Highway Structures & Bridges
Contract preparation

CP 482 Instructions for specifiers for CC 482 Structural concrete

(formerly Series 1700)

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Latest release notes

Document Code	Version number	Date of publication of relevant change	Changes made to	Type of change
CP 482	LIVE_2025-02-19	Not available	Core document	Change to policy, major revision, new document development

This document supersedes Series NG 1700, which is withdrawn.

Previous versions

Document Code	Version number	Date of publication of relevant change	Changes made to	Type of change

Foreword

This document provides specifier instructions for the production of the works specific requirements for CC 482 Structural concrete.

This document does not form part of the works specification.

The works specification is made up of both the Specification for Highway Works and the works specific requirements completed by the Specifier.

This document is applicable for contracts throughout the UK, complemented by the additional specification requirements and contractual changes of each Overseeing Organisation.

Users are responsible for applying all appropriate documents applicable to their contract.

Users are responsible for archiving contract documentation in accordance with the user's quality management system.

1. General requirements for structural concrete

Scope of this document for structural concrete

1.1 This document shall apply to structural concrete for highway structures that is mixed on site, ready-mixed or precast in a place other than its final location of use, but not to sprayed concrete which is not covered by this document.

1.2 Concrete for ancillary purposes shall comply with "Concrete for Ancillary Purposes" in Section 2 of CC 495 [Ref 55.N].

1.3 Foamed concrete shall comply with "Foamed Concrete for Structures" in Section 4 of CC 495 [Ref 55.N].

General requirements for structural concrete construction

1.4 Specification, performance, production and conformity of structural concrete shall be in accordance with BS EN 206 [Ref 21.N], BS 8500-1 [Ref 23.N]and BS 8500-2 [Ref 24.N]as amended and complemented by this document.

1.5 Structural concrete for highway structures shall be executed in accordance with BS EN 13670 [Ref 38.N]as amended and complemented by this document.

1.6 Structural concrete construction shall be as specified in CC 482/WSR/001.

Structural concrete construction

Structure ID	Structural element reference	Description of structural element	Intended working life	Drawing/ model reference(s)	Design documentation reference(s)
(a)	(b)	(c)	(d)	(e)	(f)

1. Enter a unique reference.
2. Enter a unique reference, to identify the structural element reference.
3. Enter text, to describe the structural element and/or its part.
4. Enter a number in units of , to define the intended working life of the structural element and /or its part, with the term

'intended working life' treated as being synonymous with 'design working life', 'design service life' and 'design life'.

5. Enter a unique reference, to provide reference of drawing(s) or model(s) where the structural element and/or its part, including the specified geometrical dimensions, is shown.

6. Enter a unique reference, to provide reference(s) of the design documentation for the structural element and/or its part.

Requirements for Contractor design of permanent works for structural concrete

1.7 Contractor design items of the permanent works for structural concrete shall be as stated in CC 482/WSR/001.

Contractor design items of the permanent works for structural concrete

Structure ID	Contractor design structural element reference	Description of Contractor design structural element	Drawing/ model reference(s)	Scheme specific requirements and constraints on the Contractor design of permanent works of structural concrete (where applicable)
(a)	(b)	(c)	(d)	(e)

1. Enter a unique reference.

2. Enter a unique reference, to identify the reference of the structural element that is to be a Contractor design item of the permanent works.

3. Enter text, to describe the structural element and/or its part that is to be a Contractor design item of the permanent works.

4. Enter a unique reference, to provide reference of drawing(s) or model(s) where the structural element and/or its part that is to be a Contractor design item of the permanent works is shown.

5. Enter text, to define any scheme specific requirement or constraint on the permanent works for structural concrete subject to Contractor design.

1.8 The design of items of the permanent works for structural concrete that are to be Contractor design items shall be in accordance with CC 482/WSR/001.

1.9 The requirements for "Technical approval of highway structures" in Section 18 of GC 101 [Ref 44.N] shall apply to Contractor design items of the permanent works for structural concrete.

1.10 The requirements for "Contractor design" in Section 17 of GC 101 [Ref 44.N] shall apply to Contractor design items of the permanent works for structural concrete.

1.11 The design of items of the permanent works for structural concrete that are to be Contractor design items shall be in accordance with CD 350 [Ref 120.N], CD 351 [Ref 119.N] CD 353 [Ref 27.N], CD 354 [Ref 30.N], CD 356 [Ref 29.N], CD 357 [Ref 8.N], CD 358 [Ref 125.N], CD 359 [Ref 32.N], CD 360 [Ref 124.N], CD 363 [Ref 33.N], CD 364 [Ref 43.N] CD 365 [Ref 61.N], CD 366 [Ref 26.N] CD 367 [Ref 122.N], CD 369 [Ref 103.N], CD 370 [Ref 13.N] CD 371 [Ref 102.N], CD 372 [Ref 31.N], CD 373 [Ref 51.N], CD 374 [Ref 121.N], CD 377 [Ref 79.N], CS 464 [Ref 57.N].

Requirements for design of temporary works for structural concrete

1.12 Design of temporary works for structural concrete shall be as specified in CC 482/WSR/001.

Design of temporary works for structural concrete

Structure ID	Structural element reference	Description of structural element	Drawing/ model reference(s)	Site specific constraints to temporary works for structural concrete (where applicable)
(a)	(b)	(c)	(d)	(e)

1. Enter a unique reference.

2. Enter a unique reference, to identify the reference of the structural element of the permanent works that is subject to temporary works.

3. Enter text, to describe the structural element and/or its part of the permanent works that is subject to temporary works.

4. Enter a unique reference, to provide reference of drawing(s) or model(s) showing the structural element and/or its part of the permanent works subject to temporary works.

5. Enter text, to identify any site specific constraints to temporary works for structural concrete for the structural element and/or its part of the permanent works subject to temporary works.

1.13 Design of temporary works for structural concrete shall comply with "Temporary works" in Section 19 of GC 101 [Ref 44.N].

1.14 The design of falsework and formwork for temporary works shall be in accordance with BS EN 13670 [Ref 38.N]and:.

1. BS 5975 [Ref 18.N] for permissible stress design

2. BS EN 12812 [Ref 39.N]for limit state design

1.15 The design of temporary restraints to provide stability and prevent movement of precast concrete bridge deck elements installed in position within composite precast/in-situ concrete construction before and during the placing of in-situ concrete shall be in accordance with BS 5975 [Ref 18.N].

2. Execution management of structural concrete

General requirements for structural concrete execution management

2.1 Execution management of structural concrete shall be undertaken in accordance with Section 4 of BS EN 13670 [Ref 38.N]as amended and complemented by this document.

2.2 The Execution Class for the management of work quality for structural concrete shall be Class 3 in accordance with Section 4 of BS EN 13670 [Ref 38.N].

Inspection of materials and products for structural concrete

2.3 Verification shall be undertaken for the materials and products for structural concrete by inspection in accordance with Table 1 of BS EN 13670 [Ref 38.N]as amended and complemented by this document.

2.4 The frequency of the inspection of materials and products for structural concrete shall be in accordance with this document and with Table 1 of BS EN 13670 [Ref 38.N]for Execution Class 3.

2.5 The requirements for "Verification" in Section 14 of GC 101 [Ref 44.N] shall apply to inspection of material and products for structural concrete in accordance with Table 1 of BS EN 13670 [Ref 38.N] as amended and complemented by this document.

2.6 The following Documentation shall be submitted for the execution management of materials and products for structural concrete in accordance with the Documentation timescales required in this document for the inspection of materials and products: inspection records for materials and products for structural concrete.

2.7 The requirements for Documentation in Section 2 of GC 101 [Ref 44.N] shall apply to inspection records for materials and products for structural concrete.

Inspection of execution for structural concrete

2.8 Verification shall be undertaken for the execution of structural concrete works by inspection in accordance with Tables 2 and 3 of BS EN 13670 [Ref 38.N]as amended and complemented by this document.

2.9 The frequency of the inspection of execution of structural concrete works shall be in accordance with this document and with Tables 2 and 3 of BS EN 13670 [Ref 38.N]for Execution Class 3.

2.10 The requirements for "Verification" in Section 14 of GC 101 [Ref 44.N] shall apply to inspection of execution of structural concrete works in accordance with Tables 2 and 3 of BS EN 13670 [Ref 38.N]as amended and complemented by this document.

2.11 The following Documentation shall be submitted for the execution management of execution of structural concrete works in accordance with the Documentation timescales required in this document for the inspection of execution of structural concrete works: inspection records for the execution of structural concrete works.

2.12 The requirements for Documentation in Section 2 of GC 101 [Ref 44.N] shall apply to inspection records for the execution of structural concrete works.

2.13 The need for an independent third party inspection of the execution of structural concrete works by an organisation different from that which executed the works shall be as stated in CC 482/WSR/002.

2.14 Where an independent third party inspection of the execution of structural concrete works by an organisation different from that which executed the works is specified in CC 482/WSR/002, the independent third party inspection shall be performed following the specification requirements detailed in the documentation referenced in CC 482/WSR/002.

2.15 Requirements for independent third party inspection of the execution of structural concrete works by an organisation different from that which executed the works shall be as specified in CC 482/WSR/002.

Requirements for independent third party inspection of the execution of structural concrete works by an organisation different from that which executed the works

Structure ID	**Structural element reference**	**Description of structural element**	**Drawing/ model reference(s)**	**Design documentation reference(s)**	**Independent third party inspection of the execution required**	**Reason for independent third party inspection of the execution**	**Independent third party inspection of the execution documentation reference(s)**
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)

1. Enter a unique reference.

2. Enter a unique reference, to identify the structural element reference.

3. Enter text, to describe the structural element and/or its part subject to an independent third party inspection of the execution of structural concrete works.

4. Enter a unique reference, to provide reference of drawing(s) or model(s) where the structural element/and or its part subject to an independent third party inspection of the execution of structural concrete works is shown.

5. Enter a unique reference, to provide reference(s) of the design documentation for the structural element and/or its part subject to an independent third party inspection of the execution of structural concrete works.

6. Enter a value, from options yes, no, to identify whether an independent third part inspection of the execution of structural concrete works is required for the structural element and/or its part.

7. Enter text, to identify the reason for the need of an independent third party inspection of the execution of structural concrete works for the structural element and/or its part.

8. Enter a unique reference, to provide reference(s) of the documentation containing the detailed specification requirements for the independent third party inspection of the execution of concrete works for the structural element and/or its part.

2.16 The following Documentation shall be submitted for the execution management of the execution of structural concrete works via independent third party inspection within 2 weeks of completion of the independent third party inspection: inspection records for the independent third party inspection of the execution of structural concrete works.

2.17 The requirements for Documentation in Section 2 of GC 101 [Ref 44.N] shall apply to inspection records for the independent third party inspection of the execution of structural concrete works.

Special testing requirements for the inspection of execution for structural concrete

2.18 The need for special testing for the inspection of execution of structural concrete works shall be as stated in CC 482/WSR/002.

2.19 Verification shall be undertaken for the execution of structural concrete works, where specified in CC 482/WSR/002, by inspection with special testing in accordance with the special testing requirements specified in CC 482/WSR/002.

2.20 The frequency of special testing for the inspection of execution of structural concrete works shall be as defined in CC 482/WSR/002.

2.21 The requirements for "Verification" in Section 14 of GC 101 [Ref 44.N] shall apply to the inspection of the execution of structural concrete works by special testing.

2.22 Where special testing for the inspection of execution of structural concrete works is specified in CC 482/WSR/002, special testing shall be performed following the specification requirements detailed in the documentation referenced in CC 482/WSR/002.

2.23 Special testing requirements for the inspection of execution of structural concrete works shall be as specified in CC 482/WSR/002.

Special testing requirements for the inspection of execution of structural concrete works

Structure ID	**Structural element reference**	**Description of structural element**	**Drawing/ model reference(s)**	**Reason for special testing for the inspection of execution**	**Non-destructive testing required**	**Requirements for non-destructive testing including frequency (where applicable)**
(a)	(b)	(c)	(d)	(e)	(f)	(g)

1. Enter a unique reference.

2. Enter a unique reference, to identify the structural element reference.

3. Enter text, to describe the structural element and/or its part subject to special testing requirements for the inspection of execution of structural concrete works.

4. Enter a unique reference, to provide reference of drawing(s) or model(s) where the structural element and/or its part subject to special testing requirements for the inspection of execution of structural concrete works is shown.

5. Enter text, to identify the reason for the need of special testing for the inspection of execution of structural concrete works for the structural concrete element and/or its part.

6. Enter a value, from options yes, no, to identify whether non-destructive testing is required for the structural element and/or its part.

7. Enter text, to identify the requirements for non-destructive testing for the structural element and/or its part, such as the type, extent and frequency of non-destructive testing.

Special testing requirements for the inspection of execution of structural concrete works (continued)

Structure ID	Destructive testing required	Requirements for destructive testing including frequency (where applicable)	Dimensional accuracy testing required	Requirements for dimensional accuracy testing including frequency (where applicable)	Load testing required	Requirements for load testing including frequency (where applicable)
(a)	(h)	(i)	(j)	(k)	(l)	(m)

1. Enter a value, from options yes, no, to identify whether destructive testing is required for the structural element and/or its part.

2. Enter text, to identify the requirements for destructive testing for the structural element and/or its part, such as the type, extent and frequency of destructive testing.

3. Enter a value, from options yes, no, to identify whether dimensional accuracy testing is required for the structural element and/or its part.

4. Enter text, to identify the requirements for dimensional accuracy testing for the structural element and/or its part, such as the type, extent and frequency of dimensional accuracy testing.

5. Enter a value, from options yes, no, to identify whether load testing is required for the structure and/or the structural element and/or its part.

6. Enter text, to identify the requirements for load testing, such as the type, extent (i.e. entire structure, specific structural element and/or its part) and frequency of load testing.

Special testing requirements for the inspection of execution of structural concrete works (continued)

Structure ID	Special testing specification documentation reference(s)
(a)	(n)

1. Enter a unique reference, to provide reference(s) of the documentation containing the detailed specification requirements for any special testing required.

2.24 The following Documentation shall be submitted for the execution management of the execution of structural concrete works via special testing within 2 weeks of completion of the testing: inspection records of special testing for the inspection of execution of structural concrete works.

2.25 The requirements for Documentation in Section 2 of GC 101 [Ref 44.N] shall apply to inspection records of special testing for the inspection of execution of structural concrete works.

3. Falsework and formwork for structural concrete

General requirements for falsework and formwork for structural concrete

3.1 Falsework and formwork for structural concrete shall be compliant with BS 5975 [Ref 18.N]and Section 5 of BS EN 13670 [Ref 38.N]as amended and complemented by this document.

3.2 The following Documentation shall be submitted for falsework and formwork for structural concrete prior to the commencement of the installation of falsework and formwork: method statements in accordance with 5.3 and 5.4 of BS EN 13670 [Ref 38.N].

3.3 The requirements for "Documentation" in Section 2 of GC 101 [Ref 44.N] shall apply to method statements for falsework and formwork for structural concrete in accordance with 5.3 and 5.4 of BS EN 13670 [Ref 38.N].

Product requirements for falsework and formwork for structural concrete

Product requirements for formwork for structural concrete with formed surface finish

3.4 Constituent materials and components for formwork for structural concrete to be used when a formed surface finish is specified in CC 482/WSR/006 shall be selected to produce uniformity of colour and of concrete surface finish in the resulting concrete surface finish.

Product requirements for permanent soffit formwork for structural concrete

3.5 Permanent soffit formwork for structural concrete shall be as specified in CC 482/WSR/003.

Permanent soffit formwork for structural concrete

Structure ID	Permanent soffit formwork reference	Type of permanent soffit formwork	Structural element supporting permanent soffit formwork reference(s)	Description of structural element(s) supporting permanent soffit formwork	Structural element to be supported by permanent soffit formwork reference	Description of structural element to be supported by permanent soffit formwork
(a)	(b)	(c)	(d)	(e)	(f)	(g)

1. Enter a unique reference.

2. Enter a unique reference, to identify the permanent soffit formwork reference.

3. Enter text, to identify the type of permanent soffit formwork, such as precast reinforced concrete plank (floor plates); profiled steel sheeting (PSS); glassfibre reinforced concrete (GRC); glass reinforced polymer (GRP); or other.

4. Enter a unique reference, to identify the reference of the structural element(s) supporting the permanent soffit formwork.

5. Enter text, to describe the structural element(s) and/or its/their part(s) supporting the permanent soffit formwork.

6. Enter a unique reference, to identify the reference of the structural element and/or its part to be supported by the permanent soffit formwork.

7. Enter text, to describe the structural element and/or its part to be supported by the permanent soffit formwork.

Permanent soffit formwork for structural concrete (continued)

Structure ID	Drawing/ model reference(s)	Design documentation reference(s) (where applicable)	Permanent soffit formwork mechanical strength and any other specific performance requirements (where applicable)	Required method of determination of the essential characteristics for precast reinforced concrete plank permanent soffit formwork (floor plates) to BS EN 15050 [Ref 64.N] (where applicable)
(a)	(h)	(i)	(j)	(k)

1. Enter a unique reference, to provide reference of drawing(s) or model(s) for the permanent soffit formwork and the structural element(s) and/or its/their part(s) supporting and to be supported by the permanent soffit formwork, where the span, depth of concrete to be supported by the permanent soffit formwork and any specified geometrical dimensions for the permanent soffit formwork units such as length, cross sectional dimensions, straightness, angular deviation, camber, sag and lateral bow are shown.

2. Enter a unique reference, to provide reference(s) of the design documentation for the permanent soffit formwork and the structural element and/or its part to be supported by the permanent soffit formwork, where the required mechanical strength in bending, shear and axial compression, any other specific performance requirements, such as deflection limits, and any specific load conditions or load testing requirements for the permanent soffit formwork are indicated.

3. Enter text, to identify the required mechanical strength in bending, shear and axial compression, any other specific performance requirements, such as deflection limits, and any specific load conditions or load testing requirements for the permanent soffit formwork.

4. Enter a value, from options Method 2, Method 3, to identify the required method of determination of the essential characteristics when the specified permanent formwork is of precast reinforced concrete plank (floor plates) type.

3.6 Precast reinforced concrete plank permanent soffit formwork (floor plates) shall be compliant with BS EN 15050 [Ref 64.N] and BS EN 13369 [Ref 20.N].

3.7 The precast reinforced concrete plank permanent soffit formwork (floor plates) shall meet the performance characteristics as stated in table 3.7.

Table 3.7 Characteristics and performance requirements for precast reinforced concrete plank permanent soffit formwork (floor plates) for structural concrete

Characteristic	Performance requirement
Compressive strength (of concrete)	As required in CC 482/WSR/006 for the concrete specified for the precast reinforced concrete plank permanent formwork
Ultimate tensile and tensile yield strength (of steel)	As required in CC 482/WSR/004 for any steel reinforcement and in CC 482/WSR/005 for any prestressing steel specified for the precast reinforced concrete plank permanent formwork
Mechanical strength (by calculation)	- When Method 3 is specified in CC 482/WSR/003, the requirement is compliance with a 'design specification' as per Method 3 of Table ZA.1 of BS EN 15050 [Ref 64.N]. This is met by the precast reinforced concrete plank permanent formwork being manufactured in compliance with this document and with the design documentation and drawing(s)/model(s) referenced in CC 482/WSR/003 - When Method 2 is specified in CC 482/WSR/003, the requirement is compliance with the mechanical resistance as per Method 2 of Table ZA.1 of BS EN 15050 [Ref 64.N]. This is met by the precast reinforced concrete plank permanent formwork being manufactured to have the required mechanical strength in bending, shear and axial compression, and meet any other specific performance requirement, specified in CC 482/WSR/003
Durability against corrosion	Met by the precast reinforced concrete plank permanent formwork being manufactured in compliance with "Steel reinforcement for structural concrete" in Section 4 of this document, "Prestressing of structural concrete" in Section 5 of this document, "Concreting of structural concrete" in Section 6 of this document and as required in CC 482/WSR/006 for the concrete specified for the precast reinforced concrete plank permanent formwork
Durability against freeze thaw	Met by the precast reinforced concrete plank permanent formwork being manufactured in compliance with "Concreting of structural concrete" in Section 6 of this document and as required in CC 482/WSR/006 for the concrete specified for the precast reinforced concrete plank permanent formwork
Detailing	Met by the precast reinforced concrete plank permanent

formwork being manufactured with:
- Geometrical properties complying with the values in 4.3.1 of BS EN 13369 [Ref 20.N] and 4.3.1 of BS EN 15050 [Ref 64.N]
- Dimensions measured at at 28 ± 2 days after casting and checked for accuracy in accordance with 5.2 and Annex D of BS EN 13369 [Ref 20.N] and 5.2 and Annex J of BS EN 15050 [Ref 64.N], when compared with the dimensions from the design documentation and drawing(s)/model(s) referenced in CC 482/WSR/003
- Tolerances for positioning of steel reinforcement and cover to steel reinforcement complying with "Geometrical tolerances for structural concrete" in Section 8 of this document and with "Steel reinforcement for structural concrete" in Section 4 of this document
- Surface finish complying with "Concreting of structural concrete" in Section 6 of this document

3.8 The requirements of "Designated standards" in Section 10 of GC 101 [Ref 44.N] shall apply to reinforced concrete plank permanent soffit formwork (floor plates).

