange. For a concrete flange in tension that is assumed to be cracked the mean effective breadth ratio ψ obtained from Part 3 should be modified by adding (1 - ψ)/3.

5.2.3.3 Width over which slab reinforcement is effective. Only reinforcement placed parallel to the span of the steel beam within the effective breadth of the concrete slab should be assumed to be effective in analysing cross sections."

Page 6

5.2.4.1 Para 2 and NOTE (ie starting "These effects should be.....") Delete para and NOTE, insert "Where these effects co-exist, they should be combined in accordance with 4.8 of Part 4."

5.2.4.2 Para 1, line 1, 2
Delete "Except as directed in 5.2.1 the" and insert "The".

5.2.4.3 Delete clause and Figure 1, insert the following:

"5.2.4.3 Co-existent stresses. In calculating co-existent stresses in a deck slab, which also forms the flange of a composite beam, the global longitudinal bending stress across the deck width may be calculated in accordance with appendix A.6 of Part 3".

5.2.5.1 Delete clause, insert the following:

"5.2.5.1 General. The serviceability limit state shall be checked in accordance with Part 3; in carrying out such checks consideration should be given to the effects noted in 5.2.5.2 to 5.2.5.4".

5.2.5.4 Para 1, line 5.
Delete "1 in 5.2.3", insert the following:

"where the complete span has not been concreted, the effective span".

5.2.6.2 (continues on Page 7)
Delete clause, insert the following:

"5.2.6.2 Loading. For the crack width limitations given in 5.2.6.3, load combination 1 only of Part 2 should be considered. Where type HB loading is to be taken into account, only 25 units should be considered."

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5.2.6.3 Para 1 (ie "The engineer should ... with 5.2.4.3")
Delete para, insert the following:

"The engineer should satisfy himself that cracking will not be excessive with regard to the requirements of the particular structure, its environment and the limits to the widths of cracks given in Part 4. Surface crack widths in a composite beam under the action of the loadings specified in 5.2.6.2 may be calculated by the appropriate method given in 5.8.8.2 of Part 4. In calculating the strain due to global longitudinal bending account may be taken of the beneficial effect of shear lag in regions remote from the webs in accordance with Appendix A.6 of Part 3".

5.2.6.3 Para 2 (new para)
Insert the following new para:

"Where it is expected that the concrete may be subject to abnormally high shrinkage strains (> 0.0006) consideration should be given to the increased tensile strain in the concrete slab. In the absence of a rigorous analysis, the value of longitudinal strain at the level where the crack width is being considered should be increased by adding 50% of the expected shrinkage strain."

5.2.6.4 Delete clause.

Tables 5 & 6 Delete Tables

5.3.1 Para 1, line 6. Insert the following after "unreinforced":

"in both sagging and hogging moment regions"

5.3.1 Para 1, line 10
Delete line, insert "in Part 3".

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5.3.2.4 Para (a), line 3
Delete "Not less", insert "No fewer".

Table 7 Column 2.
Deleted "Grade 43A of BS 4360: 1979", insert "Grade 43 of BS 4360" (twice).

5.3.2.5 Insert new clause as follows:

"5.3.2.5 Design resistance of shear connectors. The design resistance of shear connectors at the serviceability limit state should be taken as Pu/γ_m where Pu is the nominal static strength defined in 5.3.2.1, 5.3.2.2 or 5.3.2.3 as appropriate and $\gamma_m = 1.85$".

Page 12

5.3.3.1 Para 1, line 5
Delete ", except that:", insert ".".

5.3.3.1 Para 1, sub paras (a) and (b)
Delete sub paras ie from "(a) in negative (hogging ---" to "and the steel member".

5.3.3.4, 5.3.3.5 and 5.3.3.6. Delete clauses, insert the following:

"5.3.3.4 Design procedure: general. Shear connectors should be designed initially to satisfy the serviceability limit state in accordance with 5.3.3.5.The initial design should be checked in accordance with Part 10 for fatigue.

Shear connectors need not be checked for static strength at the ultimate limit state except when required by 5.3.3.6 or 6.1.3, or when redistribution of stresses from the tension flange has been made in accordance with Part 3.

