Design Manual for Roads and Bridges

Highway Structures & Bridges
Design

CD 359
Design requirements for permanent soffit formwork

(formerly BA 36/90, with IAN 131/11)

Revision 0

Summary
This document sets out design requirements for permanent soffit formwork for bridges.

Application by Overseeing Organisations
Any specific requirements for Overseeing Organisations alternative or supplementary to those given in this document are given in National Application Annexes to this document.

Feedback and Enquiries
Users of this document are encouraged to raise any enquiries and/or provide feedback on the content and usage of this document to the dedicated Highways England team. The email address for all enquiries and feedback is: Standards_Enquiries@highwaysengland.co.uk

This is a controlled document.

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Release notes

Version	Date	Details of amendments
0	Mar 2020	CD 359 replaces BA 36/90 and IAN 131/11. The full document has been rewritten to make it compliant with the new Highways England drafting rules.

Foreword

Publishing information

This document is published by Highways England.

This document supersedes BA 36/90 and IAN 131/11, which are withdrawn.

Contractual and legal considerations

This document forms part of the works specification. It does not purport to include all the necessary provisions of a contract. Users are responsible for applying all appropriate documents applicable to their contract.

Introduction

Background

This document sets out design requirements and associated implications when adopting permanent formwork for soffits of bridge decks.

Assumptions made in the preparation of the document

The assumptions made in GG 101 [Ref 9.N] apply to this document.

Mutual Recognition

Where there is a requirement in this document for compliance with any part of a British Standard or other technical specification, that requirement may be met by compliance with the Mutual Recognition clause in GG 101 [Ref 9.N].

Abbreviations

Abbreviation	Definition
CIRIA	Construction Industry Research and Information Association
GRC	Glassfibre reinforced concrete
GRP	Glass reinforced plastic
MCHW	Manual of Contract Documents for Highways Works
PSS	Profiled steel sheeting
SHW	Specification for Highway Works

Terms and definitions

Term	Definition
Permanent formwork	Structure that is used to contain the placed concrete in order to mould it into the required dimensions and support it until it is able to support itself.
Participating permanent formwork	Permanent formwork which is a structurally participating element forming an integral connection with the permanent works.
Non-participating permanent formwork	Permanent formwork which is not structurally participating in the permanent works.

1. Scope

Aspects covered

1.1 This document shall be used for the design of permanent formwork for soffits of bridge decks.

Implementation

1.2 This document shall be implemented forthwith on all schemes involving permanent soffit formwork on the Overseeing Organisations' motorway and all-purpose trunk roads according to the implementation requirements of GG 101 [Ref 9.N].

Use of GG 101

1.3 The requirements contained in GG 101 [Ref 9.N] shall be followed in respect of activities covered by this document.

2. Design requirements

General requirements

2.1 Permanent formwork and in-situ concrete required for the deck shall satisfy all requirements for strength, serviceability, fatigue, composite action and durability given in BS EN 1992-2 [Ref 5.N], BS EN 1993-2 [Ref 6.N] and BS EN 1994-2 [Ref 7.N] as relevant.

NOTE 1 *Specification requirements for permanent formwork are given in MCHW Series 1700 [Ref 3.I].*

NOTE 2 *Additional guidance on the design of permanent formwork is given in CIRIA C558 [Ref 5.I], SCI P382 [Ref 4.I], SCI P339 [Ref 1.I] and CS 030 [Ref 2.I].*

2.2 The design of precast reinforced concrete plank permanent formwork (floor plates) shall be in accordance with BS EN 15050 [Ref 10.N].

2.3 The design shall allow for actions during execution and in service.

2.4 The design shall allow for the construction sequence and the behaviour of the formwork during construction.

2.5 Deflection limits for the permanent formwork shall be determined taking into account appearance and the movement of the formwork relative to the reinforcement.

2.5.1 Deflection of the permanent formwork between completion of concreting and four hours later, with due allowance for the effect of creep, should not exceed 1/300 of the span.

2.5.2 The formwork may be pre-cambered by not more than 1/150 of the span of the formwork unit.

2.6 Reinforcement cover shall satisfy the design requirements after all deflection of the permanent formwork during concreting and setting of the concrete has occurred.

2.7 Cover requirements shall be in accordance with A.3 of BS 8500-1 [Ref 3.N] and the relevant provisions for participating and non-participating formwork below.

Participating formwork

2.8 Where participating reinforced concrete plank permanent formwork systems are used, the relevant exposure class shall be applied to the concrete plank itself for cover requirements and concrete quality.

2.8.1 For bridge deck soffits more than five metres vertically above the carriageway, the exposure class for the concrete plank should be taken as XD1 in accordance with BS 8500-1 [Ref 3.N].