3.9 Glass fibre reinforced concrete (GRC) permanent soffit formwork for structural concrete in highway works shall only be permitted as flat or corrugated single skin panels and with no polystyrene formers in the corrugations.

3.10 Profiled steel sheeting (PSS) permanent soffit formwork shall not contain indentations.

3.11 Verification shall be undertaken for the suitability of permanent soffit formwork other than precast reinforced concrete plank (floor plates) by load testing, carried out as part of this contract or using previous test data, of permanent soffit formwork units of the same type, manufacturing process, product composition, layout, span length and cross section as those proposed for use in the works, and checking that all test results demonstrate that the proposed permanent soffit formwork meets the performance requirements specified directly in CC 482/WSR/003 or in the design documentation referenced in CC 482/WSR/003.

3.12 The frequency of suitability testing of permanent soffit formwork other than precast reinforced concrete plank (floor plates) shall be once, with three tests for each different type, manufacturing process, product composition, layout, span length and cross section of permanent soffit formwork unit proposed for use in the works unless otherwise stated in CC 482/WSR/003.

SI.3.12 The frequency of suitability testing of permanent soffit formwork other than precast reinforced concrete plank (floor plates) shall be [enter free text].

3.13 The requirements for "Verification" in Section 14 of GC 101 [Ref 44.N] shall apply to suitability testing of permanent soffit formwork other than precast reinforced concrete plank (floor plates).

3.14 The following Documentation shall be submitted for suitability testing of permanent soffit formwork other than precast reinforced concrete plank (floor plates) prior to the commencement of installation of permanent soffit formwork: report(s) containing load testing results confirming that the permanent soffit formwork meets the requirements of CC 482/WSR/003.

3.15 The requirements for "Documentation" in Section 2 of GC 101 [Ref 44.N] shall apply to the report(s) containing results of load testing of permanent soffit formwork other than precast reinforced concrete plank (floor plates).

3.16 Tolerances for geometrical dimensions of permanent soffit formwork other than precast reinforced concrete plank (floor plates) shall be in accordance with the manufacturer's stated permitted deviations.

3.17 Verification shall be undertaken for the geometrical dimensions of permanent soffit formwork other than precast reinforced concrete plank (floor plates) by measurement of the geometrical dimensions of the units to confirm they meet the permitted deviations when compared with the dimensions from the design documentation and drawing(s)/model(s) referenced in CC 482/WSR/003.

3.18 The frequency of measurement of the geometrical dimensions of the units of permanent soffit formwork other than precast reinforced concrete plank (floor plates) shall be every 5 production days on one element to be taken at random for each different type of unit, prior to the installation of the permanent soffit formwork in the works.

3.19 The requirements for "Verification" in Section 14 of GC 101 [Ref 44.N] shall apply to the measurement of the geometrical dimensions of permanent soffit formwork other than precast reinforced concrete plank (floor plates).

3.20 The following Documentation shall be submitted for measurement of the geometrical dimensions of permanent soffit formwork other than precast reinforced concrete plank (floor plates) prior to the commencement of the installation of permanent soffit formwork: report summarising the measurement results.

3.21 The requirements for "Documentation" in Section 2 of GC 101 [Ref 44.N] shall apply to the report summarising the measurement results.

Product requirements for sealants for permanent soffit formwork for structural concrete

3.22 Sealants to be applied at gaps between permanent soffit formwork units and at interfaces between permanent soffit formwork and other structural elements shall be compatible with the surface materials they will be in contact with.

3.23 In steel/concrete composite construction, sealants at interfaces between steelwork and permanent soffit formwork shall be compatible with the steelwork paint corrosion protection system in accordance with "Paint coatings for protection of steelwork against corrosion" in Section 3 of CC 486 [Ref 78.N].

3.24 Any sealant placed along the external interface between steelwork and the permanent soffit formwork in steel/concrete composite construction shall have a minimum durability of 20 years.

Product requirements for open-mesh permanent formwork for the formation of construction joints in structural concrete

3.25 Open-mesh permanent formwork for the formation of construction joints in structural concrete shall enable the poured concrete to develop mechanically keyed construction joints for subsequent concrete pours which provide a shear strength at the interface between concretes cast at different times no less than that corresponding to a 'rough surface' to 6.2.5 of BS EN 1992-1-1 [Ref 35.N].

3.26 Open-mesh permanent formwork for the formation of construction joints in structural concrete shall be as specified in CC 482/WSR/003.

Open-mesh permanent formwork for the formation of construction joints in structural concrete

Structure ID	Open-mesh permanent formwork reference	Type of open-mesh permanent formwork	Structural element containing the open-mesh permanent formwork reference(s)	Description of structural element(s) containing the open-mesh permanent formwork	Drawing/ model reference(s)	Design documentation reference(s)
(a)	(b)	(c)	(d)	(e)	(f)	(g)

1. Enter a unique reference.

2. Enter a unique reference, to identify the open-mesh permanent formwork reference.

3. Enter text, to identify the required type, layout and size for the open-mesh permanent formwork.

4. Enter a unique reference, to identify the reference(s) of the structural element(s) containing the open-mesh permanent formwork.

5. Enter text, to describe the structural element(s) and/or its/their part containing the open-mesh permanent formwork.

6. Enter a unique reference, to provide reference of drawing(s) or model(s) for the open-mesh permanent formwork and the structural element(s) and/or its/their part(s) containing the open-mesh permanent formwork, where the type, dimensions and layout of the open-mesh permanent formwork and the volume of concrete to be poured onto it are shown.

7. Enter a unique reference, to provide reference(s) of the design documentation for the open-mesh permanent formwork and the structural element(s) and/or its/their part(s) containing the open-mesh permanent formwork, where the required interface shear strength and any other specific requirement, such as mechanical strength and bending stiffness, and any specific load conditions or testing requirements for the open-mesh permanent formwork are indicated.

3.27 Verification shall be undertaken for the suitability of open-mesh permanent formwork for the formation of construction joints by:.

1. Performing interface shear tests on hardened concrete specimens cored from concrete pours containing interfaces incorporating the specified open-mesh permanent formwork, carried out as part of this contract or using previous test data, using concrete with a compressive strength class no higher than that of the concrete proposed for use in the structural element containing the open-mesh permanent formwork, and checking that all test results for the interface shear strength demonstrate that the proposed open-mesh permanent formwork meets the performance requirements specified in the design documentation referenced in CC 482/WSR/003; and

2. Load testing units of the specified open-mesh permanent formwork, carried out as part of this contract or using previous test data, and checking that all test results meet the requirements of the specification for any characteristic of the open-mesh permanent formwork specified in the design documentation referenced in CC 482/WSR/003

3.28 The frequency of suitability testing of open-mesh permanent formwork shall be once, with three interface shear tests and three load tests for each type, layout and size of open-mesh permanent formwork unit proposed for use in the works unless otherwise stated in CC 482/WSR/003.

SI.3.28 The frequency of suitability testing of open-mesh permanent formwork shall be [enter free text].

3.29 The requirements for "Verification" in Section 14 of GC 101 [Ref 44.N] shall apply to suitability testing of open-mesh permanent formwork.

3.30 The following Documentation shall be submitted for suitability testing of open-mesh permanent formwork prior to the commencement of installation of open-mesh permanent formwork: report(s) containing test results confirming that the open-mesh permanent formwork meets the requirements of CC 482/WSR/003.

3.31 The requirements for "Documentation" in Section 2 of GC 101 [Ref 44.N] shall apply to the report(s) containing test results for the open-mesh permanent formwork.

Product requirements for special formwork for structural concrete

3.32 Special formwork for structural concrete shall be as specified in CC 482/WSR/003.

Special formwork for structural concrete

Structure ID	Special formwork reference	Type of special formwork	Structural element supported/contained by special formwork reference	Description of structural element	Drawing/ model reference(s)	Design documentation reference(s)
(a)	(b)	(c)	(d)	(e)	(f)	(g)

1. Enter a unique reference.

2. Enter a unique reference, to identify the special formwork reference.

3. Enter text, to identify the type of special formwork, such as controlled permeability formwork (CPF); or other.

4. Enter a unique reference, to identify the reference of the structural element to be supported/contained by the special formwork.

5. Enter text, to describe the structural element and/or its part to be supported/contained by the special formwork.

6. Enter a unique reference, to provide reference of drawing(s) or model(s) for the special formwork and the structural element and/or its part to be supported/contained by the special formwork.

7. Enter a unique reference, to provide reference of the design documentation for the special formwork and the structural element and/or its part to be supported/contained by the special formwork.

Product requirements for void formers for structural concrete

3.33 Void formers for structural concrete shall be as specified in CC 482/WSR/003.

Void formers for structural concrete

Structure ID	Void former reference	Type of void former	Structural element containing void former reference	Description of structural element	Drawing/ model reference(s)	Design documentation reference(s)
(a)	(b)	(c)	(d)	(e)	(f)	(g)

1. Enter a unique reference.

2. Enter a unique reference, to identify the void former reference.

3. Enter text, to identity the type, layout and material of the void former to be used in the structural element and/or its part, such as recoverable; non-recoverable; hollow plastic; circular expanded polystyrene; or other.

4. Enter a unique reference, to identify the reference of the structural element that contains the void former.

5. Enter text, to describe the structural element and/or its part containing the void former.

6. Enter a unique reference, to provide reference of drawing(s) or model(s) for the void former(s) and the structural element and/or its part containing void formers.

7. Enter a unique reference, to provide reference of the design documentation for the void former(s) and the structural element and/or its part containing void formers.

Void formers for structural concrete (continued)

Structure ID	Specific void former requirements
(a)	(h)

1. Enter text, to describe any specific requirement for the void former to be used in the structural element and/or its part, such as requirements for waterproofing and sealing; for robustness under placing of wet concrete; or other.

Product requirements for release agents for formwork for structural concrete

3.34 Release agents for formwork for structural concrete shall enable the formwork to be removed without damaging the concrete.

3.35 Release agents for formwork for structural concrete shall not cause adverse chemical reactions with the concrete mix specified in CC 482/WSR/006.

3.36 Where the concrete surface is to be permanently exposed, release agents for formwork for structural concrete shall not cause inconsistencies to the concrete appearance nor affect the concrete surface finish specified in CC 482/WSR/006.

3.37 Release agents for formwork for structural concrete shall not adversely affect any surface protection system to be subsequently applied to the concrete surface in accordance with "Surface protection systems for structural concrete" in Section 9 of this document.

3.38 Retarding agents painted onto the formwork shall not be used as they tend to migrate into the hardening concrete under vibration.

Installation requirements for falsework and formwork for structural concrete

General requirements for the installation of falsework and formwork for structural concrete

3.39 Falsework and formwork shall be clean and undamaged prior to their use in the works.

3.40 Prior to their use in the works, permanent soffit formwork units shall be cleaned in accordance with the manufacturer's instructions to remove all traces of oil and grease that would affect the bond between the unit and the in-situ concrete.

3.41 Cracked or split formwork units shall not be installed in the works.

3.42 GRP permanent soffit formwork units that have exposed steel in the ribs shall not be installed in the works.

3.43 Cut edges of PSS permanent soffit formwork and any surface area of PSS permanent soffit formwork with damage to the protective treatment shall be treated, before incorporation into the works, in compliance with "Treatment of damage and local failures of protective systems for protection of steelwork against corrosion" in Section 14 of CC 486 [Ref 78.N].

3.44 Verification shall be undertaken for the condition of falsework and formwork prior to their use in the works by visual inspection, checking that falsework and formwork are clean and undamaged.

3.45 The frequency of visual inspection of falsework and formwork shall be once, prior to their installation in the works.

3.46 The requirements for "Verification" in Section 14 of GC 101 [Ref 44.N] shall apply to visual inspection of the condition of falsework and formwork prior to their use in the works.

3.47 The following Documentation for visual inspection of the condition of falsework and formwork shall be submitted as continuous records: report with findings and photographic evidence of visual inspection of the condition of falsework and formwork prior to their use in the works.

3.48 The requirements of "Records" in Section 3 of GC 101 [Ref 44.N] shall apply to the report with findings and photographic evidence of visual inspection of the condition of falsework and formwork prior to their use in the works.

3.49 Falsework and formwork shall be installed in a manner that prevents leakage and loss of grout/mortar during the concreting works, including preventing leakage and loss of grout/mortar from any formwork holes made to accommodate projecting reinforcement and fixing devices.

3.50 Verification shall be undertaken for the installation of falsework and formwork by visual inspection, checking that joints and interfaces of installed falsework and formwork are sealed against leakage and loss of grout/mortar and that no leakage and loss of grout/mortar has occurred after placing of fresh concrete.

3.51 The frequency of visual inspection to confirm joints and interfaces of installed falsework and formwork are sealed against leakage and loss of grout/mortar and that no loss of grout/mortar has occurred after placing of fresh concrete shall be once prior to the commencement of the concreting works and once after placing of fresh concrete, respectively.

3.52 The requirements for "Verification" in Section 14 of GC 101 [Ref 44.N] shall apply to visual inspection of the installation of falsework and formwork prior to the commencement of the concreting works and after placing of fresh concrete.

3.53 The following Documentation for visual inspection of the installation of falsework and formwork shall be submitted as continuous records: report with findings and photographic evidence of visual inspection of the installation of falsework and formwork.

3.54 The requirements of "Records" in Section 3 of GC 101 [Ref 44.N] shall apply to the report with findings and photographic evidence of visual inspection of the installation of falsework and formwork.

3.55 Protective treatment on steelwork edges and surfaces, including those of profiled steel sheeting (PSS) permanent soffit formwork, that has become damaged during the installation of falsework and formwork shall be reinstated in compliance with "Treatment of damage and local failures of protective systems for protection of steelwork against corrosion" in Section 14 of CC 486 [Ref 78.N].

3.56 Prior, during and after the installation of falsework and formwork, storage of materials which produce loads in excess of 1.5 kN/m^2 on falsework and formwork shall not be permitted.

3.57 Any release agents for formwork for structural concrete shall be applied, prior to the commencement of the concreting works, in accordance with the manufacturer's instructions.

3.58 Release agents for formwork for structural concrete shall be applied in a manner that prevents any spillage leading to contamination of the steel reinforcement and any prestressing tendons and components.

3.59 Where the concrete surface is to be permanently exposed, the same release agent for formwork for structural concrete shall be used throughout the entire corresponding formwork face to prevent unintended inconsistencies in the concrete appearance.

Installation requirements specific to formwork for structural concrete with formed surface finish

3.60 To ensure uniformity in the concrete surface finish, individual plywood sheets, sections of timber in large panels of formwork and parts of metal/plastic formwork shall not be removed and replaced with different plywood sheets, sections of timber and parts of metal/plastic formwork before the installation of formwork in the works.

3.61 Formwork joints for all classes of formed surface finish other than F1 shall form a regular pattern with continuous horizontal and vertical lines throughout the structure, unless otherwise stated in CC 482/WSR/003.

3.62 Formwork joints for all classes of formed surface finish other than F1 shall be located to coincide with the construction joints of the structural element and/or its part to be formed in accordance with "Concreting of structural concrete" in Section 6 of this document, unless otherwise stated in CC 482/WSR/003.

3.63 Requirements for formwork joints for all classes of formed surface finish other than F1 shall be as specified in CC 482/WSR/003.

Requirements for formwork joints for all classes of formed surface finish other than F1

Structure ID	Structural element	Description of structural element	Drawing/model reference(s)	Specific requirements for formwork joints
(a)	(b)	(c)	(d)	(e)

1. Enter a unique reference.

2. Enter a unique reference, to identify the structural element reference.

3. Enter text, to describe the structural element and/or its part with formed surface finish other than class F1 for which formwork joints are subject to specific requirements.

4. Enter a unique reference, to provide reference of drawing(s) or model(s) where the structural element and/or its part with formed surface finish other than class F1 for which formwork joints are subject to specific requirements is/are shown.

5. Enter text, to describe the specific requirements for formwork joints for the structure and/or the structural element and/or its part with formed surface finish other than class F1, such as the need for the formwork joints to meet specific patterns or not and to be aligned with construction joints or not.

Installation requirements specific to permanent soffit formwork for structural concrete

3.64 Permanent soffit formwork shall be installed in accordance with the manufacturer's instructions and with the design documentation and drawing(s)/model(s) referenced in CC 482/WSR/003.

3.65 Permanent soffit formwork units shall be positively restrained in position in accordance with the manufacturer's instructions and with the design documentation and drawing(s)/model(s) referenced in CC 482/WSR/003 to prevent movement from wind, concrete pours, passage from vehicles and from being accidentally dislodged from their seating during construction.

3.66 Gaps between adjacent permanent soffit formwork units shall be sealed in accordance with the permanent soffit formwork manufacturer's instructions to prevent leakage/loss of grout/mortar through the gaps.

3.67 In steel/concrete and precast/in-situ concrete composite construction where permanent soffit formwork is used, any overlapping area between the steelwork, or the precast concrete beam surface, and the permanent soffit formwork units shall be sealed with a compressible sealant in

accordance with the permanent soffit formwork manufacturer's instructions to prevent leakage/loss of grout/mortar during the concreting works.

3.68 In steel/concrete and precast/in-situ concrete composite construction where permanent soffit formwork is used, the external interface between the steelwork (or the precast concrete beam surface) and the permanent sofit formwork units shall be sealed, after completion of curing, with an adhesive sealant in accordance with the permanent soffit formwork manufacturer's instructions to prevent ingress of moisture.

3.69 When ribbed glass reinforced polymer (GRP) permanent soffit formwork is used, no expanded polystyrene or any other filler material which would prevent full contact between the deck concrete and the surface of the ribbed panels shall be placed between the GRP ribs.

Installation requirements specific to void formers for structural concrete

3.70 Once positioned, void formers shall be positively restrained so that they do not move from position or float during the concreting works.

3.71 Joints between adjacent void formers and between void formers and the formwork faces shall be sealed to prevent leakage/loss of grout/mortar.

3.72 The nominal cover to any additional reinforcement required for the restraint or support of void formers shall be as stated in CC 482/WSR/006.

3.73 A 40 mm diameter PVC drainage outlet, positively fixed to the void former and grout tight in its joint with the void former and with any soffit formwork, shall be installed at each end of the void former and at any low point along the void length to prevent accumulation of water inside the void.

Installation requirements specific to formwork at continuity joints in bridge decks

3.74 The requirements for the formation of continuity joints in bridge decks shall comply with "Concreting of structural concrete" in Section 6 of this document.

3.75 Where the in-fill strip method of construction is used for the formation of longitudinal continuity joints in bridge decks by constructing a separate new deck parallel to the one being widened followed by an in-fill strip as a second stage, the formwork for the separate new deck shall be kept independent from the existing deck to prevent the transmission of traffic vibrations from the existing deck to the new deck during construction.

3.76 Verification shall be undertaken for the compressive strength of concrete in the new parts of the deck in the formation of continuity joints in bridge decks before formwork removal to prevent too high an initial deflection prior to concrete maturing by determining, in accordance with BS EN 12390-3 [Ref 116.N]with test specimens made and cured in accordance with BS EN 12390-2 [Ref 118.N]and stored under environmental conditions representative of those of the concrete in the new parts of the deck, the compressive strength of samples taken in accordance with Annex B.3 of BS 8500-1 [Ref 23.N]and Annex B.2(4) of BS EN 206 [Ref 21.N]and tested at different ages and checking that the formwork is not removed until either the compressive strength of the samples meets the identity criteria in Annex B.7 of BS 8500-1 [Ref 23.N]in relation to the compressive strength class of the concrete in the new parts of the deck specified in CC 482/WSR/006, or until a minimum of 7 days after placing of the concrete of the new parts of the deck, whichever is later, subject to the requirements for removal of formwork for structural concrete specified in CC 482/WSR/003 also being met.