5.3.3.5 Design procedure: spacing and design resistance. The size and spacing of the connectors at each end of each span should be not less than that required for the maximum loading considered. This size and spacing should be maintained for at least 10% of the length of each span. Elsewhere, the size and spacing of connectors may be kept constant over any length where, under the maximum loading considered, the maximum shear force per unit length does not exceed the design shear resistance/unit length by more than 10%. Over every such length the total design longitudinal shear force should not exceed the product of the number of connectors and the design static strength per connectors as defined in 5.3.2.5.

5.3.3.6 Uplift on shear connectors. Where the shear connectors are subject to significant direct tension due either to:

a) forces tending to separate the slab from a girder caused, for example, by differential bending of the girders or of the two sides of a box girder or tension-field action in a web, or

(b) transverse moments on a group of connectors resulting from transverse bending of the slab particularly in the region of diaphragms or transverse cross bracing, or from the forces generated at the corners when the slab acts as part of 'U' frame

then additional ties, suitably anchored, should be provided to resist these forces.

Where stud connectors are used and are subject to both shear Q and tension due to uplift T_u the equivalent shear Q_{max} to be used in checking the connectors for static strength and fatigue should be taken as:

$$Q_{max} = \sqrt{Q^2 + \frac{T_u^2}{3}}$$

In addition the stud connectors should be also checked at the ultimate limit state in accordance with 6.3.4 using the appropriate value of Q_{max}".

5.4.1 Delete clause, insert the following:

"5.4.1 General. Longitudinal stresses due to the effects of temperature and shrinkage modified by creep should be considered at the serviceability limit state for the beam section as required under Part 3. Serviceability checks are however essential for shear connectors. In such checks account should be taken of the longitudinal shear forces arising from these effects. Where appropriate, variations in the stiffness of a composite beam along its length, eg due to changes in the cross section of the steel member or where the concrete flange is case in stages, should be taken into account when calculating the longitudinal shear force per unit length."

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5.4.2.1 Para 2, lines 7 & 8
Delete "and assuming the concrete slab to be of effective breadth as given in table 8.", insert the following:

"No account need be taken of shear lag. Concrete should be assumed to be uncracked, except that for calculating longitudinal bending stresses due to the secondary effects in (c) above the concrete in tension may be ignored."

Table 8 Delete table

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5.5.2 Para 2, lines 3 & 4
Delete "and neglecting concrete in tension".

5.5.2 Para 2, line 7
Insert "in accordance with Part 3" after "flange".

5.5.2 Para 3
Delete para.

5.5.2 Para 4, line 9
Insert the following after "Part 4":

"or as ϕc times the short term modulus where ϕc is given in Table 9 for concrete mixes complying with Fig 5."

6.1.1 Para 1, line 2
Delete "and 6.1.4.3".

6.1.1 Para 1, line 6
Insert the following after "Part 1":

"and should only be undertaken where they can be shown to model adequately the combined effects of local and global loads due to combinations 1-5 as given in Part 2".

6.1.2 Para 1, line 8
Insert "subject to the requirements in 6.1.1" after "exists".

6.1.2 Paras 2 and 3 Delete paras, insert the following:

“The resistance to global effects should be determined in accordance with 6.2.1. For local effects the design of the slab cross-section should be in accordance with Part 4. The combined effects of global bending and local wheel loading shall be taken into account in accordance with Part 4."

6.1.3 Para 1
Delete para, insert the following:

"6.1.3 <u>Composite action</u>. Where, for a beam built in stages, the entire load is assumed to act on the final cross-section in accordance with 9.9.5 of Part 3, or where tensile stresses are redistributed from the tension flange in accordance with 9.5.5 of Part 3, the shear connectors and transverse reinforcement should be designed for the corresponding longitudinal shear in accordance with 6.3".

6.1.4.2 Delete clause, insert the following:

"6.1.4.2 <u>Redistribution of moments in principal longitudinal members</u>. If the concrete is assumed uncracked over the whole length, up to 10% of the support moments may be redistributed to the span provided that equilibrium between the internal forces and external loads is maintained under each appropriate combination of ultimate loads."

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Table 10 Delete table

6.1.4.3 Delete clause.

6.1.5 Para 1, line 2 Delete "When the steel section is slender (as defined".

6.1.5 Para 1, line 3
Delete "in 6.2.2.2), the", insert "The".

6.1.5 Para 1, line 5
Delete "need only", insert "should".

6.1.5 Para 1, line 6
Delete "except as directed in 6.2.4.1(b)", insert "where required by Part 3".

6.2 Delete clause, insert the following:

"6.2 <u>Analysis of sections</u>

6.2.1 <u>General</u>

The strength of composite sections should be assessed by using the plastic moduli of compact sections or the elastic moduli of non-compact sections as specified in Part 3 for calculating the bending resistance of beams.