2.8.2 A minimum of 20 mm cover should be provided from the upper surface of the concrete plank to the reinforcement in the in-situ concrete slab above.

Non-participating formwork

2.9 Where the permanent formwork is non-participating, any potential adverse effect of differential shrinkage or composite action shall be considered.

NOTE *Typical non-participating permanent formwork used for bridge decks include glassfibre reinforced concrete (GRC), glass reinforced plastic (GRP) and profiled steel sheeting (PSS) systems.*

2.10 When PSS permanent formwork systems containing indentations forming a potential shear connection with the in-situ concrete are used, it shall be demonstrated by calculation or testing that the detail is not likely to lead to fatigue cracks during the lifetime of the bridge.

2.11 Where non-participating permanent formwork systems are used, the relevant exposure class shall be applied to the in-situ concrete above the permanent formwork for cover requirements and concrete quality, ignoring the presence of the permanent formwork.

2.11.1 For bridge deck soffits more than five metres vertically above the carriageway, the exposure class for the in-situ concrete above the non-participating permanent formwork should be taken as XD1 in accordance with BS 8500-1 [Ref 3.N].

2.11.2 A minimum of 20 mm cover should be provided from the upper surface of the non-participating permanent formwork to the reinforcement in the in-situ concrete slab above.

2.11.3 Where ribbed glass reinforced plastic (GRP) permanent formwork systems are used and where the GRP ribs protrude into the concrete, the cover should be measured from the horizontal GRP/concrete interface, provided that at least 20 mm is also provided between the top of the rib and the nearest reinforcement.

3. Actions during execution

3.1 Participating formwork shall be designed to support actions during execution and permanent actions in accordance with BS EN 1991-1-6 [Ref 1.N] and BS EN 1991-1-1 [Ref 4.N] respectively.

NOTE *Participating formwork forms part of the permanent structural elements and is therefore subject to the same design requirements as the permanent works.*

3.2 Non-participating formwork shall be designed to support actions during execution and permanent actions in accordance with either BS EN 1991-1-6 [Ref 1.N] and BS EN 1991-1-1 [Ref 4.N] respectively, or BS 5975 [Ref 2.N] and BS EN 12812 [Ref 8.N].

NOTE *Non-participating formwork is part of the temporary works and therefore the permanent design considerations can be deemed not to comply provided the criteria for temporary works are met.*

3.3 Irrespective of the design method employed, in no case shall the factor of safety against collapse of formwork during execution, based on unfactored actions and resistances, be less than 2.0.

4. Normative references

The following documents, in whole or in part, are normative references for 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.

Ref 1.N	BSI. BS EN 1991-1-6, 'Actions on structures. General actions. Actions during execution.'
Ref 2.N	BSI. BS 5975, 'Code of practice for temporary works procedures and the permissible stress design of falsework.'
Ref 3.N	BSI. BS 8500-1, 'Concrete. Complementary British Standard to BS EN 206. Method of specifying and guidance for the specifier.'
Ref 4.N	BSI. BS EN 1991-1-1, 'Eurocode 1 - Actions on Structures - Part 1-1: General actions- Densities, self weight, imposed loads for buildings'
Ref 5.N	BSI. BS EN 1992-2, 'Eurocode 2. Design of concrete structures. Part 2: Concrete bridges. Design and detailing rules'
Ref 6.N	BSI. BS EN 1993-2, 'Eurocode 3. Design of steel structures Part 2: Steel bridges'
Ref 7.N	BSI. BS EN 1994-2, 'Eurocode 4. Design of composite steel and concrete structures. Part 2: General rules and rules for bridges'
Ref 8.N	BSI. BS EN 12812, 'Falsework. Performance requirements and general design.'
Ref 9.N	Highways England. GG 101, 'Introduction to the Design Manual for Roads and Bridges'
Ref 10.N	BSI. BS EN 15050, 'Precast concrete products. Bridge elements.'

5. Informative references

The following documents are informative references for this document and provide supporting information.

Ref 1.I	The British Constructional Steelwork Association. Iles, DC. SCI P339, 'Design Guide for Ladder Deck Bridges.'
Ref 2.I	Concrete Society. CS 030, 'Formwork - a guide to good practice.'
Ref 3.I	Highways England. MCHW Series 1700, 'Manual of Contract Documents for Highway Works, Volume 1 Specification for Highway Works - Series 1700 Structural Concrete'
Ref 4.I	The Steel Construction Institute (SCI). Steel Bridge Group. SCI P382, 'Model Project Specification for the Execution of Steelwork in Bridge Structures.'
Ref 5.I	CIRIA. R. G. Wrigley. CIRIA C558, 'Permanent formwork in construction.'