3.77 The frequency of determination of the compressive strength of the concrete in the new parts of the deck in the formation of continuity joints in bridge decks before formwork removal shall be at 7 days after concrete placing and thereafter every 24 hours until the compressive strength reaches the value corresponding to the compressive strength class specified, using two test specimens made from one sample for each age of testing taken randomly from an amount of concrete representing no more than the lesser of 4 batches or 24m^3, but with no less than one sample per day of concreting unless otherwise stated in CC 482/WSR/003.

SI.3.77 The frequency of determination of the compressive strength of the concrete in the new parts of the deck shall be [enter free text].

3.78 The requirements for "Verification" in Section 14 of GC 101 [Ref 44.N] shall apply to detemination of the compressive strength of the concrete in the new parts of the deck in the formation of continuity joints in bridge decks.

3.79 The following Documentation for the compressive strength testing of the concrete in the new parts of the deck in the formation of continuity joints before formwork removal shall be submitted as continuous records: report with concrete compressive strength test results and timeline of formwork removal.

3.80 The requirements of "Records" in Section 3 of GC 101 [Ref 44.N] shall apply to the report with concrete compressive strength test results and timeline of formwork removal.

Requirements for removal of falsework and formwork for structural concrete

3.81 Falsework and formwork for structural concrete shall be removed in a manner that does not damage the concrete.

3.82 Projecting reinforcement and fixing devices passing through holes in fomwork, and any concrete edge adjacent to them, shall not be damaged during formwork removal.

3.83 Falsework and formwork for structural concrete shall be removed at times to suit the requirements for curing of the structural element and/or its part in accordance with "Concreting of structural concrete" in Section 6 of this document.

3.84 Falsework and formwork for structural concrete shall be removed at times to prevent, for the structural element and/or its part, any restraint arising from elastic shortening, shrinkage and creep in accordance with the design documentation referenced in CC 482/WSR/003.

3.85 Falsework and formwork for structural concrete shall be removed at times to suit requirements for any deflection profile for the structural element and/or its part in accordance with the drawing(s)/model(s) referenced in CC 482/WSR/003.

3.86 The following Documentation shall be submitted for the removal of falsework and formwork for structural concrete prior to the commencement of the removal of falsework and formwork for structural concrete: method statement covering the sequence of removal of falsework and formwork, including any backpropping and re-propping.

3.87 The requirements for "Documentation" in Section 2 of GC 101 [Ref 44.N] shall apply to the method statement for removal of falsework and formwork for structural concrete.

3.88 Soffit formwork supporting concrete in bending shall not be removed until the concrete achieves a minimum compressive cube strength of 15 MPa, unless otherwise stated in CC 482/WSR/003.

3.89 Vertical formwork supporting concrete in compression shall not be removed until the concrete achieves a minimum compressive cube strength of 3 MPa, unless otherwise stated in CC 482/WSR/003.

3.90 Requirements for removal of falsework and formwork shall be as specified in CC 482/WSR/003.

Requirements for removal of falsework and formwork

Structure ID	Structural element reference	Description of structural element	Drawing/ model reference(s)	Design documentation reference(s) (where applicable)	Minimum concrete compressive cube strength before removal of formwork	Backpropping and/or re-propping required	Backping and re-propp duration follow formw remov (wher applic)
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)

1. Enter a unique reference.

2. Enter a unique reference, to identify the structural element reference.

3. Enter text, to describe the structural element and/or its part supported by falsework/formwork, including whether concrete is supported in bending or in compression.

4. Enter a unique reference, to provide reference of drawing(s) or model(s) where the structural element and/or its part supported by falsework/formwork is shown, including details of any required deflection profile and any backpropping/re-propping.

5. Enter a unique reference, to provide reference of the design documentation for the structural element and/or its part supported by falsework/formwork where any constraints on elastic shortening, shrinkage and creep and details of any backpropping/re-propping are described.

6. Enter a number in units of , to identify the minimum compressive cube strength required for the concrete in the structural element and/or its part before removal of formwork is permitted.

7. Enter a value, from options yes, no, to identify whether backpropping and/or re-propping following formwork removal is required for the structural element and/or its part.

8. Enter a number in units of , to identify the duration for backpropping and/or re-propping to be kept in place after formwork is removed for the structural element and/or its part.

3.91 Verification shall be undertaken for the compressive strength of concrete before the formwork can be removed by determining, in accordance with BS EN 12390-3 [Ref 116.N] with test specimens made and cured in accordance with BS EN 12390-2 [Ref 118.N]and stored under environmental conditions representative of those of the concrete in the structural element, the compressive strength of samples taken in accordance with Annex B.3 of BS 8500-1 [Ref 23.N] and Annex B.2(4) of BS EN 206 [Ref 21.N]and tested at different ages and checking that the formwork is not removed until the compressive strength of the samples meets the identity criteria in Annex B.7 of BS 8500-1 [Ref 23.N]in relation to the minimum compressive cube strength specified in CC 482/WSR/003.

3.92 The frequency of determination of the compressive strength of concrete before the formwork can be removed shall be every 24 hours after concrete placing and until the compressive strength reaches the minimum value specified, using four test specimens made from one sample for each age of testing taken randomly from an amount of concrete representing no more than the lesser of 4 batches or 24m^3, but with no less than one sample per day of concreting unless otherwise stated in CC 482/WSR/003.

SI.3.92 The frequency of determination of the compressive strength of concrete before the formwork can be removed shall be [enter free text].

3.93 The requirements for "Verification" in Section 14 of GC 101 [Ref 44.N] shall apply to determination of the compressive strength of concrete before the formwork can be removed.

3.94 The following Documentation shall be submitted for compressive strength testing of concrete before the formwork can be removed prior to the commencement of formwork removal: report with test results confirming achievement of the required minimum compressive strength of concrete prior to formwork removal.

3.95 Documentation for compressive strength testing of concrete before the formwork can be removed shall be submitted at least 24 hours prior to the commencement of formwork removal.

3.96 Any removable part of internal metal ties in formwork shall be extracted in accordance with the internal metal ties manufacturer's instructions without damaging the concrete.

3.97 Internal metal ties that are left in place in the formwork shall be provided with a minimum concrete cover of 50 mm.

3.98 Passing holes left from the extraction of internal metal ties and outer holes originated from internal metal ties that are left in place shall be reinstated in accordance with "Concrete repairs - general requirements" in Section 4 of CC 484 [Ref 22.N].

4. Steel reinforcement for structural concrete

General requirements for steel reinforcement for structural concrete

4.1 Steel reinforcement used in the execution of structural concrete shall be compliant with Section 6 of BS EN 13670 [Ref 38.N]as amended and complemented by this document.

4.2 Only non-galvanised, non-epoxy coated carbon steel or stainless steel shall be used as reinforcement for structural concrete.

4.3 Welding of steel reinforcement for structural concrete shall only be permitted in a factory environment for the fabrication of steel fabric reinforcement conforming to BS 4483 [Ref 95.N].

Product requirements for steel reinforcement for structural concrete

Product requirements for hot rolled and cold worked carbon steel bars for the reinforcement of structural concrete

4.4 Hot rolled and cold worked carbon steel bars for the reinforcement of structural concrete shall be compliant with BS EN 10080 [Ref 98.N] and BS 4449 [Ref 97.N]as amended and complemented by this document.

4.5 The hot rolled and cold worked carbon steel bars for the reinforcement of structural concrete shall meet the following performance characteristics: grade B500B or B500C to BS 4449 [Ref 97.N].

4.6 The requirements for "Product certification schemes" in Section 11 of GC 101 [Ref 44.N] shall apply to hot rolled and cold worked carbon steel bars for the reinforcement of structural concrete.

4.7 Product certification schemes for hot rolled and cold worked carbon steel bars for the reinforcement of structural concrete shall be operated in accordance with BS ISO 10144 [Ref 100.N] by certification bodies accredited in accordance with BS EN ISO/IEC 17021-1 [Ref 25.N]ensuring that:.

1. All steel bars are fully traceable to the cast/heat/batch number, steel bar supplier(s) and steel bar manufacturer(s)

2. The certificate of conformity with BS 4449 [Ref 97.N]and a certificate of approval issued by the certification body are provided by the steel bar supplier(s) and steel bar

manufacturer(s) for each cast/heat/batch number of steel bar produced

3. The steel bars have a physical surface marking system compliant with BS 4449 [Ref 97.N]and documented in the scheme that identifies the steel grade and ductility of the bars

4. The steel bars have a physical surface marking system compliant with BS 4449 [Ref 97.N]and documented in the scheme that identifies the provenance of the bars from the manufacturer's specific mill and the country of origin

5. Each bundle of steel bars is fully identifiable with a secure and durable label or tag attached, which identifies the product certification scheme and compliance of the bars with BS 4449 [Ref 97.N]

6. The scheme has a technical supervisory panel, with documented structure and governance, made up of relevant industry experts, highway structures owners and product users

7. The scheme documentation, including the assessment criteria, is publicly accessible and is reviewed at least bi-annually

8. The scheme has a documented list of manufacturers and suppliers that hold a current approval with the scheme

9. The scheme requires documented audit and quality control of product production, product traceability, independent product testing at UKAS accredited laboratories, processing and installation

10. The scheme documents the frequency of surveillance audits, periodic independent product testing at UKAS accredited laboratories and management of non-conformance

4.8 Bond property requirements of hot rolled and cold worked carbon steel bars for the reinforcement of structural concrete shall be met by compliance with the surface geometry requirements of BS 4449 [Ref 97.N], without the need for bond tests.

4.9 Hot rolled and cold worked carbon steel bars for the reinforcement of structural concrete shall be cut and bent in accordance with BS 8666 [Ref 80.N].

4.10 Hot rolled and cold worked carbon steel bars for the reinforcement of structural concrete shall be as specified in CC 482/WSR/004.

Hot rolled and cold worked carbon steel bars for the reinforcement of structural concrete

Structure ID	Structural element reference	Description of structural element	Drawing/ model reference(s)	Notation of steel reinforcement for hot rolled and cold worked carbon steel bars	Reinforcement bending schedule reference(s)
(a)	(b)	(c)	(d)	(e)	(f)

1. Enter a unique reference.

2. Enter a unique reference, to identify the structural element reference.

3. Enter text, to describe the structural element and/or its part that incorporates hot rolled or cold worked carbon steel bars.

4. Enter a unique reference, to provide reference of drawing(s) or model(s) where the structural element and/or its part incorporating hot rolled or cold worked carbon steel bars is shown.

5. Enter a value, from options B, C, to identify the notation of steel reinforcement to BS 8666 [Ref 80.N]for hot rolled and cold worked carbon steel bars in the structural element and/or its part.

6. Enter a unique reference, to provide reference(s) of the reinforcement bending schedule for hot rolled and cold worked carbon steel bars in the structural element and/or its part.

4.11 The following Documentation shall be submitted for hot rolled and cold worked carbon steel bars for the reinforcement of structural concrete prior to the commencement of the works: certification that hot rolled and cold worked steel bars are supplied by organisations holding a current certificate of approval for the steel bars that confirms compliance with the specific requirements of the product certification scheme for hot rolled and cold formed carbon steel bars; certificate of approval issued by the certification body and certificate of conformity with BS 4449 [Ref 97.N]for each cast/heat/batch number of steel bar produced.

4.12 The requirements for "Documentation" in Section 2 of GC 101 [Ref 44.N] shall apply to : certification that hot rolled and cold worked carbon steel bars are supplied by organisations holding a current certificate of approval for the steel bars that confirms compliance with the specific requirements of the product certification scheme; certificate of approval

issued by the certification body and certificate of conformity with BS 4449 [Ref 97.N]for each cast/heat/batch number of steel bar produced.

Product requirements for steel wires for the reinforcement of structural concrete

4.13 Steel wires for the reinforcement of structural concrete shall be compliant with BS EN 10080 [Ref 98.N]and BS 4482 [Ref 99.N]as amended and complemented by this document.

4.14 The steel wires for the reinforcement of structural concrete shall meet the following performance characteristics: ribbed; grade 500 to BS 4482 [Ref 99.N]; minimum nominal diameter of 8 mm.

4.15 The requirements for "Product certification schemes" in Section 11 of GC 101 [Ref 44.N] shall apply to steel wires for the reinforcement of structural concrete.

4.16 Product certification schemes for steel wires for the reinforcement of structural concrete shall be operated in accordance with BS ISO 10144 [Ref 100.N] by certification bodies accredited in accordance with BS EN ISO/IEC 17021-1 [Ref 25.N]ensuring that:.

1. All steel wires are fully traceable to the cast/heat/batch number, steel wire supplier(s) and steel wire manufacturer(s)

2. The certificate of conformity with BS 4482 [Ref 99.N]and a certificate of approval issued by the certification body are provided by the steel wire supplier(s) and steel wire manufacturer(s) for each cast/heat/batch number of steel wire produced

3. The steel wires have a physical surface marking system compliant with BS 4482 [Ref 99.N]and documented in the scheme that identifies the steel grade and ductility of the wires

4. The steel wires have a physical surface marking system compliant with BS 4482 [Ref 99.N]and documented in the scheme that identifies the provenance of the wires from the manufacturer's specific mill and country of origin

5. Each coil of wires or bundle of straight wires is fully identifiable with attached a secure and durable label or tag that identifies the product certification scheme and compliance of the wires with BS 4482 [Ref 99.N]

6. The scheme has a technical supervisory panel, with documented structure and governance, made up of relevant industry experts, highway structures owners and product users

7. The scheme documentation, including the assessment criteria, is publicly accessible and is reviewed at least bi-annually

8. The scheme has a documented list of manufacturers and suppliers that hold a current approval with the scheme

9. The scheme requires documented audit and quality control of product production, product traceability, independent product testing at UKAS accredited laboratories and installation, processing and installation

10. The scheme documents the frequency of surveillance audits, periodic independent product testing at UKAS accredited laboratories and management of non-conformance

4.17 Bond property requirements of steel wires for the reinforcement of structural concrete shall be met by compliance with the surface geometry requirements of BS 4482 [Ref 99.N], without the need for bond tests.

4.18 Steel wires for the reinforcement of structural concrete shall be as specified in CC 482/WSR/004.

Steel wires for the reinforcement of structural concrete

Structure ID	**Structural element reference**	**Description of structural element**	**Drawing/ model reference(s)**	**Notation of steel reinforcement for steel wires**	**Reinforcement bending schedule reference(s)**
(a)	(b)	(c)	(d)	(e)	(f)

1. Enter a unique reference.

2. Enter a unique reference, to identify the structural element reference.

3. Enter text, to describe the structural element and/or its part that incorporates steel wires.

4. Enter a unique reference, to provide reference of drawing(s) or model(s) where the structural element and/or its part incorporating steel wires is shown.

5. Enter a value, from options X, to identify the notation of steel reinforcement to BS 8666 [Ref 80.N]for steel wires in the structural element and/or its part.

6. Enter a unique reference, to provide reference(s) of the reinforcement bending schedule for steel wires in the structural element and/or its part.

4.19 The following Documentation shall be submitted for steel wires for the reinforcement of structural concrete prior to the commencement of the works: certification that steel wires are supplied by organisations holding a current certificate of approval for the steel wires that confirms compliance with the specific requirements of the product certification scheme for steel wires; certification of approval issued by the certification body and certificate of conformity with BS 4482 [Ref 99.N]for each cast/heat/batch of steel wire produced.

4.20 The requirements for "Documentation" in Section 2 of GC 101 [Ref 44.N] shall apply to : certification that steel wires are supplied by organisations holding a current certificate of approval for the steel wires that confirms compliance with the specific requirements of the product certification scheme for steel wires; certificate of approval issued by the certification body and certificate of conformity with BS 4482 [Ref 99.N]for each cast/heat/batch number of steel wire produced.

Product requirements for steel fabric for the reinforcement of structural concrete

4.21 Steel fabric for the reinforcement of structural concrete shall be compliant with BS EN 10080 [Ref 98.N]and BS 4483 [Ref 95.N]as amended and complemented by this document.

4.22 The steel fabric for the reinforcement of structural concrete shall meet the following performance characteristics: grade B500A, B500B or B500C to BS 4449 [Ref 97.N]; minimum nominal diameter of 8 mm for grade B500A to BS 4449 [Ref 97.N]; minimum nominal diameter of 6 mm for grade B500B and B500C to BS 4449 [Ref 97.N].

4.23 The requirements for "Product certification schemes" in Section 11 of GC 101 [Ref 44.N] shall apply to steel fabric for the reinforcement of structural concrete.

4.24 Product certification schemes for steel fabric for the reinforcement of structural concrete shall be operated in accordance with BS ISO 10144 [Ref 100.N] by certification bodies accredited in accordance with BS EN ISO/IEC 17021-1 [Ref 25.N]ensuring that:.

1. All steel fabric is fully traceable to the cast/heat/batch number, steel fabric supplier(s) and steel fabric manufacturer(s)

2. The certificate of conformity with BS 4483 [Ref 95.N] and a certificate of approval issued by the certification body are provided by the steel fabric supplier(s) for each cast/heat/batch number of steel fabric produced

3. The steel bars or wires the fabric is comprised of have a physical surface marking system compliant with BS 4449 [Ref 97.N]or BS

4482 [Ref 99.N] and documented in the scheme that identifies the steel grade and ductility of the bars or wires

4. The steel bars or wires the fabric is comprised of have a physical surface marking system compliant with BS 4483 [Ref 95.N]and documented in the scheme that identifies the provenance of the steel reinforcement from the manufacturer's specific mill and country of origin

5. Each steel fabric bundle is fully identifiable with a secure and durable label or tag attached, which identifies the product certification scheme and compliance of the fabric with BS 4483 [Ref 95.N]

6. The scheme has a technical supervisory panel, with documented structure and governance, made up of relevant industry experts, highway structures owners and product users

7. The scheme documentation, including the assessment criteria, is publicly available and is reviewed at least bi-annually

8. The scheme has a documented list of manufacturers and suppliers that hold a current approval with the scheme

9. The scheme requires documented audit and quality control of product production, product traceability, independent product testing at UKAS accredited laboratories, processing and installation

10. The scheme documents the frequency of surveillance audits, periodic independent product testing at UKAS accredited laboratories and management of non-conformance

4.25 Steel fabric for the reinforcement of structural concrete shall be cut and bent in accordance with BS 8666 [Ref 80.N].

4.26 Steel fabric for the reinforcement of structural concrete shall be as specified in CC 482/WSR/004.

Steel fabric for the reinforcement of structural concrete

Structure ID	**Structural element reference**	**Description of structural element**	**Drawing/ model references(s)**	**Notation of steel reinforcement for steel fabric**	**Reinforcement bending schedule reference(s)**
(a)	(b)	(c)	(d)	(e)	(f)

1. Enter a unique reference.

2. Enter a unique reference, to identify the structural element reference.

3. Enter text, to describe the structural element and/or its part incorporating steel fabric.

4. Enter a unique reference, to provide reference of drawing(s) or model(s) where the structural element incorporating steel fabric is shown.

5. Enter a value, from options A, B, C, to identify the notation of steel reinforcement to BS 8666 [Ref 80.N]for steel fabric in the structural element.

6. Enter a unique reference, to provide reference(s) to the reinforcement bending schedule for steel fabric in the structural element and/or its part.

4.27 The following Documentation shall be submitted for steel fabric for the reinforcement of structural concrete prior to the commencement of the works: certification steel fabric is supplied by organisations holding a current certificate of approval for steel fabric that confirms compliance with the specific requirements of the product certification scheme for steel fabric; certificate of approval issued by the certification body and certificate of conformity with BS 4483 [Ref 95.N]for each cast/heat/batch number of steel fabric produced.

4.28 The requirements for "Documentation" in Section 2 of GC 101 [Ref 44.N] shall apply to : certification that steel fabric is supplied by organisations holding a current certificate of approval for steel fabric that confirms compliance with the specific requirements of the product certification scheme for steel fabric; certificate of approval issued by the certification body and certificate of conformity with BS 4483 [Ref 95.N]for each cast/heat/batch number of steel fabric produced.

Product requirements for hot rolled and cold worked stainless steel bars for the reinforcement of structural concrete

4.29 Hot rolled and cold worked stainless steel bars for the reinforcement of structural concrete shall be compliant with BS 6744 [Ref 91.N] as amended and complemented by this document.

4.30 The hot rolled and cold worked stainless steel bars for the reinforcement of structural concrete shall meet the following performance characteristics: ribbed; grade B500B to BS 6744 [Ref 91.N].

4.31 The requirements for "Product certification schemes" in Section 11 of GC 101 [Ref 44.N] shall apply to hot rolled and cold worked stainless steel bars for the reinforcement of structural concrete.

4.32 Product certification schemes for hot rolled and cold worked stainless steel bars for the reinforcement of structural concrete shall be operated in accordance with BS ISO 10144 [Ref 100.N] by certification bodies accredited in accordance with BS EN ISO/IEC 17021-1 [Ref 25.N]ensuring that:.