When the cross section of a beam and the applied loading increase by stages, a check for adequacy should be made for each stage of construction in accordance with 6.2.2. or 6.2.3.

6.2.2 Bending resistance of compact sections

For a beam that is of compact section at the stage under consideration the bending resistance should be determined in accordance with 9.9.1.2 of Part 3 assuming that the entire load acts on the cross section of the beam appropriate to the stage under consideration.

The plastic modulus Z_{pe} should include the transformed area of the concrete in compression which should be obtained from:

$$\text{The gross area of the concrete} \times \frac{0.4 f_{cu}}{\sigma_{yc}/\gamma_m}$$

where

f_{cu} is the characteristic concrete cube strength

σ_{yc} is the nominal yield stress of the steel compression flange as defined in Part 3.

γ_m is the partial material factor for steel in accordance with Part 3.

Concrete in tension should be ignored but the transformed area of the reinforcement in concrete subject to tension should be included and should be obtained from:

$$\text{The gross area of the concrete} \times \frac{0.87 f_{ry}}{\sigma_{yc}/\gamma_m}$$

Where f_{ry} is the characteristic yield strength of the reinforcement.

6.2.3 Bending resistance of non-compact sections

For a beam that is not of compact section at the stage under consideration the stresses should be calculated at each stage of construction, using the appropriate loading and section properties based on transformed elastic section moduli. The transformed area of the concrete compression flange should be obtained using either the short term or the long term modular ratio, 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. At the appropriate extreme fibres, the sum of these stresses at any stage should not exceed:

(a) $\dfrac{\sigma_{lc}}{\gamma_m \gamma_{f3}}$ for steel compression flange

(b) $\dfrac{\sigma_{yt}}{\gamma_m \gamma_{f3}}$ for steel tension flange

(c) $\dfrac{0.5 f_{cu}}{\gamma_{f3}}$ for concrete compression flange

(d) $\dfrac{0.87 f_{ry}}{\gamma_{f3}}$ for reinforcement in tension where

σ_{lc} and σ_{yt} are as defined in 9.9.1.3 of Part 3 appropriate to the cross section at the stage under consideration

f_{cu} is the characteristic concrete cube strength

f_{ry} is the characteristic yield strength of the reinforcement

γ_{f3} is the partial safety factor in accordance with Part 3

γ_m is the partial material factor for steel in accordance with Part 3.

6.2.4 Delete clause.

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6.3.1 Para 1, line 4
Insert "and neglecting the effects of shear lag" after "state".

6.3.2 Note, lines 4, 5 & 6
Delete lines, insert the following:

"reinforcement. Where separate ultimate limit state checks are necessary for shear connectors the requirements are given in 6.3.4."

6.3.2 Note, line 7
Delete "limit state".

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6.3.3.2 Para 1, lines 3 to 10
Delete lines, insert the following;

"should not exceed the lesser of the following:

(a) $k_1 f_{cu} L_s$

(b) $v_1 L_s + 0.7 A_e f_{ry}$

where

k_1 is a constant equal to 0.15 for normal density concrete and 0.12 for lightweight aggregate concrete

v_1 is the ultimate longitudinal shear stress in the concrete for the shear plane under consideration, to be taken as 0.9 N/mm^2 for normal density concrete and 0.7N/mm^2 for lightweight aggregate concrete".

Para 2, line 1
Delete "$k_1 s L_s$ in (a)", insert "$v_1 L_s$ in (b)".

Para 2, line 2
Delete "$k_3 f_{cu} L_s$ where k_3", insert "$k_2 f_{cu} L_s$ where k_2".

Para 3, line 2
Delete "(a) above", insert "(b) above".

6.3.3.3 Para (b), lines 8 and 15
Delete "6.3.3.2 (a)", insert "6.3.3.2 (b)" (twice).

Para (b), two equations
Delete the term "k_1sL_s", insert "v_1L_s" (twice).

6.3.4 Line 3
Delete "5.3.3.4", insert "5.3.3.6".

Line 5
Delete "5.3.3.6", insert "5.3.3.5".