1. All stainless steel bars are fully traceable to the cast/heath/batch number, steel bar supplier(s) and steel bar manufacturer(s)

2. The certificate of conformity with BS 6744 [Ref 91.N] and a certificate of approval issued by the certification body are provided by the stainless steel bar supplier(s) and the stainless steel bar manufacturer(s) for each cast/heat/batch of stainless steel bar produced

3. The stainless steel bars have a physical surface marking system compliant with BS 6744 [Ref 91.N] and documented in the scheme that identifies the provenance of the bars from the manufacturer's specific mill and the country of origin

4. Each bundle of stainless steel bars is fully identifiable with a secure and durable label or tag attached, which identifies the product certification scheme and compliance of the bars with BS 6744 [Ref 91.N]

5. The scheme has a technical supervisory panel, with documented structure and governance, made up of relevant industry experts, highway structures owners and product users

6. The scheme documentation, including the assessment criteria, is publicly available and is reviewed at least bi-annually

7. The scheme has a documented list of manufacturers and suppliers that hold a current approval with the scheme

8. The scheme requires documented audit and quality control of product production, product traceability, independent product testing at UKAS accredited laboratories, processing and installation

9. The scheme documents the frequency of surveillance audits, periodic independent product testing at UKAS accredited laboratories and management of non-conformance

4.33 Hot rolled and cold worked stainless steel bars for the reinforcement of structural concrete shall be cut and bent in accordance with BS 8666 [Ref 80.N].

4.34 Hot rolled and cold worked stainless steel bars for the reinforcement of structural concrete shall be as specified in CC 482/WSR/004.

Hot rolled and cold worked stainless steel bars for the reinforcement of structural concrete

Structure ID	Structural element reference	Description of structural element	Drawing/ model reference(s)	Reason for hot rolled or cold worked stainless steel requirement	Steel designation number for hot rolled and cold worked stainless steel bars	Notation of steel reinforcement for hot rolled and cold worked stainless steel bars	Reinforcement bending schedule reference(s)
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)

1. Enter a unique reference.

2. Enter a unique reference, to identify the structural element reference.

3. Enter text, to describe the structural element and/or its part incorporating stainless steel bars.

4. Enter a unique reference, to provide reference of drawing(s) or model(s) where the structural element and/or its part incorporating stainless steel bars is shown.

5. Enter text, to identify the reason for requiring hot rolled or cold worked stainless steel bars to be used in the structural element and/or its part.

6. Enter a number, to identify the steel designation number to BS EN 10088-1 [Ref 92.N]for hot rolled and cold worked stainless steel bars in the structural element and/or its part.

7. Enter a value, from options S, to identify the notation of steel reinforcement to BS 8666 [Ref 80.N]for hot rolled and cold worked stainless steel bars in the structural element and/or its part.

8. Enter a unique reference, to provide reference(s) of the reinforcement bending schedule for hot rolled and cold worked stainless steel bars in the structural element and/or its part.

4.35 The following Documentation shall be submitted for hot rolled and cold worked stainless steel bars for the reinforcement of structural

concrete prior to the commencement of the works: certification that hot rolled and cold worked stainless steel bars are supplied by organisations holding a current certificate of approval for the stainless steel bars that confirms compliance with the specific requirements of the product certification scheme for stainless steel bars; certificate of approval issued by the certification body and certificate of conformity with BS 6744 [Ref 91.N]for each cast/heat/batch of stainless steel bar produced.

4.36 The requirements for "Documentation" in Section 2 of GC 101 [Ref 44.N] shall apply to : certification that hot rolled and cold worked stainless steel bars are supplied by organisations holding a current certificate of approval for the stainless steel bars that confirms compliance with the specific requirements of the product certification scheme; certificate of approval issued by the certification body and certificate of conformity with BS 6744 [Ref 91.N]for each cast/heat/batch of stainless steel bar produced.

Product requirements for dowels for use in structural concrete

4.37 Dowels for use in structural concrete shall be plain round bars made of stainless steel.

4.38 Dowels for use in structural concrete shall be compliant with BS EN 10088-5 [Ref 93.N].

4.39 The dowels for use in structural concrete shall meet the performance characteristics as stated in table 4.39.

Table 4.39 Performance requirements for dowels for use in structural concrete

Characteristic	Performance requirement
Tolerances on dimensions and shape	Pass - in relation to the tolerances in 6.9 and Annex B of BS EN 10088-5 [Ref 93.N]
Elongation	As required in 6.5.1 of BS EN 10088-5 [Ref 93.N]and in BS EN 10002-1 [Ref 104.N] for plain round bars specified as dowels in accordance with CC 482/WSR/004
Tensile Strength	As required in 6.5.1 of BS EN 10088-5 [Ref 93.N]and in BS EN 10002-1 [Ref 104.N]for plain round bars specified as dowels in accordance with CC 482/WSR/004
0.2% proof strength (yield strength)	As required in 6.5.1 of BS EN 10088-5 [Ref 93.N]and in BS EN 10002-1 [Ref 104.N] for plain round bars specified as dowels in accordance with CC 482/WSR/004
Impact strength	As required in 6.5.1 of BS EN 10088-5 [Ref 93.N]and in BS EN 10045-1 1990 [Ref 17.N]for plain round bars specified as dowels in

	accordance with CC 482/WSR/004
Weldability	As required in 6.3 of BS EN 10088-5 [Ref 93.N] for plain round bars specified as dowels in accordance with CC 482/WSR/004
Durability	As required in 6.3 and 6.4 of BS EN 10088-5 [Ref 93.N] for plain round bars specified as dowels in accordance with CC 482/WSR/004
Fracture toughness/brittle strength (covered by impact strength)	As required in 6.5.1 of BS EN 10088-5 [Ref 93.N]and in BS EN 10045-1 1990 [Ref 17.N]for plain round bars specified as dowels in accordance with CC 482/WSR/004
Cold formability	As required in 6.8 of BS EN 10088-5 [Ref 93.N]and in BS EN 10002-1 [Ref 104.N]

4.40 The requirements of "Designated standards" in Section 10 of GC 101 [Ref 44.N] shall apply to dowels for use in structural concrete.

4.41 Dowels for use in structural concrete shall be as specified in CC 482/WSR/004.

Dowels for use in structural concrete

Structure ID	**Structural element reference**	**Description of structural element**	**Drawing/ model reference(s)**	**Steel designation number for stainless steel dowels**	**0.2% proof strength (yield strength) of stainless steel dowels**	**Notation of steel reinforcement for stainless steel dowels**	**Reinforcement bending schedule reference(s)**
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)

1. Enter a unique reference.

2. Enter a unique reference, to identify the structural element reference.

3. Enter text, to describe the structural element and/or its part incorporating dowels.

4. Enter a unique reference, to provide reference of drawing(s) or model(s) where the structural element and/or its part incorporating dowels is shown.

5. Enter a number, to identify the steel designation number to BS EN 10088-1 [Ref 92.N]for stainless steel dowels in the structural element and/or its part.

6. Enter a number in units of , to state the required 0.2% proof strength (yield strength) to BS EN 10088-5 [Ref 93.N]for the stainless steel dowels in the structural element and/or its part, ensuring the strength is compatible with the steel designation number specified.

7. Enter a value, from options D, to identify the notation for steel reinforcement to BS 8666 [Ref 80.N]for stainless steel dowels in the structural element and/or its part.

8. Enter a unique reference, to provide reference(s) of the reinforcement bending schedule for stainless steel dowels in the structural element and/or its part.

Product requirements for steel reinforcement couplers for use in structural concrete

4.42 Steel reinforcement couplers for use in structural concrete shall be compliant with BS 8597 [Ref 101.N]as amended and complemented by this document.

4.43 The steel reinforcement couplers for use in structural concrete shall meet the following performance characteristics: certified for high cycle elastic fatigue performance in accordance with Annex B.2 of BS 8597 [Ref 101.N].

4.44 The requirements for "Product certification schemes" in Section 11 of GC 101 [Ref 44.N] shall apply to steel reinforcement couplers for use in structural concrete.

4.45 Product certification schemes for steel reinforcement couplers for use in structural concrete shall be operated by certification bodies accredited in accordance with BS EN ISO/IEC 17021-1 [Ref 25.N]ensuring that:.

1. All couplers are fully traceable to the cast/heat/batch number of steel feedstock from which it was produced

2. The certificate of conformity with BS 8597 [Ref 101.N]and a certificate of approval issued by the certification body are provided by the coupler manufacturer(s) for each cast/heat/batch number of steel feedstock from which the coupler was produced

3. Where couplers are supplied by fabricators who have prepared the ends of steel bars for attachment of the coupler, the

certificate of conformity with BS 8597 [Ref 101.N]and a certificate of approval for the application of the coupler to the reinforcing steel issued by the certification body are provided by the coupler supplier(s) for each type of coupler supplied

4. The couplers have a physical surface marking system compliant with BS 8597 [Ref 101.N]and documented in the scheme that identifies the coupler type and the nominal bar size for which it is intended

5. The couplers have a physical surface marking system compliant with BS 8597 [Ref 101.N]and documented in the scheme that identifies the provenance of the couplers from the manufacturer's specific mill and the cast/heat/batch number of steel feedstock from which they were produced

6. Each box of couplers supplied is fully identifiable with a secure and durable label/tag system that identifies the cast/heat/batch number of steel feedstock from which the coupler(s) were produced, the product certification scheme and compliance of the coupler(s) with BS 8597 [Ref 101.N]

7. Each coupler type has the method of application to the reinforcing steel certified by the certification body and subject to surveillance audit

8. The scheme has a technical supervisory panel, with documented structure and governance, made up of relevant industry experts, highway structures owners and product users

9. The scheme documentation, including the assessment criteria, is publicly available and is reviewed at least bi-annually

10. The scheme has a documented list of manufacturers and suppliers that hold a current approval with the scheme

11. The scheme requires documented audit and quality control of product production, product traceability, independent product testing at UKAS accredited laboratories, processing and installation

12. The scheme documents the frequency of surveillance audits, periodic independent product testing at UKAS accredited laboratories and management of non-conformance

4.46 Grouted steel reinforcement couplers shall not be used.

4.47 Steel reinforcement couplers for use in structural concrete shall be as specified in CC 482/WSR/004.

Steel reinforcement couplers for use in structural concrete

Structure ID	Structural element reference	Description of structural element	Drawing or model reference(s)	Type of steel reinforcement coupler	Steel reinforcement coupler material type	Steel reinforcement coupler minimum tensile strength	Stainless steel coupler steel designation number (where applicable)
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)

1. Enter a unique reference.

2. Enter a unique reference, to identify the structural element.

3. Enter text, to describe the structural element and/or its part containing steel reinforcement couplers.

4. Enter a unique reference, to provide reference of drawing(s) or model(s) where the structural concrete element and/or its part containing steel reinforcement couplers is shown.

5. Enter text, to identify the type of coupler to be used in the structural element and/or its part, such as swaged coupler; tapered threaded bars and coupler; parallel thread coupler with upset bar ends; coupler fixed with studs for transmitting compressive force only; sleeve with tapered closers that align the square sawn ends of bars for transmitting compression force only; or other.

6. Enter a value, from options carbon steel, stainless steel, to identify the material type for the steel reinforcement coupler to be used in the structural element and/or its part.

7. Enter a number in units of , to state the required minimum tensile strength, to Table 2 of BS 8597 [Ref 101.N]for couplers made of carbon steel or to Table A.1 of BS 8597 [Ref 101.N]for couplers made of stainless steel, for the coupler to be used in the structural element and/or its part.

8. Enter a number, to identify the steel designation number to BS EN 10088-1 [Ref 92.N]for the stainless steel coupler to be used in the structural element and/or its part, ensuring the steel designation for the coupler is compatible with its strength in accordance with BS EN 10088-5 [Ref 93.N]and with the steel designation of the stainless steel reinforcing bars being coupled.

Steel reinforcement couplers for use in structural concrete (continued)

Structure ID	Coupler minimum fatigue class	Reinforcement bending schedule reference(s)
(a)	(i)	(j)

1. Enter a value, from options Class R1, Class R2, Class D, to identify the minimum fatigue class to Table B.2 of BS 8597 [Ref 101.N] for the steel reinforcement coupler to be used in the structural element and/or its part.

2. Enter a unique reference, to provide reference(s) of the reinforcement bending schedule for steel reinforcement couplers in the structural element and/or its part.

4.48 The following Documentation shall be submitted for steel reinforcement couplers for use in structural concrete prior to the commencement of the works: certification that steel reinforcement couplers are supplied by organisations holding a current certificate of approval for the couplers that confirms compliance with the specific requirements of the product certification scheme for couplers; certificate of approval issued by the certification body and certificate of conformity with BS 8597 [Ref 101.N] for each type of supplied coupler and for each cast/heat/batch number of steel feedstock from which the couplers were produced, including certificate of approval for the application of the coupler to the reinforcing steel where the coupler type requires reinforcement to be pre-prepared prior to coupling.

4.49 The requirements for "Documentation" in Section 2 of GC 101 [Ref 44.N] shall apply to : certification that steel reinforcement couplers are supplied by organisations holding a current certificate of approval for the couplers that confirms compliance with the specific requirements of the product certification scheme for the couplers; certificate of approval issued by the certification body and certificate of conformity with BS 8597 [Ref 101.N]for each type of supplied coupler and for each cast/heat/batch number of steel feedstock from which the couplers were produced, including certificate of approval for the application of the coupler to the reinforcing steel where the coupler type requires reinforcement to be pre-prepared prior to coupling.

Product requirements for spacers, chairs and tying wires for use in structural concrete

4.50 Spacers, chairs and tying wires for use in structural concrete shall comply with BS 7973-1 [Ref 84.N] and BS 7973-2 [Ref 83.N]as amended and complemented by this document.

4.51 Spacers which restrict the concrete flow into the cover zone to an extent that the homogeneity of the concrete in the cover zone during placing and compacting can be compromised shall not be used.

4.52 Tying wires for stainless steel reinforcement, and for carbon steel reinforcement within bridge decks and permanently exposed concrete surfaces, shall be 1.2 mm diameter stainless steel wire of tensile strength between 700MPa and 800MPa complying with BS EN 10088-5 [Ref 93.N].

4.53 Tying wires for carbon steel reinforcement in locations other than within bridge decks and permanently exposed reinforced concrete surfaces shall be either 1.2 mm diameter stainless steel wire of tensile strength between 700MPa and 800MPa complying with BS EN 10088-5 [Ref 93.N], or 1.6 mm diameter soft annealed iron wire of tensile strength between 415MPa and 515MPa complying with ASTM A853 [Ref 94.N].

Installation requirements for steel reinforcement for structural concrete

Cutting, bending and end preparation of steel reinforcement for structural concrete

4.54 Carbon steel bars, stainless steel bars, steel wires and steel fabric for the reinforcement of structural concrete in need of cutting, bending and end preparation before concreting shall only be cut, bent and end prepared by fabricators covered by a third party scheme for cutting, bending and end preparation of steel reinforcement that is in compliance with BS 8666 [Ref 80.N].

4.55 The requirements for "Product acceptance schemes" in Section 12 of GC 101 [Ref 44.N] shall apply to cutting, bending and end preparation of carbon steel bars, stainless steel bars, steel wires and steel fabric for the reinforcement of structural concrete in compliance with BS 8666 [Ref 80.N].

4.56 The following Documentation shall be submitted for cutting, bending and end preparation of carbon steel bars, stainless steel bars, steel wires and steel fabric for the reinforcement of structural concrete prior to the commencement of the works: certification that cutting, bending and end preparation of steel reinforcement is performed by fabricators holding a current certificate of approval for cutting, bending and end preparation of steel reinforcement that confirms compliance with the specific requirements of the product acceptance scheme for cutting bending and end preparation of steel reinforcement; certificate of approval issued by the acceptance body to the supplier and certificate of conformity with BS 8666 [Ref 80.N] for all the reinforcement supplied which confirms the reinforcement meets the reinforcement bending schedule requirements of the specification.

4.57 The requirements for "Documentation" in Section 2 of GC 101 [Ref 44.N] shall apply to : certification that cutting, bending and end preparation of steel reinforcement is performed by fabricators holding a current certificate of approval for cutting, bending and end preparation of steel reinforcement that confirms compliance with the specific requirements of the product acceptance scheme for cutting, bending and end preparation of steel reinforcement; certificate of approval issued by the acceptance body to the supplier and certificate of conformity with BS 8666 [Ref 80.N] for all the reinforcement supplied which confirms the reinforcement meets the reinforcement bending schedule requirements of the specification.

4.58 The minimum diameter of mandrels for bending steel reinforcement shall comply with Tables NA.6a) and NA.6b) of the NA to BS EN 1992-1-1 [Ref 123.N].

4.59 Bending of steel reinforcement shall not be undertaken at temperatures below -5°C or in excess of 100°C.

4.60 Re-bending of steel reinforcement, including straightening from bent and repeated bending, shall not be permitted as it affects the ductility and fatigue resistance of the steel reinforcement.

4.61 Reinforcement continuity strips requiring re-bending of steel reinforcement shall not be used.

4.62 When bending reinforcement projecting from concrete, the radius of the bend shall not be less than that specified in BS 8666 [Ref 80.N].

4.63 When bending reinforcement projecting from concrete, a clear distance of four times the bar diameter shall be provided between the surface of concrete and the start of any bend.

Fixing of steel reinforcement for structural concrete

4.64 Steel reinforcement shall be secured against displacement and tied together to achieve the correct positioning and cover to reinforcement in accordance with BS 7973-2 [Ref 83.N]using spacers, chairs and tying wires.

4.65 The tolerances of positioning of steel reinforcement shall comply with "Geometrical tolerances for structural concrete" in Section 8 of this document.

4.66 Positioning of steel reinforcement as 'running metres' to BS EN 13670 [Ref 38.N] shall not be permitted.

4.67 Chairs, tying wires and projecting ends of clips and tying wires for spacers shall be positioned as to not encroach within the cover zone to reinforcement.

4.68 Spacers shall be fixed to reinforcement in the orientation specified in the manufacturer's instructions..

4.69 Spacers and chairs shall remain in place when the concrete is poured.

4.70 Lapped steel reinforcement and couplers shall not encroach within the cover zone to reinforcement.

4.71 Lapped steel reinforcement shall be secured using tying wires at all bar intersections.

4.72 Verification shall be undertaken for the fixing of all of the steel reinforcement by: measuring the cover and positioning of the steel reinforcement before concreting and checking that is within the values specified in CC 482/WSR/006 and the tolerances specified in "Geometrical tolerances for structural concrete" in Section 8 of this document; visually inspecting, during concreting, the position of reinforcement and checking that it is not evidently displaced by the concreting operations.

4.73 The frequency of the measurement of cover and the visual inspection of the position of reinforcement shall be once before the concreting operations and once during the concreting operations, respectively.

4.74 The requirements for "Verification" in Section 14 of GC 101 [Ref 44.N] shall apply to the measurement of cover and visual inspection of the position of reinforcement.

4.75 The following Documentation for the cover and position of steel reinforcement shall be submitted as continuous records: written records of cover measurements before concreting and any observations from visual inspection of the position of reinforcement during concreting.

4.76 The requirements of "Records" in Section 3 of GC 101 [Ref 44.N] shall apply to the written records of cover measurements before concreting and any observations from visual inspection of the position of reinforcement during concreting.

4.77 Verification shall be undertaken for the concrete cover to steel reinforcement by cover measurement survey of reinforced concrete surfaces on a 500 mm grid over the entire exposed surface area of the concrete elements and checking that the cover is within the values specified in CC 482/WSR/006 and the tolerances specified in "Geometrical tolerances for structural concrete" in Section 8 of this document.

4.78 The frequency of the cover measurement survey of reinforced concrete surfaces shall be once, within 24 hours following the removal of formwork.

4.79 The requirements for "Verification" in Section 14 of GC 101 [Ref 44.N] shall apply to the cover measurement survey of reinforced concrete surfaces.

4.80 The following Documentation shall be submitted for the cover measurement survey of reinforced concrete surfaces within 14 days of the removal of formwork: report with cover measurement survey results.

Steel reinforcement at continuity joints in bridge decks

4.81 The steel reinforcement at continuity joints in bridge decks shall be made continuous across the joint by laps, couplers or by systems for post-installed reinforcing bar connections for structural concrete.

4.82 The exposed existing steel reinforcement within the continuity joint shall be cleaned to achieve surface preparation standard SA2 ½ to BS EN ISO 8501-1 [Ref 67.N].

4.83 When the in-fill strip method of construction is used for the formation of continuity joints in bridge decks by constructing a separate new deck parallel to the one being widened followed by an in-fill strip as a second stage, the reinforcement of the existing deck shall not extend beyond the in-fill strip to lap with new reinforcement.

4.84 The steel reinforcement within continuity joints shall be securely tied at all bar intersections by fixing of the steel reinforcement in accordance with this document to minimise differential movements which could result in defects to the fresh concrete caused by vibrations..

Product requirements for post-installed anchors and systems for post-installed reinforcing bar connections for structural concrete

4.85 Post-installed anchors and systems for post-installed reinforcing bar connections for structural concrete shall have a United Kingdom Technical Assessment (UKTA)/European Technical Assessment (ETA) suitable for their intended use and application issued against a United Kingdom Assessment Document (UKAD)/European Assessment Document (EAD) that is in accordance with CC 482/WSR/004.

4.86 Post-installed anchors and systems for post-installed reinforcing bar connections for structural concrete shall be in compliance with the requirements for "UK Technical Assessments" in Section 13 of GC 101 [Ref 44.N].

Product requirements for systems for post-installed reinforcing bar connections for structural concrete

4.87 The characteristics of the structural element and/or its part where post-installed reinforcing bar connections are to be installed shall be as specified in CC 482/WSR/004.

The characteristics of the structural element and/or its part where post-installed reinforcing bar connections are to be installed

Structure ID	**Structural element reference**	**Description of structural element**	**UKAD/ EAD reference(s)**	**Temperature range of the concrete base material in service in accordance with the UKAD/EAD**	**Maximum long-term temperature (T_{mlt} or T_{lt}) and maximum short-term temperature (T_{mst} or T_{st}) of the concrete base material in service (where applicable)**	**Compressive strength class of the concrete base material**
(a)	(b)	(c)	(d)	(e)	(f)	(g)

1. Enter a unique reference.

2. Enter a unique reference, to identify the structural element reference.

3. Enter text, to describe the structural element and/or its part where the post-installed reinforcing bar connections are to be installed.

4. Enter a unique reference, to identify which UKAD/EAD the system for post-installed reinforcing bar connections to be installed into the structural element and/or its part is to have a UKTA/ETA issued against.

5. Enter a value, from options T1, T2, T3, to identify the temperature range, in accordance with the relevant UKAD/EAD, of the concrete base material in service for the structural

element and/or its part where the post-installed reinforcing bar connections are to be installed.

6. Enter text, to identify, where the temperature range T3 is specified, the maximum long-term and the maximum short-term temperature of the concrete base material in service for the structural element and/or its part where the post-installed reinforcing bar connections are to be installed, in accordance with the relevant UKAD/EAD.

7. Enter text, to identify the compressive strength class of the concrete base material for the structural element and/or its part where the post-installed reinforcing bar connections are to be installed, selecting from the classes in Tables 12 and 13 of BS EN 206 [Ref 21.N]and Table A.3 of BS 8500-2 [Ref 24.N], with the relevant UKADs/EADs typically allowing for a C20/25 or C50/60 class.

The characteristics of the structural element and/or its part where post-installed reinforcing bar connections are to be installed (continued)

Structure ID	**Applicable exposure class**	**Chloride content class of the concrete base material**	**Limit/ constraint to the force(s) to be applied by the reinforcing bar connection(s) to avoid damage to, or instability of, the structural element and/or its part**	**Limit/ constraint to the concrete base material hole(s) diameter/length**	**Direction of installation of the post-installed reinforcing bar connections into the structural element and/or its part in accordance with the UKAD/EAD**
(a)	(h)	(i)	(j)	(k)	(l)

1. Enter text, to identify the applicable exposure class to BS 8500-1 [Ref 23.N] for the structural element and/or its part where the post-installed reinforcing bar connections are to be installed.

2. Enter text, to identify the chloride content class of the concrete base material of the structural element and/or its part where the post-installed reinforcing bar connections are to be installed, with the relevant UKADs/EADs typically allowing for a 0,20 or 0,40 class.

3. Enter text, to identify any limit/constraint to the force(s) to be applied onto the structural element via the post-installed reinforcing bar connection(s) to avoid damage to the structural element and/or its part.

4. Enter text, to identify any limit/constraint to the diameter/length of the hole(s) in the concrete base material of the structural element and/or its part where the post-installed reinforcing bar connections are to be installed.

5. Enter one or more values, from options D1, D2, D3, vertically downward, horizontal, vertically upwards, to identify the requirement, in accordance with the relevant UKAD/EAD, for the post-installed reinforcing bar connections to be installed into the structural element and/or its part at specific directions.

4.88 Systems for post-installed reinforcing bar connections shall be as specified in CC 482/WSR/004.

Systems for post-installed reinforcing bar connections

Structure ID	**Structural element reference**	**Description of structural element**	**Drawing/ model reference(s)**	**Design documentation reference(s)**	**UKAD/ EAD reference (s)**	**Safety criticality of the post-installed reinforcing bar connections**	**Design working life of t post-installe reinforc g bar connect ns**
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)

1. Enter a unique reference.

2. Enter a unique reference, to identify the structural element reference.

3. Enter text, to describe the structural element and/or its part where post-installed reinforcing bar connections are to be installed.

4. Enter a unique reference, to provide reference of drawing(s) or model(s) for the post-installed reinforcing bar connections to be installed into the structural element and/or its part showing their layout and position.

5. Enter a unique reference, to provide reference(s) of the design documentation for the post-installed reinforcing bar connections to be installed into the structural element and/or its part.

6. Enter a unique reference, to identify which UKAD/EAD the system for post-installed reinforcing bar connections to be installed into the structural element and/or its part shall have a UKTA/ETA issued against.

7. Enter a value, from options safety critical, non-safety critical, to identify whether the post-installed reinforcing bar connections to be installed into the structural element and/or its part are safety critical or not.

8. Enter a number in units of , to identify the design working life of the post-installed reinforcing bar connections to be installed into the structural element and/or its part, with the relevant UKADs/EADs typically catering for a 50 or 100 years design working life.

Systems for post-installed reinforcing bar connections (conti

Structure ID	**Type of reinforcing bar in the post-installed reinforcing bar connections**	**Corrosion resistance class to Annex A of BS EN 1993-1-4 [Ref 37.N]for the stainless steel of the post-installed reinforcing bar connections in accordance with the UKAD/EAD (where applicable)**	**Steel designation number for the stainless steel of the post-installed reinforcing bar connections (where applicable)**	**Design bond strength of the post-installed reinforcing bar connections in accordance with the UKAD/EAD**	**Bond efficiency factor of the post-installed reinforcing bar connections in accordance with the UKAD/EAD**	**Anchorage length or lap length of the post-installed reinforcing bar connections in accordance with the UKAD/EAD**	**Amplification factor for minimum anchorage or lap length of the post-installed reinforcing bar connections in accordance with the UKAD/EAD**
(a)	(i)	(j)	(k)	(l)	(m)	(n)	(o)

1. Enter a value, from options carbon steel grade B500B to BS 4449 [Ref 97.N], carbon steel grade B500C to BS 4449 [Ref 97.N], stainless steel grade B500B to BS 6744 [Ref 91.N], to identify the type of reinforcing bar to be used in the post-installed reinforcing bar connections to be installed into the structural element and/or its part.

2. Enter a value, from options I, II, III, IV, V, to identify the corrosion resistance class required for the stainless steel used as part of the post-installed reinforcing bar connections to be installed into the structural element and/or its part in accordance with the relevant UKAD/EAD, selecting from Annex A of BS EN 1993-1-4 [Ref 37.N].

3. Enter a number, to identify the steel designation number to BS EN 10088-1 [Ref 92.N] required for the stainless steel used as part of the post-installed reinforcement bar connections to be installed into the structural element and/or its part, ensuring compatibility with the specified corrosion resistance class.

4. Enter a number in units of , to identify the design bond strength of the post-installed reinforcing bar connections to be installed into the structural element and/or its part for the specified design working life and concrete strength in accordance with the relevant UKAD/EAD.

5. Enter a number, to identify the bond efficiency factor of the post-installed reinforcing bar connections to be installed into the structural element and/or its part for the specified design working life and concrete strength in accordance with the relevant UKAD/EAD.

6. Enter a number in units of , to identify the design anchorage length or lap length of the post-installed reinforcing bar connections to be installed into the structural element and/or its part for the specified concrete strength in accordance with the relevant UKAD/EAD.

7. Enter a number, to identify the amplification factor for minimum anchorage or lap length of the post-installed reinforcing bar connections to be installed into the structural element and/or its part for the specified design working life and concrete strength in accordance with the relevant UKAD/EAD.

8. Enter a value, from options R30, R60, R90, R120, R180, R240, to identify the fire resistance class for the load-bearing criterion in standard fire exposure to BS EN 1992-1-2 [Ref 36.N] for the post-installed reinforcing bar connections to be installed into the structural element and/or its part.

9. Enter a number in units of , to identify the design bond strength at increased temperature, relating to fire-critical situations, of the post-installed reinforcing bar connections to be installed into the structural element and/or its part for the specified design working life and fire resistance class in accordance with the relevant UKAD/EAD.

Systems for post-installed reinforcing bar connections (continued)

Structure ID	Bar diameter of the reinforcing bars
(a)	(r)

1. Enter a number in units of , to identify the nominal diameter of the reinforcing bars used as part of the post-installed reinforcing bar connections to be installed into the structural element and/or its part.

Product requirements for post-installed anchors for structural concrete

4.89 The characteristics of the structural element and/or its part where post-installed anchors are to be installed shall be as specified in CC 482/WSR/004.

The characteristics of the structural element and/or its part where post-installed anchors are to be installed

Structure ID	Structural element reference	Description of structural element	UKAD/ EAD reference	Temperature range of the concrete base material in service in accordance with the UKAD/EAD	Maximum long-term temperature (T_{mlt}) and maximum short-term temperature (T_{mst}) of the concrete base material in service (where applicable)	Compressive strength class of the concrete base material
(a)	(b)	(c)	(d)	(e)	(f)	(g)

1. Enter a unique reference.

2. Enter a unique reference, to identify the structural element reference.

3. Enter text, to describe the structural element and/or its part where the post-installed anchors are to be installed.

4. Enter a unique reference, to identify which UKAD/EAD the post-installed anchors to be installed into the structural element and/or its part is to have a UKTA/ETA issued against.

5. Enter a value, from options T1, T2, T3, to identify the temperature range, in accordance with the relevant UKAD/EAD, of the concrete base material in service for the structural element and/or its part where the post-installed anchors are to be installed.

6. Enter text, to identify, where the temperature range T3 is specified, the maximum long-term and the maximum short-term temperature of the concrete base material in service for the structural element and/or its part where the post-installed anchors are to be installed, in accordance with the relevant UKAD/EAD.

7. Enter text, to identify the compressive strength class of the concrete base material for the structural element and/or its part where the post-installed anchors are to be installed selecting from the classes in Tables 12 and 13 of BS EN 206 [Ref 21.N]and Table A.3 of BS 8500-2 [Ref 24.N], with the relevant UKADs/EADs typically allowing for a C20/25 or C50/60 class.

The characteristics of the structural element and/or its part where post-installed anchors are to be installed (continued)

Structure ID	**Applicable exposure class**	**Thickness of concrete base material**	**Cracked or uncracked concrete base material to BS EN 1992-4 [Ref 34.N]**	**Limit/ constraint to force(s) to be applied by the post-installed anchor(s) to avoid damage to, or instability of, the structural element and/or its part**	**Limit/ constraint to the concrete base material hole(s) diameter/length**	**Concrete base material wetness in accordance with the UKAD/EAD**
(a)	(h)	(i)	(j)	(k)	(l)	(m)

1. Enter text, to identify the applicable exposure class to BS 8500-1 [Ref 23.N]for the structural element and/or its part where the post-installed anchors are to be installed.

2. Enter a number in units of , to identify the thickness of the concrete base material of the structural element and/or its part where the post-installed anchors are to be installed.

3. Enter a value, from options cracked, uncracked, to identify whether the concrete base material of the structural element and/or its part where the post-installed anchors are to be installed is assumed to be cracked or uncracked in accordance with BS EN 1992-4 [Ref 34.N].

4. Enter text, to identify any limit/constraint to the force(s) to be applied onto the structural element via the post-installed anchors to avoid damage to the structural element and/or its part.

5. Enter text, to identify any limit/constraint to the diameter/length of the hole(s) in the concrete base material of the structural element and/or its part where the post-installed anchors are to be installed.

6. Enter one or more values, from options I1, I2, to identify the requirement, in accordance with the relevant UKAD/EAD, for the post-installed anchors to be installed into the structural element and/or its part at dry/wet concrete conditions and/or into water-filled holes.

The characteristics of the structural element and/or its part where post-installed anchors are to be installed (continued)

Structure ID	**Direction of installation of the post-installed anchors into the structural element and/or its part in accordance with the UKAD/EAD**
(a)	(n)

1. Enter a value, from options D1, D2, D3, to identify the requirement, in accordance with the relevant UKAD/EAD, for the post-installed anchors to be installed into the structural element and/or its part at specific directions.

4.90 Post-installed anchors shall be as specified in CC 482/WSR/004.

Post-installed anchors

Structure ID	Structural element reference	Description of structural element	Drawing/ model reference(s)	Design documentation reference(s)	Type of post-installed anchors	UKAD/ EAD reference	Safety criticality of the post-installed anchors
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)

1. Enter a unique reference.

2. Enter a unique reference, to identify the structural element reference.

3. Enter text, to describe the structural element and/or its part where post-installed anchors are to be installed.

4. Enter a unique reference, to provide reference of drawing(s) or model(s) for post-installed anchors to be installed into the structural element and/or its part showing their layout and position.

5. Enter a unique reference, to provide reference(s) of the design documentation for the post-installed anchors to be installed into the structural element and/or its part.

6. Enter a value, from options bonded anchors, mechanical anchors, to identify the type of post-installed anchors required to be installed into the structural element and/or its part.

7. Enter a unique reference, to identify which UKAD/EAD the post-installed anchors to be installed into the structural element and/or its part is to have a UKTA/ETA issued against.

8. Enter a value, from options safety critical, non-safety critical, to identify whether the post-installed anchors to be installed into the structural concrete and/or its part are safety critical or not.

Post-installed anchors (continued)

Structure ID	Design working life of the post-installed anchors	Type of design actions on post-installed anchors in accordance with the UKAD/EAD	Corrosion resistance class to Annex A of BS EN 1993-1-4 [Ref 37.N]for the stainless steel of the post-installed anchors in accordance with the UKAD/EAD (where applicable)	Durability classification for mechanical anchors in accordance with the relevant UK designated pre-Exit UKAD/EAD (where applicable)	Steel designation number for the stainless steel of the post-installed anchors	Design tension force on the post-installed anchors at the ULS to BS EN 1992-4 [Ref 34.N] (where applicable)	Design tension force on the post-installed anchors at the SLS to BS EN 1992-4 [Ref 34.N] (where applicable)	Des she for the ins and at t ULS EN 4 [34. (wh app e)
(a)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)

1. Enter a number in units of , to identify the design working life of the post-installed anchors to be installed into the structural element and/or its part, with the relevant UKADs/EADs typically catering for a 50 or 100 years design working life.

2. Enter a value, from options static/quasi-static, fatigue, to identify the type of design actions, in accordance with the relevant UKAD/EAD, the post-installed anchors to be installed into the structural element and/or its part are designed for.

3. Enter a value, from options I, II, III, IV, V, to identify the corrosion resistance class required for the stainless steel used for the post-installed anchors to be installed into the structural element and/or its part in accordance with the relevant UKAD/EAD, selecting from Annex A of BS EN 1993-1-4 [Ref 37.N].

4. Enter a value, from options 2, 3, to identify the durability classification for mechanical anchors in accordance with the relevant UK designated pre-Exit UKAD/EAD.

5. Enter a number, to identify the steel designation number to BS EN 10088-1 [Ref 92.N]required for the stainless steel used for the post-installed anchors to be installed into the structural

element and/or its part, ensuring compatibility with the specified corrosion resistance class or durability classification.

6. Enter a number in units of , to identify the design tension force acting on the post-installed anchors to be installed into the structural element and/or its part at the ultimate limit state in accordance with BS EN 1992-4 [Ref 34.N].

7. Enter a number in units of , to identify the design tension force acting on the post-installed anchors to be installed into the structural element and/or its part at the serviceability limit state in accordance with BS EN 1992-4 [Ref 34.N].

8. Enter a number in units of , to identify the design shear force acting on the post-installed anchors to be installed into the structural element and/or its part at the ultimate limit state in accordance with BS EN 1992-4 [Ref 34.N].

9. Enter a number in units of , to identify the design shear force acting on the post-installed anchors to be installed into the structural element and/or its part at the serviceability limit state in accordance with BS EN 1992-4 [Ref 34.N].

				Post-installed anchors (continued)				
Structure ID	**Sustained actions ratio to BS EN 1992-4 [Ref 34.N]**	**Design fatigue tensile action on the post-installed anchors to BS EN 1992-4 [Ref 34.N] (where applicable)**	**Design fatigue shear action on the post-installed anchors to BS EN 1992-4 [Ref 34.N] (where applicable)**	**Fire resistance class for the post-installed anchors (where applicable)**	**Design tension force on the post-installed anchors at the ULS under fire exposure to BS EN 1992-4 [Ref 34.N]and TR 082 [Ref 28.N] (where applicable)**	**Design shear force on the post-installed anchors at the ULS under fire exposure to BS EN 1992-4 [Ref 34.N] and TR 082 [Ref 28.N] (where applicable)**	**Sustained actions ratio under fire exposure at the ULS to BS EN 1992-4 [Ref 34.N]and TR 082 [Ref 28.N] (where applicable)**	**Anchors diameter**
(a)	(r)	(s)	(t)	(u)	(v)	(w)	(x)	(y)

1. Enter a number, to identify the ratio between the value of sustained actions and the value of total actions at the ULS in accordance with BS EN 1992-4 [Ref 34.N]acting on the post-installed anchors to be installed into the structural element and/or its part.

2. Enter a number in units of , to identify the design peak to peak amplitude of the fatigue action acting in tension on the post-installed anchors to be installed into the structural element and/or its part in accordance with BS EN 1992-4 [Ref 34.N].

3. Enter a number in units of , to identify the design peak to peak amplitude of the fatigue action acting in shear on the post-installed anchors to be installed into the structural element and/or its part in accordance with BS EN 1992-4 [Ref 34.N].

4. Enter a value, from options R30, R,60, R90, R120, to identify the fire resistance class for the load-bearing criterion in standard fire exposure to BS EN 1992-1-2 [Ref 36.N] for the post-installed anchors to be installed into the structural element and/or its part.

5. Enter a number in units of , to identify the design tension force acting on the post-installed anchors to be installed into the structural element and/or its part at the ultimate limit state under fire exposure, in accordance with BS EN 1992-4 [Ref 34.N] for mechanical anchors and with BS EN 1992-4 [Ref 34.N] and TR 082 [Ref 28.N] for bonded anchors.

6. Enter a number in units of , to identify the design shear force acting on the post-installed anchors to be installed into the structural element and/or its part at the ultimate limit state under fire exposure, in accordance with BS EN 1992-4 [Ref 34.N]for mechanical anchors and with BS EN 1992-4 [Ref 34.N] and TR 082 [Ref 28.N] for bonded anchors.

7. Enter a number, to identify the ratio between the value of sustained actions and the value of total actions under fire exposure at the ultimate limit state on the post-installed anchors to be installed into the structural element and/or its part, in accordance with BS EN 1992-4 [Ref 34.N] for mechanical anchors and with BS EN 1992-4 [Ref 34.N] and TR 082 [Ref 28.N] for bonded anchors.

8. Enter a number in units of , to identify the nominal diameter of the post-installed anchors to be installed into the structural element and/or its part.

9. Enter a number in units of , to identify the maximum permitted value of the displacement in tension under short term loading for the post-installed anchors to be installed into the structural element and/or its part.

10. Enter a number in units of , to identify the maximum permitted value of the displacement in tension under long term loading for the post-installed anchors to be installed into the structural element and/or its part.

Post-installed anchors (continued)

Structure ID	Admissible displacement limit in shear under short term loading for the post-installed anchors in accordance with the UKAD/EAD	Admissible displacement limit in shear under long term loading for the post-installed anchors in accordance with the UKAD/EAD	Base plate thickness (where applicable)	Minimum edge distances between anchors and concrete edges	Minimum spacing between anchors	Embedment depth of the post-installed anchors
(a)	(ab)	(ac)	(ad)	(ae)	(af)	(ag)

1. Enter a number in units of , to identify the maximum permitted value of the displacement in shear under short term loading for the post-installed anchors to be installed into the structural element and/or its part.