Para 1, line 3
Delete "and 6.2.4.1(b)(3)", insert the following:

"or where redistribution of stresses from the tension flange is carried out in accordance with Part 3".

Para 1, lines 9-13 inc.
Delete lines, insert the following:

"P_u /γ_m where
P_u is the nominal strength as defined in 5.3.2.1 or 5.3.2.2,
γ_m = 1.40".

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7.3 Para 1, line 2
Insert "for serviceability limit state calculations" after "flange".

Para 1, lines 2 & 3 and Line 7
Delete "clauses 5 or 6 as appropriate", insert "Part 3"

7.5.1 Para 3
Delete para, insert the following:

"In open-top box girders the spacing requirements for shear connectors are as given in 5.3.3.1 for composite I beams."

7.5.1 Para 1, line 4
Delete “5.3.3.4", insert “5.3.3.6".

7.5.2 Para 1, line 5
Delete “5.3.3.5 and 5.3.3.6", insert “5.3.3.4 and 5.3.3.5".

7.5.2 Between para 2 and note 2 insert the following:

"n is the total number of connectors per unit length of girder within breadth b_w, including any provided in accordance with 7.5.1 or 7.7(a)."

"n' is the number of connectors per unit length placed within 200mm of the centre line of the web considered".

7.5.2 Note 3
Delete note.

7.6 Para 1, line 5
Insert the following after "shear forces":

"In addition to its effect on the global distribution of moments and shear forces, the cracking may also need to be taken into account when assessing the torsional resistance of the particular section".

7.7 Para 3 (new para)
Insert the following new para:

"The longitudinal shear forces due to local wheel loads in the regions of a composite plate supported by cross-members may be determined by considering the plate as an equivalent simply supported beam spanning between these cross-frames; the width of the equivalent beam, b, supporting the wheel load should be taken as:

$$b = \frac{4}{3}x + 1_w$$

Where x = distance from centroid of wheel patch to the nearest cross-frame

1_w = length of wheel patch which is parallel to cross-frame."

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8.3.1 Para 2, line 9
Insert "of the beams" after "span".

8.4 Delete clause, insert the following:

"8.4 Analysis of sections. The moments of resistance of cased and filler beams should be checked in accordance with 5.2 and 6.2 at the serviceability and ultimate limit states respectively. For this purpose a beam shall be considered as compact provided any part of the steel section not encased in concrete satisfies the criteria given in part 3. Vertical shear should be assumed to be resisted by the steel section alone and the effects of shear lag in filler beam decks may be neglected at the serviceability limit state."

8.5.2 Expression
Delete the term "$k_1 s L_s$", insert "$v_1 L_s$".

Para 2, (i.e., starting “In cased beams where...”
Delete para.

8.6.3 Para 1, line 6
Delete "change in".

8.6.3 Para 1, last line
Delete "(see table 8)".

8.7.2 Para 2, lines 5 and 6
Delete "(see appendix B)", insert "(see 5.2.6)".

Para 3 (ie starting "The clear distance......")
Delete para

9.5.2 Para 1, line 9
Delete "the minimum"; insert "adequate".

9.5.2 Para 1, line 9
Insert "during the life of the bridge" after "separation".

9.5.3 Para 1, line 5
Insert the following after "Standard":

"Particular attention should be paid to the following aspects of any design:

(a) fatigue behaviour;
(b) durability;
(c) bond between permanent formwork and concrete slab both under long term and under impact loading;
(d) corrosion protection

Participating formwork should only be used with the prior approval of the appropriate Technical Approval Authority".

9.6 Title
Insert "Special requirements for" before "Precast".

Page 22

10.1 Para 1, line 6
Delete "or BS 3139: Part 1"

10.1 Para 1, line 7
Insert "in accordance with BS 4604: Part 1" after "used".

10.2.1 Para 1, line 3
Delete "flange", insert "slab".

10.2.1 Para 2, line 4
Delete "or".

10.2.1 Para 2, line 5
Delete "BS 3294, as appropriate,".

10.2.1 Para 2, line 6
Delete "this British Standards", insert "that British Standard".

10.2.2 Para 1, line 3
Insert the following new sentence after "limit state.":

"When checking for the possibility of longitudinal shear failure through the depth of the slab in accordance with 6.3.3, it should be noted that the presence of pockets for the bolts will reduce the length of the effective shear plane."