2. Enter a number in units of , to identify the maximum permitted value of the displacement in shear under long term loading for the post-installed anchors to be installed into the structural element and/or its part.

3. Enter a number in units of , to identify the thickness of the base plate to be used to connect the post-installed anchors to be installed into the structural element and/or its part with the concrete base material.

4. Enter a number in units of , to identify the minimum permitted distance between the post-installed anchors to be installed into the structural element and/or its part and the edges of concrete base material.

5. Enter a number in units of , to identify the minimum permitted spacing between the post-installed anchor(s) to be installed into

the structural element and/or its part and its/their neighbouring post-installed anchor(s).

6. Enter a number in units of , to identify the required embedment depth of the post-installed anchors to be installed into the structural element and/or its part.

Installation requirements for post-installed anchors and systems for post-installed reinforcing bar connections for structural concrete

General requirements for the installation of post-installed anchors and systems for post-installed reinforcing bar connections for structural concrete

4.91 Post-installed anchors and systems for post-installed reinforcing bar connections shall be installed in accordance with their United Kingdom Technical Assessment (UKTA)/European Technical Assessment (ETA) and the manufacturer's instructions as amended and complemented by this document.

4.92 The installation of post-installed anchors and systems for post-installed reinforcing bar connections shall not cause damage to the existing concrete base material or any waterproofing around the drill holes.

4.93 Steel reinforcement within the existing concrete base material shall not be struck, damaged or cut during the installation of post-installed anchors and systems for post-installed reinforcing bar connections, unless otherwise stated in CC 482/WSR/004.

4.94 When steel reinforcement within the existing concrete base material is of dissimilar metal to that specified for the post-installed anchors and systems for post-installed reinforcing bar connections, the dissimilar metals shall be electrically isolated from one another in accordance with CC 482/WSR/004.

4.95 Relaxation criteria for striking, damaging or cutting of steel reinforcement within the existing concrete base material and constraints on electrical insulation between dissimilar metals when installing post-installed anchors and systems for post-installed bar connections shall be as specified in CC 482/WSR/004.

Relaxation criteria for striking, damaging or cutting of steel reinforcement within the existing concrete base material and constraints on electrical insulation between dissimilar metals when installing post-installed anchors and systems for post-installed bar connections

Structure ID	Structural element reference	Description of structural element	Drawing/ model reference(s)	Relaxation criteria for striking, damaging or cutting steel reinforcement	Existing steel reinforcement of dissimilar metal to post-installed anchor/bar	Isolation of dissimilar metals document reference (s) (where applicable)
(a)	(b)	(c)	(d)	(e)	(f)	(g)

1. Enter a unique reference.

2. Enter a unique reference, to identify the structural element reference.

3. Enter text, to describe the structural element and/or its part where existing reinforcement is affected by the drilling for installation of post-installed anchors or systems for post-installed reinforcing bar connections.

4. Enter a unique reference, to provide reference of drawing(s) or model(s) showing the existing reinforcement in the structural element and/or its part affected by the drilling for installation of post-installed anchors or systems for post-installed reinforcing bar connections.

5. Enter text, to identify the specific relaxation criteria on striking, damaging or cutting existing steel reinforcement of the structural element and/or its part affected by the drilling for installation of post-installed anchors or systems for post-installed reinforcing bar connections.

6. Enter a value, from options yes,no, to state whether the existing steel reinforcement in the structural element and/or its part is of dissimilar metal to that specified for the post-installed anchors and systems for post-installed bar connections.

7. Enter a unique reference, to provide reference of the document(s) containing the detailed specification requirements for the isolation of dissimilar metals where the existing steel reinforcement in the structural element and/or its part is is of

dissimilar metal to that specified for the post-installed anchors and systems for post-installed bar connections.

4.96 For post-installed bonded anchors and systems for post-installed reinforcing bar connections, the cementitious grout or resin used for bonding the anchor/bar to the concrete shall fill the hole entirely without air voids, leaving the anchor/bar fully surrounded by the grout/resin following its insertion.

4.97 The cementitious grout or resin that remains in excess after insertion of the anchor/bar during the installation of post-installed bonded anchors and systems for post-installed reinforcing bar connections shall be removed immediately.

4.98 The surfaces of steel anchors and bars used for post-installed anchors and systems for post-installed reinforcing bar connections shall be, before installation, free of loose rust and deleterious substances which could affect the anchorage bond or functionality of the anchor/bar.

4.99 Post-installed anchors shall not be removed and reused.

Visual inspection of concrete at drill locations during installation of post-installed anchors and systems for post-installed reinforcing bar connections for structural concrete

4.100 Verification shall be undertaken for the installation of post-installed anchors and systems for post-installed reinforcing bar connections by a visual inspection of concrete at drill locations checking that: prior to drilling there are no fractures, cracks or voids in the concrete base material; immediately after drilling the drilled holes are correctly located, have the correct diameter, the correct depth, are appropriately prepared and there are no fractures, cracks or voids in the concrete base material; immediately before installation the holes remain free from debris and there are no fractures, cracks or voids in the concrete base material.

4.101 The frequency of the visual inspection of concrete at drill locations for post-installed anchors and systems for post-installed reinforcing bar connections shall be once prior to drilling, once immediately after drilling and once immediately before installation, on an area comprising all exposed concrete base material within 300 mm of each drill location.

4.102 The requirements for "Verification" in Section 14 of GC 101 [Ref 44.N] shall apply to the visual inspection of concrete at drill locations for post-installed anchors and systems for post-installed reinforcing bar connections.

4.103 The following Documentation for the visual inspection of concrete at drill locations for post-installed anchors and systems for post-installed reinforcing bar connections shall be submitted as continuous records:

written records of the findings of the visual inspections prior to drilling, after drilling and before installation, including notification of any defects.

4.104 The requirements of "Records" in Section 3 of GC 101 [Ref 44.N] shall apply to the records of the visual inspection of concrete at drill locations for post-installed anchors and systems for post-installed reinforcing bar connections.

Axial load proof tests of post-installed anchors and systems for post-installed reinforcing bar connections for structural concrete

4.105 Verification shall be undertaken for the installation of post-installed anchors and systems for post-installed reinforcing bar connections by axial load proof tests.

4.106 The frequency of axial load proof tests shall be : once after completion of the installation of the anchors and systems for post-installed reinforcing bar connections taking into account, for bonded bars/anchors, completion of the curing period as recommended by the manufacturer's instructions and with the number and location of axial load proof tests in accordance with CC 482/WSR/004; during future inspections in accordance with CC 482/WSR/004.

4.107 The requirements for "Verification" in Section 14 of GC 101 [Ref 44.N] shall apply to axial load proof tests of post-installed anchors and systems for post-installed reinforcing bar connections for structural concrete.

4.108 Requirements for axial load proof tests of post-installed anchors and systems for post-installed reinforcing bar connections for structural concrete shall be as specified in CC 482/WSR/004.

Requirements for axial load proof tests of post-installed anchors and systems for post-installed reinforcing bar connections for structural concrete

Structure ID	**Structural element reference**	**Description of structural element**	**Drawing/ model reference(s)**	**Requirements for sacrificial fixings for testing after installation (where applicable)**	**Requirements for physical measures to enable proof testing of fixings following installation**	**Axial load proof tests for anchors carrying tension after installation (where applicable)**
(a)	(b)	(c)	(d)	(e)	(f)	(g)

1. Enter a unique reference.

2. Enter a unique reference, to identify the structural element reference.

3. Enter text, to describe the structural element and/or its part that contains the fixings to be tested including sacrificial ones, if any.

4. Enter a unique reference, to provide reference to drawing(s) or model(s) showing the location, within the structural element and/or its part, of the fixings to be tested including sacrificial ones, if any.

5. Enter text, to identify the number, location and specific requirements for sacrificial fixings that are to be installed for the purpose of axial load proof testing after installation.

6. Enter text, to identify type, number, location, dimensions and specific requirements for any fixture/connection facilities that are to be installed and any space provisions for testing rigs that are to be used for the purpose of axial load proof testing following installation.

7. Enter text, to identify the total number and location of axial load proof tests to be undertaken on anchors carrying tension after installation including on any sacrificial fixings, with a minimum of 3 tests for each area with different fixing diameter, different base material concrete strength and different direction of installation.

Requirements for axial load proof tests of post-installed anchors and systems for post-installed reinforcing bar connections for structural concrete (continued)

Structure ID	**Axial load proof tests for anchors carrying shear after installation (where applicable)**	**Axial load proof tests for reinforcing bar connections after installation (where applicable)**	**Requirements for extra fixings for future testing in service (where applicable)**	**Requirements for physical measures to enable future testing of fixings in service (where applicable)**	**Magnitude of axial load for proof test for anchors carrying tension (where applicable)**	**Magnitude of axial load for proof test for anchors carrying shear (where applicable)**
(a)	(h)	(i)	(j)	(k)	(l)	(m)

1. Enter text, to identify the total number and location of axial load proof tests to be undertaken on anchors carrying shear after installation including on any sacrificial fixings, with a minimum of 3 tests for each area with different fixing diameter, different base material concrete strength and different direction of installation.

2. Enter text, to identify the total number and location of axial load proof tests to be undertaken on reinforcing bar connections after installation including on any sacrificial fixings, with a minimum of 3 tests for each area with different fixing diameter, different base material concrete strength and different direction of installation.

3. Enter text, to identify the number, location and specific requirements for any extra fixings that are to be installed for the purpose of future axial load proof testing in service.

4. Enter text, to identify type, number, location, dimensions and specific requirements for any fixture/connection facilities that are to be installed and any space provisions for testing rigs that are to be used for the purpose of future axial load proof testing in service.

5. Enter a number in units of , to identify the proof test axial load for anchors carrying tension.

6. Enter a number in units of , to identify the proof test axial load for anchors carrying shear.

Requirements for axial load proof tests of post-installed anchors and systems for post-installed reinforcing bar connections for structural concrete (continued)

Structure ID	**Magnitude of axial load for proof test for reinforcing bar connections (where applicable)**
(a)	(n)

1. Enter a number in units of , to identify the proof test axial load for reinforcing bar connections.

4.109 Where the installation of fixings on a structure is undertaken by different teams, the regime of axial load proof testing for each type of fixing in accordance with CC 482/WSR/004 shall be repeated for each new installation team.

4.110 Under axial load proof testing, the total movement of a fixing, less the calculated elongation of the fixing based on the length of the fixing

between the concrete surface and the load application, shall not exceed 5% of the nominal diameter of the fixing.

4.111 Under axial load proof testing, after the initial movement there shall be no slip between the fixing and the concrete.

4.112 Axial load proof tests of fixings shall comply with the procedures and acceptance criteria in CFA (Construction fixings) [Ref 49.N]as amended and complemented by the following:.

1. The magnitude of the test load is to be in accordance with CC 482/WSR/004

2. Movement is to be always recorded so that a load/elongation curve is produced for each tested fixing

3. The total movement of the fixing, less the calculated elongation of the fixing during the test based on the length of the fixing between the concrete surface and the load application, is not to exceed 5% of the nominal diameter of the fixing

4. The slope of the load/elongation curve after the initial movement has to show no slip between the fixing and the concrete.

4.113 A detailed axial load proof testing report shall be prepared in accordance with the requirements of CFA (Construction fixings) [Ref 49.N].

4.114 The following Documentation shall be submitted for the axial load proof tests of post-installed anchors and systems for post-installed reinforcing bar connections for structural concrete within 14 days of completion of the axial load proof tests: axial load proof testing report.

4.115 Axial load proof tests of post-installed anchors and systems for post-installed reinforcing bar connections shall only be carried out by personnel holding third party accreditation with a competence assessment scheme for axial load proof testing of fixings that covers testing of the type of fixing used in the works.

4.116 The following Documentation shall be submitted for all personnel undertaking axial load proof tests of fixings prior to the commencement of the axial load proof testing: certificate(s) of third party accreditation with a competence assessment scheme demonstrating suitability of personnel for axial load proof testing of the type of fixings used in the works.

4.117 The requirements for "Documentation" in Section 2 of GC 101 [Ref 44.N] shall apply to certificate(s) of third party accreditation with a competence assessment scheme demonstrating suitability of personnel for axial load proof testing of the type of fixings used in the works.

Post construction activity documentation requirements for post-installed anchors and systems for post-installed reinforcing bar connections for structural concrete

4.118 The following Documentation shall be submitted for post-installed anchors and systems for post-installed reinforcing bar connections for structural concrete within 21 days of completion of the axial load proof tests of the post-installed anchors and systems for post-installed reinforcing bar connection incorporated into the works: post construction activity records.

4.119 Post construction activity records for post-installed anchors and systems for post-installed reinforcing bar connections for structural concrete shall be prepared in accordance with CG 302 [Ref 7.N], incorporating the following information in accordance with BS 8539 [Ref 19.N]:.

1. Full description of the fixings, including make, type, UKAD/EAD, UKTA/ETA and Declaration of Performance, manufacturer's reference number

2. Design actions and their nature

3. Performance data, including characteristic resistance and design resistance

4. Material details for the fixings and any resin used, including steel grade, designation and corrosion resistance

5. Assumed substrate strength

6. Diameter and embedment depth of the fixings

7. Minimum spacing, edge distances, base material thicknesses

8. Measures to enable future testing of safety critical fixings in service

9. Locations and identification of extra fixings for future testing in service

10. Future testing strategy for safety critical fixings, including future testing frequency

5. Prestressing of structural concrete

General requirements for prestressing of structural concrete

5.1 Prestressing in the execution of structural concrete shall be in compliance with Section 7 of BS EN 13670 [Ref 38.N]as amended and complemented by this document.

5.2 Only steel wires, steel strands and cold worked high tensile alloy bars shall be used as prestressing tensile elements (tendons).

5.3 Type of prestressing of structural concrete shall be as specified in CC 482/WSR/005.

Type of prestressing of structural concrete

Structure ID	Structural element reference	Description of structural element	Drawing/ model reference(s)	Design documentation reference(s)	Type of prestressing
(a)	(b)	(c)	(d)	(e)	(f)

1. Enter a unique reference.

2. Enter a unique reference, to identify the structural element reference.

3. Enter text, to describe the structural element and/or its part where prestressing is used.

4. Enter a unique reference, to provide reference of drawing(s) or model(s) where the details of prestressing in the structural element and/or its part are shown.

5. Enter a unique reference, to provide reference(s) of the design documentation for the prestressing of the structural element and/or its part.

6. Enter one or more values, from options pre-tensioning, post-tensioning with internal bonded tendons, post-tensioning with internal unbonded tendons, post-tensioning with external tendons, to identify the type of prestressing of the structural element and/or its part.

5.4 Post-tensioning with internal bonded tendons shall not be used in precast segmental construction where ducts are not continuous across the concrete segment joints.

General requirements specific to pre-tensioning of structural concrete

5.5 Pre-tensioning of structural concrete shall be as specified in CC 482/WSR/005.

Pre-tensioning of structural concrete

Structure ID	Structural element reference	Description of structural element	Drawing/ model reference(s)	Design documentation reference(s)	Pre-tensioning tendon reference	Pre-tensioning tendon force to be applied	Pre-tensioning tendon elongation at the applied force
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)

1. Enter a unique reference.

2. Enter a unique reference, to identify the structural element reference.

3. Enter text, to describe the structural element and/or its part prestressed by pre-tensioning.

4. Enter a unique reference, to provide reference of drawing(s) or model(s) for the structural element prestressed by pre-tensioning which include the layout of the pre-tensioning tendons with their nominal cover to reinforcement and identifies the portions of tendons to be debonded by protective sleeves, if any.

5. Enter a unique reference, to provide reference(s) of the design documentation for the structural element and/or its part prestressed by pre-tensioning which include the calculated tendon force/elongation diagram accounting for any effects of friction.

6. Enter a unique reference, to identify the reference of the pre-tensioning tendon used for prestressing the structural element and/or its part.

7. Enter a number in units of , to provide the force to be applied at the jack for the pre-tensioning tendon, accounting for any effects of friction.

8. Enter a number in units of , to provide the expected elongation of the pre-tensioning tendon at the applied force, accounting for any effects of friction.

Pre-tensioning of structural concrete (continued)

Structure ID	Order of release of pre-tensioning tendons	Minimum concrete compressive strength at transfer before stressing
(a)	(i)	(j)

1. Enter text, to describe the order of release of the pre-tensioning tendons in the structural element and/or its part prestressed by pre-tensioning.

2. Enter a number in units of , to identify the minimum compressive strength required for the concrete in the structural element and/or its part before it can be stressed by the pre-tensioning tendons.

General requirements specific to post-tensioning of structural concrete

5.6 Post-tensioning of structural concrete shall be as specified in CC 482/WSR/005.

Post-tensioning of structural concrete

Structure ID	Structural element reference	Description of structural element	Drawing/ model reference(s)	Design documentation reference(s)	Type of post-tensioning system	Protection level for the post-tensioning tendon to EAD 160004-00-0301 [Ref 62.N]	Duct type
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)

1. Enter a unique reference.

2. Enter a unique reference, to identify the structural element reference.

3. Enter text, to describe the structural element and/or its part prestressed by post-tensioning.

4. Enter a unique reference, to provide reference of drawing(s) or model(s) for the structural element prestressed by post-tensioning including the layout of the post-tensioning tendons and other components of the post-tensioning system including the nominal cover to reinforcement.

5. Enter a unique reference, to provide reference(s) of the design documentation for the structural element and/or its part prestressed by post-tensioning which include the calculated tendon force/elongation diagram accounting for any effects of friction.

6. Enter one or more values, from options internal bonded tendon with grouted corrugated plastic duct, internal unbonded tendon with greased/waxed smooth plastic duct, internal unbonded tendon with individually greased and sheathed monostrand(s) with grouted smooth plastic duct, internal unbonded tendon with individually greased and sheathed monostrand(s) without grouted smoooth plastic duct, external unbonded tendon with grouted smooth plastic duct, external unbonded tendon with greased/waxed smooth plastic duct, external unbonded tendon with individually greased and sheathed monostrand(s) with grouted plastic duct, to identify the type of post-tensioning system to be used for prestressing the structural element and/or its part.

7. Enter a value, from options PL2, PL3, to identify the required protection level of the internal/external post-tensioning tendon in accordance with FIB Bulletin 75 [Ref 11.N], FIB Bulletin 97 [Ref 12.N], FIB Bulletin 33 [Ref 10.N] and EAD 160004-00-0301 [Ref 62.N].

8. Enter a value, from options corrugated plastic, smooth plastic, none, to identify the type of duct, to be consistent with the type of post-tensioning system, to be used in the structural element and/or its part prestressed by post-tensioning.

Post-tensioning of structural concrete (continued)

Structure ID	Duct filling material	Post-tensioning tendon reference	Provision for post-tensioning tendon to be retensionable in service required	Post-tensioning tendon replaceability required	Post-tensioning tendon force to be applied	Post-tensioning tendon elongation at the applied force	Order of stressing of post-tensioning tendons	Minim concre compr ve streng at transf before stress
(a)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)

1. Enter a value, from options grout, grease, wax, to identify the type of filling material for the duct, to be consistent with the type of post-tensioning system, to be used in the structural element and/or its part prestressed by post-tensioning.

2. Enter a unique reference, to identify the reference of the post-tensioning tendon used for prestressing the structural element and/or its part.

3. Enter a value, from options yes, no, to identify whether the post-tensoning tendon used for prestresssing the structural element and/or its part is required to be retensionable in service or not.

4. Enter a value, from options yes, no, to identify whether the post-tensioning tendon used for prestressing the structural element and/or its part is required to be replaceable in service or not.

5. Enter a number in units of , to provide the force to be applied at the jack for the post-tensioning tendon, accounting for any effects of friction.

6. Enter a number in units of , to provide the expected elongation of the post-tensioning tendon at the applied force, accounting for any effects of friction.

7. Enter a number, to identify the order of stressing of the post-tensioning tendons in the structural element and/or its part prestressed by post-tensioning.

8. Enter a number in units of , to identify the minimum compressive strength required for the concrete in the structural element and/or its part before it can be stressed by the post-tensioning tendons.

Post-tensioning of structural concrete (continued)

Structure ID	**Friction coefficients requirements for tendons and friction losses at anchorages/couplings**	**Minimum radii of curvature requirements for tendons**	**Duct fracture resistance testing to EAD 160004-00-0301 [Ref 62.N]required**
(a)	(q)	(r)	(s)

1. Enter text, to indicate the values assumed in design for the friction coefficient between tendon and duct/sheathing, any internal tendon wobble coefficient and the friction losses at anchorage/coupling for the post-tensioning system in the structural element and/or its part.

2. Enter text, to indicate the minimum values assumed in design for the radii of curvature for of any internal bonded/unbonded and external unbonded post-tensioning tendons used for prestressing the structural element and/or its part.

3. Enter a value, from options yes, no, to identify the need for testing of the fracture resistance of duct to FIB Bulletin 75 [Ref 11.N] in accordance with 2.2.11 and 2.2.12 of EAD 160004-00-0301 [Ref 62.N].

5.7 Post-tensioning systems for structural concrete, typically comprising tendons, anchorages, ducts, filling material, sheathed monostrands, couplings, deviators, bursting reinforcement and special accessories such as vents, drains, tendon support devices, caps, connectors, shall have a United Kingdom Technical Assessment (UKTA)/European Technical Assessment (ETA) suitable for their intended use and application issued against the European Assessment Document EAD 160004-00-0301 [Ref 62.N].

5.8 Post-tensioning systems for structural concrete shall meet the performance characteristics as stated in Table 5.8.

Table 5.8 Characteristics and performance requirements for post-tensioning systems for structural concrete

Characteristic	Performance requirement
Resistance to static load	As required in 2.2.1 of EAD 160004-00-0301 [Ref 62.N]amended and complemented by 6.1 of FIB Bulletin 97 [Ref 12.N] for external tendons
Resistance to fatigue	As required in 2.2.2 of EAD 160004-00-0301 [Ref 62.N]amended and complemented by 6.2 of FIB Bulletin 97 [Ref 12.N]for external tendons
Load transfer to structure	As required in 2.2.3 of EAD 160004-00-0301 [Ref 62.N]amended and complemented by 6.3 of FIB Bulletin 97 [Ref 12.N]for external tendons
Friction coefficient	As required in 2.2.4 of EAD 160004-00-0301 [Ref 62.N]in relation to the friction coefficients and losses specified in CC 482/WSR/005
Deviation/deflection (limits) for internal tendons	As required in 2.2.5 of EAD 160004-00-0301 [Ref 62.N]in relation to the radii of curvature specified in CC 482/WSR/005
Deviation/deflection (limits) for external unbonded tendons, for wear of duct of external	As required in 2.2.6 of EAD 160004-00-0301 [Ref 62.N]amended and complemented by 6.4 of FIB Bulletin 97

unbonded tendons and for wear of sheathing of internal unbonded tendons	[Ref 12.N] for external tendons, in relation to the radii of curvature specified in CC 482/WSR/005
Assessment of assembly	Satisfactory perfomance of assembly/stressing and filling test in accordance with 2.2.7 of EAD 160004-00-0301 [Ref 62.N]amended and complemented by 6.5 and 6.6 of FIB Bulletin 97 [Ref 12.N] for external tendons
Material properties, component performance and system performance of plastic duct for encapsulated tendon (PL2)	As required in 2.2.11 of EAD 160004-00-0301 [Ref 62.N]and in accordance with CC 482/WSR/005 when PL2 is specified
Material properties, component performance and system performance of plastic duct for electrically isolated tendon (PL3)	As required in 2.2.12 of EAD 160004-00-0301 [Ref 62.N] and in accordance with CC 482/WSR/005 when PL3 is specified
Melt index of sheathing base material for monostrand	As required in 2.2.14 of EAD 160004-00-0301 [Ref 62.N]
Density of sheathing base material for monostrand	As required in 2.2.15 of EAD 160004-00-0301 [Ref 62.N]
Carbon black of sheathing base material for monostrand	As required in 2.2.16 of EAD 160004-00-0301 [Ref 62.N]
Tensile strength of sheathing base material for monostrand	As required in 2.2.17 of EAD 160004-00-0301 [Ref 62.N]
Elongation of sheathing base material for monostrand	As required in 2.2.18 of EAD 160004-00-0301 [Ref 62.N]
Thermal stability of sheathing base material for monostrand	As required in 2.2.19 of EAD 160004-00-0301 [Ref 62.N]
Tensile strength of manufactured sheathing for monostrand	As required in 2.2.20 of EAD 160004-00-0301 [Ref 62.N]
Elongation of manufactured sheathing for monostrand	As required in 2.2.21 of EAD 160004-00-0301 [Ref 62.N]
Surface of manufactured sheathing for monostrand	As required in 2.2.22 of EAD 160004-00-0301 [Ref 62.N]
Environmental stress cracking of manufactured sheathing for monostrand	As required in 2.2.23 of EAD 160004-00-0301 [Ref 62.N]
Temperature resistance of manufactured sheathing for monostrand	As required in 2.2.24 of EAD 160004-00-0301 [Ref 62.N]
Resistance to externally applied agents of manufactured sheathing for monostrand	As required in 2.2.25 of EAD 160004-00-0301 [Ref 62.N]
Minimum thickness of manufactured sheathing for monostrand	As required in 2.2.26 of EAD 160004-00-0301 [Ref 62.N]

External diameter of sheathing for manufactured monostrand	As required in 2.2.27 of EAD 160004-00-0301 [Ref 62.N]
Mass of sheathing per metre for manufactured monostrand	As required in 2.2.28 of EAD 160004-00-0301 [Ref 62.N]
Mass of filling material per metre for manufactured monostrand	As required in 2.2.29 of EAD 160004-00-0301 [Ref 62.N]
Alteration of dropping point caused by monostrand manufacturing	As required in 2.2.30 of EAD 160004-00-0301 [Ref 62.N]
Alteration of oil separation caused by monostrand manufacturing	As required in 2.2.31 of EAD 160004-00-0301 [Ref 62.N]
Impact resistance of manufactured monostrand	As required in 2.2.32 of EAD 160004-00-0301 [Ref 62.N]
Friction between sheathing and strand for manufactured monostrand	As required in 2.2.33 of EAD 160004-00-0301 [Ref 62.N]
Leak tightness for manufactured monostrand	As required in 2.2.34 of EAD 160004-00-0301 [Ref 62.N]

5.9 Documentation for post-tensioning systems for structural concrete shall be in compliance with the requirements for "UK Technical Assessments" in Section 13 of GC 101 [Ref 44.N].

Product requirements for prestressing of structural concrete

Product requirements for steel wires and strands for prestressing of structural concrete

5.10 Steel wires and strands for prestressing of structural concrete shall be compliant with BS 5896 [Ref 50.N]as amended and complemented by this document.

5.11 The steel wires and strands for prestressing of structural concrete shall meet the following performance characteristics: those necessary to comply with BS 5896 [Ref 50.N], including fatigue behaviour, deflected tensile behaviour and all the requirements in Section 11 and Section 12 of BS 5896 [Ref 50.N].

5.12 The requirements for "Product certification schemes" in Section 11 of GC 101 [Ref 44.N] shall apply to steel wires and strands for prestressing of structural concrete.

5.13 Product certification schemes for steel wires and strands for prestressing of structural concrete shall be operated in accordance with BS ISO 10144 [Ref 100.N] by certification bodies accredited in accordance with BS EN ISO/IEC 17021-1 [Ref 25.N]ensuring that:.

1. All steel wires and strands are fully traceable to the cast/heat/batch number, steel wire and strand supplier(s) and steel wire and strand manufacturer(s)

2. The certificate of conformity with BS 5896 [Ref 50.N] including test data and a certificate of approval issued by the certification body are provided by the steel wire and strand supplier(s) and steel wire and strand manufacturer(s) for each cast/heat/batch number of steel wire and strand produced

3. Each coil or bundle of wires/strands is fully identifiable with a secure and durable label or tag attached, which identifies the product certification scheme, identifies compliance of the wires/strands with BS 5896 [Ref 50.N]and contains the identification information for the wires/strands in accordance with BS 5896 [Ref 50.N]

4. The scheme has a technical supervisory panel, with documented structure and governance, made up of relevant industry experts, highway structures owners and product users

5. The scheme documentation, including the assessment criteria, is publicly accessible and is reviewed at least bi-annually

6. The scheme has a documented list of manufacturers and suppliers that hold a current approval with the scheme

7. The scheme requires documented audit and quality control of product production, product traceability, independent product testing at UKAS accredited laboratories, processing and installation

8. The scheme documents the frequency of surveillance audits, periodic independent product testing at UKAS accredited laboratories and management of non-conformance

5.14 Steel wires and strands for prestressing of structural concrete shall be as specified in CC 482/WSR/005.

Steel wires and strands for prestressing of structural concrete

Structure ID	Structural element reference	Description of structural element	Drawing/ model reference(s)	Type of steel wire (where applicable)	Steel designation number for wires (where applicable)	Wire nominal diameter (where applicable)	Type of steel strand (where applicable)	Ste des on nu for str (wh app e)
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)

1. Enter a unique reference.

2. Enter a unique reference, to identify the structural element reference.

3. Enter text, to describe the structural element and/or its part incorporating prestressing steel wires/strands.

4. Enter a unique reference, to provide reference of drawing(s) or model(s) where the structural element and/or its part incorporating prestressing steel wires/strands is shown.

5. Enter a value, from options plain, indented type T1, indented type T2, to identify the type of steel wire to BS 5896 [Ref 50.N] in the structural element and/or its part.

6. Enter a number, to identify the steel designation number to BS 5896 [Ref 50.N] for the wires in the structural element and/or its part.

7. Enter a number in units of , to identify the nominal diameter to BS 5896 [Ref 50.N] for the wires in the structural element and/or its part, to be compatible with the steel designation number for the wires.

8. Enter a value, from options 7-wire strand, indented strand, 7-wire compacted strand, to identity the type of steel strand to BS 5896 [Ref 50.N]in the structural element and/or its part.

9. Enter a number, to identify the steel designation number to BS 5896 [Ref 50.N] for the strands in the structural element and/or its part.

Steel wires and strands for prestressing of structural concrete (continued)

Structure ID	Strand nominal diameter (where applicable)
(a)	(j)

1. Enter a number in units of , to identify the nominal diameter to BS 5896 [Ref 50.N]for the strands in the structural element and/or its part, to be compatible with the steel designation number of the strands.

5.15 When the wires/strands have steel designations other than those corresponding to the lowest tensile strength to BS 5896 [Ref 50.N]for the same diameter, they shall only be used in the works if their tested maximum force and 0.1% proof force exceed the characteristic value of the maximum force and the characteristic value of the 0.1% proof force stated in BS 5896 [Ref 50.N], respectively.

5.16 Verification shall be undertaken for steel wires/strands of steel designation other than that corresponding, for the same diameter, to the lowest tensile strength to BS 5896 [Ref 50.N] by testing their maximum force and 0.1% proof force in accordance with BS EN ISO 15630-3 [Ref 96.N].

5.17 The frequency of the maximum force and 0.1% proof force testing shall be one sample per coil/bundle of steel wires/strands, tested once prior to installation in the works.

5.18 The requirements for "Verification" in Section 14 of GC 101 [Ref 44.N] shall apply to the maximum force and 0.1% proof force testing of steel wires/strands.

5.19 Verification for the maximum force and 0.1% proof force testing of steel wires/strands for the prestressing of structural concrete shall be undertaken by an accredited testing laboratory in compliance with "Accredited laboratory" in Section 16 of GC 101 [Ref 44.N].

5.20 The following Documentation shall be submitted for steel wires/strands for the prestressing of structural concrete prior to the commencement of prestressing works: certification that steel wires/strands are supplied by organisations holding a current certificate of approval for the steel wires/strands that confirms compliance with the specific requirements of the product certification scheme for steel wires/strands; certificate of approval issued by the certification body and certificate of conformity with BS 5896 [Ref 50.N]including test data for each cast/heat/batch number of steel wire and strand produced; test report for wires/strands with steel designation other than that corresponding, for the same diameter, to the lowest tensile strength to BS 5896 [Ref 50.N].

5.21 The requirements for "Documentation" in Section 2 of GC 101 [Ref 44.N] shall apply to : certification that steel wires/strands are supplied by organisations holding a current certificate of approval for the steel wires/strands that confirms compliance with the specific requirements of the product certification scheme for steel wires/strands; certificate of approval issued by the certification body and certificate of conformity with BS 5896 [Ref 50.N]including test data for each cast/heat/batch number of steel wire and strand produced; test report for wires/strands with steel designation other than that corresponding, for the same diameter, to the lowest tensile strength to BS 5896 [Ref 50.N].

Product requirements for cold worked high tensile alloy bars for prestressing of structural concrete

5.22 Cold worked high tensile alloy bars for prestressing of structural concrete shall be compliant with BS 4486 [Ref 87.N]as amended and complemented by this document.

5.23 The cold worked high tensile alloy bars for prestressing of structural concrete shall meet the following performance characteristics: those necessary to comply with BS 4486 [Ref 87.N].

5.24 The requirements for "Product certification schemes" in Section 11 of GC 101 [Ref 44.N] shall apply to cold worked high tensile alloy bars for prestressing of structural concrete.

5.25 Product certification schemes for cold worked high tensile alloy bars for prestressing of structural concrete shall be operated in accordance with BS ISO 10144 [Ref 100.N] by certification bodies accredited in accordance with BS EN ISO/IEC 17021-1 [Ref 25.N]ensuring that:.

1. All steel bars are fully traceable to the cast/heat/batch number, steel bar supplier(s) and steel bar manufacturer(s)

2. The certificate of conformity with BS 4486 [Ref 87.N]including test data and a certificate of approval issued by the certiifcation boby are provided by the steel bar supplier(s) and steel bar manufacturer(s) for each cast/heat/batch number of steel bar produced

3. Each bar or bundle of bars is fully identifiable with a secure and durable label or tag attached, which identifies the product certification scheme and compliance of the bars with BS 4486 [Ref 87.N]

4. The scheme has a technical supervisory panel, with documented structure and governance, made up of relevant industry experts, highway structures owners and product users

5. The scheme documentation, including the assessment criteria, is publicly accessible and is reviewed at least bi-annually

6. The scheme has a documented list of manufacturers and suppliers that hold a current approval with the scheme

7. The scheme requires documented audit and quality control of product production, product traceability, independent product testing at UKAS accredited laboratories, processing and installation

8. The scheme documents the frequency of surveillance audits, periodic independent product testing at UKAS accredited laboratories and management of non-conformance

5.26 Cold worked high tensile alloy bars for prestressing of structural concrete shall be as specified in CC 482/WSR/005.

Cold worked high tensile alloy bars for prestressing of structural concrete

Structure ID	**Structural element reference**	**Description of structural element**	**Drawing/ model reference(s)**	**Type of prestressing bar**	**Prestressing bar nominal diameter**
(a)	(b)	(c)	(d)	(e)	(f)

1. Enter a unique reference.

2. Enter a unique reference, to identify the structural element reference.

3. Enter text, to describe the structural element and/or its part incorporating prestressing bars.

4. Enter a unique reference, to provide reference of drawing(s) or model(s) where the structural element and/or its part incorporating prestressing bars is shown.

5. Enter a value, from options smooth, deformed, to identify the type of prestressing bar to BS 4486 [Ref 87.N]in the structural element and/or its part.

6. Enter a number in units of , to identify the nominal diameter to BS 4486 [Ref 87.N] for the prestressing bars in the structural element and/or its part.

5.27 The following Documentation shall be submitted for cold worked high tensile alloy bars for prestressing of structural concrete prior to the

commencement of the works: certification that the prestressing bars are supplied by organisations holding a current certificate of approval for the prestressing bars that confirms compliance with the specific requirements of the product certification scheme for prestressing bars; certificate of approval issued by the certification body and certificate of conformity with BS 4486 [Ref 87.N] including test data for each cast/heat/batch number of prestressing bar produced.

5.28 The requirements for "Documentation" in Section 2 of GC 101 [Ref 44.N] shall apply to : certification that the prestressing bars are supplied by organisations holding a current certificate of approval for the prestressing bars that confirms compliance with the specific requirements of the product certification scheme for prestressing bars; certificate of approval issued by the certification body and certificate of conformity with BS 4486 [Ref 87.N]including test data for each cast/heat/batch number of prestressing bar produced.

Product requirements for sheathing and ducts in post-tensioning systems for structural concrete

5.29 Sheathing and ducts in post-tensioning systems for structural concrete shall only be made of plastic/polymer materials and not of steel or other metallic materials.

5.30 Corrugated plastic ducts used for internal bonded tendons shall be compliant with FIB Bulletin 75 [Ref 11.N] and EAD 160004-00-0301 [Ref 62.N].

5.31 The corrugated plastic ducts used for internal bonded tendons shall meet the following performance characteristics: those in table 5.8.

5.32 Smooth-surfaced polymer sheathing used for individually greased tendons shall be compliant with EAD 160004-00-0301 [Ref 62.N].

5.33 The smooth-surfaced polymer sheathing used for individually greased tendons shall meet the following performance characteristics: those in table 5.8.

5.34 Smooth plastic ducts used for internal and external unbonded tendons shall be compliant with Annex D of EAD 160004-00-0301 [Ref 62.N].

5.35 The minimum wall thickness of corrugated plastic ducts used for internal bonded tendons shall be 2.0 mm.

5.36 The minimum wall thickness of smooth plastic ducts used for internal unbonded tendons shall be 2.0 mm.

5.37 The minimum wall thickness of smooth plastic ducts used for external unbonded tendons shall be 4.0 mm.

Product requirements for grout in post-tensioning systems for structural concrete

5.38 Site batched and pre-bagged grout for use in post-tensioning systems for structural concrete shall be compliant with BS EN 447 [Ref 48.N]as amended and complemented by this document.

5.39 The site batched and pre-bagged grout for use in post-tensioning systems for structural concrete shall meet the performance characteristics as stated in table 5.39.

Table 5.39 Characteristics and performance requirements for grouts in post-tensioning systems for structural concrete

Characteristic	Performance requirement
Chloride, sulfate and sulfide-ions content	As required in 6.1 of BS EN 447 [Ref 48.N]
Sieve test	As required in 6.2 of BS EN 447 [Ref 48.N]amended and complemented by 2.2.27 of EAD 160027-00-0301 [Ref 85.N]
Fluidity	As required in 6.3 of BS EN 447 [Ref 48.N]amended and complemented by 2.2.27 of EAD 160027-00-0301 [Ref 85.N], but with the target time of 90 minutes rather than 30 minutes
Bleeding	As required in 6.4 of BS EN 447 [Ref 48.N]amended and complemented by 2.2.27 of EAD 160027-00-0301 [Ref 85.N]
Volume change	As required in 6.5 of BS EN 447 [Ref 48.N]amended and complemented by 2.2.27 of EAD 160027-00-0301 [Ref 85.N], but with the target volume change limit to be within the range of -0.5% and 2.0% rather than -1.0% and 5.0%
Strength	As required in 6.6 of BS EN 447 [Ref 48.N]amended and complemented by 2.2.27 of EAD 160027-00-0301 [Ref 85.N]
Setting time	As required in 6.7 of BS EN 447 [Ref 48.N]amended and complemented by 2.2.27 of EAD 160027-00-0301 [Ref 85.N]
Density	As required in 6.8 of BS EN 447 [Ref 48.N]amended and complemented by 2.2.27 of EAD 160027-00-0301 [Ref 85.N]
Sedimentation	As required in 2.2.28 of EAD 160027-00-0301 [Ref 85.N]

5.40 Site-batched grout for use in post-tensioning systems for structural concrete shall have a United Kingdom Technical Assessment (UKTA)/European Technical Assessment (ETA) suitable for its intended use and application issued against the EAD 160027-00-0301 [Ref 85.N], with the performance characteristics as stated in table 5.39.

5.41 The requirements for Product certification schemes in Section 11 of GC 101 [Ref 44.N] shall apply to pre-bagged grout for use in post-tensioning systems for structural concrete.

5.42 Product certification schemes for pre-bagged grout for use in post-tensioning systems for structural concrete shall be operated by certification bodies accredited in accordance with BS EN ISO/IEC 17021-1 [Ref 25.N]ensuring that:.

1. The certificate of conformity with BS EN 447 [Ref 48.N]as amended and complemented by table 5.39, test results to BS EN 445 [Ref 47.N]as amended and complemented by table 5.39 and a certificate of approval issued by the certification body are provided by the pre-bagged grout supplier(s) and manufacturer(s) for the pre-bagged grout

2. The scheme has a technical supervisory panel, with documented structure and governance, made up of relevant industry experts, highway structures owners and product users

3. The scheme documentation, including the assessment criteria, is publicly accessible and is reviewed at least bi-annually

4. The scheme has a documented list of manufacturers and suppliers that hold a current approval with the scheme

5. The scheme requires documented audit and quality control of product production, product traceability, independent product testing at UKAS accredited laboratories, processing and installation

6. The scheme documents the frequency of surveillance audits, periodic independent product testing at UKAS accredited laboratories and management of non-conformance

5.43 Admixtures for site batched grout in post-tensioning systems for structural concrete shall be compliant with BS EN 934-1 [Ref 2.N]and BS EN 934-4 [Ref 1.N].