10.4 Para 1, line 3
Delete “concrete flange”, insert “concrete slab”

Para 1, line 3
Insert the following after "concrete flange":

"and that suitable washers or bearing plates are provided to spread the loads from the bolts in order to prevent the concrete underneath being crushed".

10.4 Para 1, line 11
Delete line.

10.4 Para 2, line 4
Insert the following after "concrete":

"slab, although this can be difficult to achieve while at the same time maintaining adequate cover around the bolt hole. The detail around the bolt hole needs careful attention to ensure that local crushing forces on the concrete are not increased by loads being directly transmitted via the bolt head. Care must also be taken to ensure that forces and moments can be adequately transmitted across the joints between adjacent pre-cast units, and that no gaps are left, or may occur in the course of time, between the flange and the concrete slab, where corrosion could take place. In view of these and other practical difficulties the design and method of construction should only be used with the prior approval of the appropriate Technical Approval Authority".

11.1.2.1(a) Line 3
Insert "and BS 4360" after "Part 1".

11.1.2.1(b) Line 2
Insert "complying with BS 4360" after "steel".

11.1.2.1(1) Line 2
Insert "complying with BS 4360" after "steel".

11.1.2.1(2) Line 1
Insert "BS 4360 and" after "with".

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11.1.4 Para 1, line 10
Delete "0.91", insert "0.95".

11.2.2.4 Para 1, line 3
Insert “of Part 4" after “table 11". Delete Table 11.

Para 2 (i.e, starting “where columns form part of ...”)
Delete para.

11.3.1 Para 2, line 5
Delete "$E_cI_c + E_sI_s + E_rI_r$", insert "$0.45\ E_cI_c + 0.95\ E_sI_s + 0.87\ E_rI_r$".

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11.3.7 Para 1, line 8 (cont'd from page 24)
Delete "0.91", insert "0.95".

<u>Page 27</u>

Appendix A
Delete Appendix

Pages 27 & 28

Appendix B
Delete Appendix

Page 28

C1 Para 1
Delete para, insert the following:

"C1. Coefficient K_1. Values of the coefficient K_1 used with the additional subscripts x or y to describe the plane of bending may be determined from Clause 10.6 of Part 3. The value of K_1 should be taken as the value of δ_c/δ_y determined in accordance with fig 37 of Part 3 for a value of the slenderness parameter $\frac{le}{r}\sqrt{\frac{\delta_y}{355}}$ given by 75.5 λ, where λ is defined in 11.3.1 of this Part."

C1 Table 13
Delete table

Page 29

C1 Table 13.1
Delete table.

C1 Table 13.2
Delete table.

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C1 Table 13.3
Delete table.

C1 Para 2 (ie starting "Alternatively, values of K_1 ....)
Delete para.

C1 Table 14
Delete table.

C2.1 Line 3
Delete "α_{c2}", insert "α_2^c"

C2.2 Para 1, lines 6, 7 and 8
Delete "a", "b" and "c"; insert "A", "B" and "C" respectively.

C2.2 Para 1, line 8/9
Insert new line between lines 8 and 9 as follows:

"the appropriate curve being selected in accordance with Fig 37 of Part 3".

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C.4.1(c) Line 2
Delete "tressed", insert "stressed".

C.4.2.1 Para 1, line 3
Delete "C.4.2.5", insert "C.4.2.6".

C.4.2.1 Para 1, line 4
Delete expression $\rho = \frac{0.4 f_{cu}}{0.91 f_y}$

C.4.2.1 Para 1, line 5
Delete "where".

C.4.2.1 Para 1, line 8
Delete "0.91", insert "0.95".

C.4.2.2 Para 1, lines 6 and 7
Delete "0.91", insert "0.95".

C.4.2.3 Para 1, lines 5 and 7

Delete "0.91", insert "0.95".

C.4.2.4 Para 1, line 5
Delete "0.91", insert "0.95".

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C.4.2.5 Para 1, line 6
Delete "0.91", insert "0.95".

C.4.2.5 Para 1, line 1 (second ref)
Delete "C.4.2.5", insert "C.4.2.6".

C.4.2.6 Para 1, line 4
Delete "0.91", insert "0.95".

C.4.3 Para 1, line 6
Delete "0.91", insert "0.95".

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Fig 8 Delete all references to "0.91", replace by "0.95" (11 times)

Fig 8(c) Delete "0.5 $A_r f_{ry}$", insert "0.5 $A_r(0.87f_{ry})$".