5.44 The admixtures for site batched grout for post-tensioning systems shall meet the performance characteristics as stated in table 5.44.

Table 5.44 Characteristics and performance requirements for

admixtures for site batched grout in post-tensioning systems for structural concrete.

Characteristic	Performance requirement
Chloride ion content	As required in Table 1(8) of BS EN 934-1 [Ref 2.N]
Thiocyanate content	As required in 5.1 of BS EN 934-1 [Ref 2.N]
Sulfide content	As required in 5.1 of BS EN 934-1 [Ref 2.N]
Corrosion behaviour	As required in Table 1(10) of BS EN 934-1 [Ref 2.N], with the exception that the admixtures shall not contain any aluminium powder
Durability	Durability relates to the grout and is met by the grout being in compliance with table 5.39
Compressive strength	As required in Table 1(2) of BS EN 934-4 [Ref 1.N]
Bleeding	As required in Table 1(3) of BS EN 934-4 [Ref 1.N]
Consistency (fluidity)	As required in Table 1(1) of BS EN 934-4 [Ref 1.N]but with the target time of 90 minutes rather than 30 minutes
Range of volume change at 24h	As required in Table 1(4) of BS EN 934-4 [Ref 1.N]but with the target volume change limit to be within the range of -0.5% and 2.0% rather than -1.0% and 5.0% (for non-expanding admixtures), and within the range of 0.0% and 2.0% rather than 0.0% and 5.0% (for expanding admixtures)

5.45 The requirements of "Designated standards" in Section 10 of GC 101 [Ref 44.N] shall apply to admixtures for site batched grout in post-tensioning systems for structural concrete.

5.46 Documentation for site batched grout for use in post-tensioning systems for structural concrete shall be in compliance with the requirements for "UK Technical Assessments" in Section 13 of GC 101 [Ref 44.N].

5.47 The following Documentation shall be submitted for site batched and pre-bagged grout for use in post-tensioning systems for structural concrete prior to the commencement of the works: certification of conformity with BS EN 447 [Ref 48.N] as amended and complemented by table 5.39; test report to BS EN 445 [Ref 47.N] as amended and complemented by table 5.39.

5.48 The requirements for "Documentation" in Section 2 of GC 101 [Ref 44.N] shall apply to : certification of conformity with BS EN 447 [Ref 48.N]as amended and complemented by table 5.39 ; test report to BS EN 445 [Ref 47.N]as amended and complemented by table 5.39.

5.49 The following Documentation shall be submitted for pre-bagged grout for use in post-tensioning systems for structural concrete prior to

the commencement of the works: certification that pre-bagged grout is supplied by organisations holding a current certificate of approval for pre-bagged grouts that confirms compliance with the specific requirements of the product certification scheme for pre-bagged grout; certificate of approval issued by the certification body.

5.50 The requirements for "Documentation" in Section 2 of GC 101 [Ref 44.N] shall apply to : certification that pre-bagged grout is supplied by organisations holding a current certificate of approval for pre-bagged grouts that confirms compliance with the specific requirements of the product certification scheme for pre-bagged grout; certificate of approval issued by the certification body.

Product requirements for grease and wax in post-tensioning systems for structural concrete

5.51 Grease and wax for use in post-tensioning systems for structural concrete shall have a United Kingdom Technical Assessment (UKTA)/European Technical Assessment (ETA) suitable for their intended use and application issued against the EAD 160027-00-0301 [Ref 85.N], with the performance characteristics as stated in table 5.51.

Table 5.51 Characteristics and performance requirements for grease and wax in post-tensioning systems for structural concrete

Characteristic	Performance requirement
Grease consistency	As required in 2.2.1 of EAD 160027-00-0301 [Ref 85.N]
Grease heat resistance, dropping point	As required in 2.2.2 of EAD 160027-00-0301 [Ref 85.N]
Grease heat resistance, flash point	As required in 2.2.3 of EAD 160027-00-0301 [Ref 85.N]
Grease stability	As required in 2.2.4 of EAD 160027-00-0301 [Ref 85.N]
Grease oxidation stability	As required in 2.2.5 of EAD 160027-00-0301 [Ref 85.N]
Grease corrosion protection	As required in 2.2.6, 2.2.7, 2.2.8 and 2.2.9 of EAD 160027-00-0301 [Ref 85.N]
Grease content of aggressive elements	As required in 2.2.10 of EAD 160027-00-0301 [Ref 85.N]
Grease possible interaction with polyethylene duct	As required in 2.2.11 of EAD 160027-00-0301 [Ref 85.N]
Grease water content	As required in 2.2.12 of EAD 160027-00-0301 [Ref 85.N]
Wax congealing point	As required in 2.2.13 of EAD 160027-00-0301 [Ref 85.N]
Wax heat resistance, dropping point	As required in 2.2.14 of EAD 160027-00-0301 [Ref 85.N]

Wax heat resistance, flash point	As required in 2.2.15 of EAD 160027-00-0301 [Ref 85.N]
Wax consistency	As required in 2.2.16 of EAD 160027-00-0301 [Ref 85.N]
Wax cold resistance	As required in 2.2.17 of EAD 160027-00-0301 [Ref 85.N]
Wax stability	As required in 2.2.18 of EAD 160027-00-0301 [Ref 85.N]
Wax oxidation stability	As required in 2.2.19 of EAD 160027-00-0301 [Ref 85.N]
Wax corrosion protection	As required in 2.2.20, 2.2.21, 2.2.22 and 2.2.23 of EAD 160027-00-0301 [Ref 85.N]
Wax content of aggressive elements	As required in 2.2.24 of EAD 160027-00-0301 [Ref 85.N]
Wax viscosity	As required in 2.2.25 of EAD 160027-00-0301 [Ref 85.N]
Wax possible interaction with polyethylene duct	As required in 2.2.26 of EAD 160027-00-0301 [Ref 85.N]

5.52 Documentation for grease and wax for use in post-tensioning systems for structural concrete shall be in compliance with the requirements for "UK Technical Assessments" in Section 13 of GC 101 [Ref 44.N].

Installation requirements of components for prestressing of structural concrete

General requirements for transport, handling and storage of components for prestressing of structural concrete

5.53 Tendons and other components for prestressing of structural concrete shall be transported, handled and stored in accordance with the manufacturer's instructions and with Annex E of BS EN 13670 [Ref 38.N].

5.54 Steel wires and strands for prestressing of structural concrete shall be delivered in bundles or in coils of sufficiently large diameter to ensure that the wire/strand pays off straight.

5.55 Cold worked high tensile alloy bars for prestressing of structural concrete as delivered shall be straight.

5.56 Tendons and other components for prestressing of structural concrete shall be protected during transport, handling and storage from environmental/weather conditions and site activities that can affect their performance and from any condition conducive to corrosion.

5.57 Wrappings used for protecting tendons and other components for prestressing of structural concrete shall not cause any adverse chemical reaction on them.

5.58 The threaded ends of cold worked high tensile alloy bars for prestressing of structural concrete and all threaded parts of anchorages shall be protected with greased wrappings to prevent damage and contamination.

5.59 Tendons and other components for prestressing of structural concrete shall be free from oil, paint, grease, soap, lubricants, loose mill scale and loose rust with pitting.

5.60 The presence, on prestressing tendons, of loose rust without pitting that can be removed by a soft cloth shall be acceptable, unless the structural element is subject to exposure class XD3 (severe marine or industrial sites) to BS 8500-1 [Ref 23.N]in accordance with CC 482/WSR/006.

5.61 Tendons and other components for prestressing of structural concrete shall not be mechanically damaged, work hardened or weakened through heating.

5.62 Tendons and other components for prestressing of structural concrete shall be at all times kept clean and free from any harmful matter detrimental to their strength, surface bond and performance.

5.63 Tendons and other components for prestressing of structural concrete shall be at all times kept free from standing water.

5.64 Tendons and other components for prestressing of structural concrete shall not be subjected, after manufacture, to any welding operation, heat treatment or metallic coating such as galvanising and epoxy coating.

5.65 Tendons for prestressing of structural concrete shall be protected from splashes from other materials and processes, such as those resulting from the cutting operations of an oxy-acetylene torch or arc-welding processes in the vicinity.

General requirements for installation of components for prestressing of structural concrete

5.66 Tendons for prestressing of structural concrete shall be cleaned by wire brushing or by passing them through a pressure box containing carborundum powder to remove all contaminants before incorporation in the works.

5.67 Unintended ingress of materials at the interface between wires/strands and the protective debonding sleeves positioned in accordance with CC 482/WSR/005 shall be prevented by securely sealing the ends of the sleeves to the wires/strands before incorporation in the works.

5.68 Solvent solutions shall not be used for cleaning of tendons for prestressing of structural concrete before incorporation in the works.

5.69 Tendons and other components for prestressing of structural concrete that have been delivered and stored for more than 8 weeks shall not be used in the works.

5.70 Steel wires and strands for prestressing of structural concrete that have become unravalled, kinked or twisted shall not be used in the works.

5.71 Cold worked high tensile alloy bars for prestressing of structural concrete that are bent in the threaded portion shall not be used in the works.

5.72 Prestressing tendons shall be installed straight, with the maximum bow height from a baseline 1 m of tendon in length no greater than 25 mm when measured from the inside of the curved tendon profile.

5.73 Verification shall be undertaken for the straightness of prestressing tendons to be installed in the works by testing in accordance with Section 14 of BS EN ISO 15630-3 [Ref 96.N]and checking that the straightness of the prestressing tendons meets the requirements of the specification.

5.74 The frequency of testing for the straightness of prestressing tendons to be installed in the works shall be once, prior to the incorporation in the works.

5.75 The requirements for "Verification" in Section 14 of GC 101 [Ref 44.N] shall apply to testing for straightness of prestressing tendons to be installed in the works.

5.76 Any small adjustments on site to achieve the required straightness of cold worked high tensile alloy bars for prestressing of structural concrete shall only be made by hand in a way that is not detrimental to the mechanical properties of the bars, and at a temperature not less than 5°C.

5.77 Warming of cold worked high tensile alloy bars for prestressing of structural concrete for the purpose of bending them to achieve the required straightness shall be by steam or hot water.

5.78 Tendons and other components for prestressing of structural concrete shall be accurately located and maintained in position both

vertically and horizontally in accordance with the drawing(s)/model(s) referenced in CC 482/WSR/005.

5.79 Components for prestressing of structural concrete shall be securely fixed and supported in position in a way that prevents them being displaced by actions including those resulting from heavy or prolonged vibration, workers, construction traffic and the pressure of the wet concrete being placed.

5.80 The tolerances for location of tendons and/or sheathing/ducts for prestressing of structural concrete shall comply with "Geometrical tolerances for structural concrete" in Section 8 of this document.

5.81 Verification shall be undertaken for the location of tendons and/or any sheathing/ducts and components for prestressing of structural concrete by measuring the cover and position of the tendons and/or sheathing/ducts and components for prestressing of structural concrete, and checking that they are within the values specified in the drawing(s)/model(s) referenced in CC 482/WSR/005 and the tolerances in "Geometrical tolerances for structural concrete" in Section 8 of this document.

5.82 The frequency of measurement of cover and position of the tendons and/or sheathing/ducts and components for prestressing of structural concrete shall be once, before the concreting and tensioning operations.

5.83 The requirements for "Verification" in Section 14 of GC 101 [Ref 44.N] shall apply to measurement of cover and position of the tendons and/or sheathing/ducts and components for prestressing of structural concrete.

5.84 The following Documentation for the cover and position of tendons and/or sheathing/ducts and components for prestressing of structural concrete shall be submitted as continuous records: written record of cover and position measurements before the concreting and tensioning operations.

5.85 The requirements of "Records" in Section 3 of GC 101 [Ref 44.N] shall apply to the written record of cover and position measurements.

Installation requirements specific to post-tensioning systems for structural concrete

5.86 Post-tensioning systems for structural concrete shall be installed in accordance with their United Kingdom Technical Assessment (UKTA)/European Technical Assessment (ETA) and the manufacturer's instructions as amended and complemented by this document.

5.87 The requirements for "Product acceptance schemes" in Section 12 of GC 101 [Ref 44.N] shall apply to the installation of post-tensioning systems for structural concrete for use in highway structures.

5.88 Post-tensioning systems for structural concrete shall only be installed by organisations with personnel holding third party accreditation with a competence assessment scheme for the installation of post-tensioning systems for structural concrete that covers the type of post-tensioning system used in the works.

5.89 The following Documentation shall be submitted for installation of post-tensioning systems for structural concrete prior to the commencement of the works and prior to any testing and trial: method statement covering all phases of installation of post-tensioning systems for the works and any testing and trials, including requirements on personnel, equipment and quality control.

5.90 Documentation for installation of post-tensioning systems for structural concrete shall be submitted at least 4 weeks prior to the commencement of the works and 4 weeks prior to any testing and trial, respectively.

5.91 The following Documentation shall be submitted for installation of post-tensioning systems for structural concrete prior to the commencement of the works and prior to any testing and trial: certification that installation is perfomed by organisations holding a current certificate of approval for installation of post-tensioning systems for structural concrete that confirms compliance with the specific requirements of the product acceptance scheme for installation of post-tensioning systems; certificate of approval issued by the certification body; certificate of third party accreditation with a competence assessment scheme demonstrating suitability of personnel for installation of the type of post-tensioning system used in the works.

5.92 Documentation for installation of post-tensioning systems for structural concrete shall be submitted at least 4 weeks prior to the commencement of the works and 4 weeks prior to any testing and trial, respectively.

5.93 Tendons and other components of post-tensioning systems for structural concrete shall be securely fixed and supported in position in a way that prevents misalignments, damage and deformation of the components that could lead to unintended increase in friction between tendons and ducts during tensioning operations or unintended leakages during air pressure testing or injection of duct filling material.

5.94 Internal and external unbonded tendons shall be sealed throughout their length so that they remain free of moisture.

5.95 Joints in sheathing/ducts for internal bonded tendons shall be securely taped to prevent unintended ingress of concrete and laitance inside the sheathing/duct.

5.96 Joints in adjacent sheathing/ducts shall be staggered and spaced at least 300 mm apart longitudinally.

5.97 Vents for the duct system shall be provided at the anchorages, in the troughs and crests of the duct and beyond each intermediate crest in the direction of flow of the duct filling material.

5.98 Vents on each duct shall be clearly identified by labelling that confirms the duct reference number and location of each vent on the tendon profile in accordance with the drawing(s)/model(s) in CC 482/WSR/005.

5.99 Vents shall be rigidly connected in position with the duct ensuring the holes in the duct are no smaller than the internal diameter of the vents.

5.100 Vents shall be fitted with valves capable of being closed and re-opened to maintain the pressure during air pressure testing and to control the flow during injection of the duct filling material.

5.101 Duct systems of post-tensioning systems for structural concrete shall be as specified in CC 482/WSR/005.

Duct systems of post-tensioning systems for structural concrete

Structure ID	**Structural element reference**	**Description of structural element**	**Drawing/ model reference(s)**	**Duct reference**	**Duct diameter for circular ducts (where applicable)**	**Duct dimensions for-non circular ducts (where applicable)**	**Wall thickness of duct**
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)

1. Enter a unique reference.

2. Enter a unique reference, to identify the structural element reference.

3. Enter text, to describe the structural element and/or its part prestressed by post-tensioning with tendons within ducts.

4. Enter a unique reference, to provide reference of drawing(s) or model(s) for the structural element prestressed by post-

tensioning with tendons within ducts, showing the layout of the post-tensioning system including any tendons, sheathing, anchorages, ducts, couplings, deviators, vents, drains, tendon support devices, connectors, caps.

5. Enter a unique reference, to identify the reference of the duct associated with structural element and/or its part prestressed by post-tensioning.

6. Enter a number in units of , to identify the required outer diameter of the duct.

7. Enter text, to identify the required outer duct dimensions.

8. Enter a number in units of , to identify the required wall thickness of the duct.

Duct systems of post-tensioning systems for structural concrete (continued)

Structure ID	Leak tightness of assembled duct systems test required	Minimum vent internal diameter	Maximum vent spacing	Minimum vent height above highest point	Distance beyond crests to the next vent	Vent arrangements at deviators/diaphragms (where applicable)
(a)	(i)	(j)	(k)	(l)	(m)	(n)

1. Enter a value, from options yes, no, to identify the need for performing a leak tightness test of the assembled duct systems on site in accordance with the procedure in B.5 of Annex B of FIB Bulletin 75 [Ref 11.N].

2. Enter a number in units of , to identify the minimum allowed internal diameter of the vents.

3. Enter a number in units of , to identify the maximum allowed spacing for the vents along the duct.

4. Enter a number in units of , to identify the minimum required height of the vents above the highest point of the duct profile.

5. Enter a number in units of , to identify the horizontal distance between an intermediate crest of the duct and the next vent in the direction of flow of the duct filling material.

6. Enter text, to identify any specific requirement for the arrangement of the vents at deviators/diaphragms for duct systems for post-tensioning systems with external tendons.

5.102 The horizontal distance between an intermediate crest of the duct and the next vent in the direction of flow of the duct filling material shall be the distance from the crest until the point where the duct is half its diameter lower than at the crest, or 1 m, whichever is the lesser, unless otherwise stated in CC 482/WSR/005.

5.103 The maximum vent spacing along the duct shall be 15 m, unless otherwise stated in CC 482/WSR/005.

5.104 The minimum height of vents above the highest point of the duct profile to ensure an effective head of the filling material shall be 500 mm, unless otherwise stated in CC 482/WSR/005.

5.105 The minimum internal diameter of vents shall be 15 mm, unless otherwise stated in CC 482/WSR/005.

5.106 Verification shall be undertaken for the leak tightness of each assembled duct system on site, unless otherwise stated in CC 482/WSR/005, by checking, in accordance with the procedure in B.5 of Annex B of FIB Bulletin 75 [Ref 11.N], that the air pressure loss after 5 minutes of application of a positively maintained air pressure of 0.5 bar to the duct system does not exceed 10% of the initial air pressure.

5.107 The frequency of the air pressure loss testing of the assembled duct system shall be once prior to the concreting operations surrounding the duct, for duct systems with internal tendons, or once prior to tensioning of the tendons, for duct systems with external tendons and/or segmental construction.

5.108 The requirements for "Verification" in Section 14 of GC 101 [Ref 44.N] shall apply to air pressure loss testing of the assembled duct system.

5.109 Testing for leak tightness of the assembled duct system shall be performed with the assembled duct system incorporating all the components of the post-tensioning system used for the works, including tendons, sheathing, anchorages, ducts, couplings, deviators, vents, drains, tendon support devices, connectors, caps.

5.110 The following Documentation for testing for leak tightness of the assembled duct system shall be submitted as continuous records: test report in accordance with B.5 of Annex B of FIB Bulletin 75 [Ref 11.N].

5.111 The requirements of "Records" in Section 3 of GC 101 [Ref 44.N] shall apply to the test report for leak tightness of the assembled duct system testing.

5.112 In the event of failure of the leak tightness testing of the assembled duct system, the system shall be dismantled, any damaged parts replaced, the installation method statement and/or sealing details revised and the system reassembled and re-tested until compliance is achieved.

5.113 Before the insertion of the tendons in ducts for subsequent tensioning, a dolly of diameter/dimensions slightly smaller than the duct diameter/dimensions shall be drawn through the duct to clear any obstruction or deformation caused by concreting operations surrounding the ducts, for duct systems with internal tendons, or by external agents, for duct systems with external tendons, and ensure a clear passage for the insertion of the tendons.

5.114 Inflatable duct formers shall not be used to clear any obstruction or deformation in the ducts.

Tensioning requirements for prestressing of structural concrete

General tensioning requirements for prestressing of structural concrete

5.115 The prestressing tendons to be stressed together in a single operation shall be taken from the same coil or bundle, to minimise the risk of excessive variability in their properties.

5.116 The ends of each individual prestressing tendon shall be labelled to facilitate the identification, jacking and measurement of elongation during tensioning operations.

5.117 Where two or more prestressing tendons are to be stressed simultaneously, they shall be of equal length between anchorage points, at the datum of force and elongation measurement, to ensure consistent strains, stresses and forces are achieved during tensioning operations.

5.118 The tensioning equipment shall be capable of applying the stressing force in a controlled manner to avoid sudden energy release that could damage the prestressing components and the concrete.

5.119 The tensioning equipment shall be capable to of measuring force and elongations in the prestressing tendons and other components within an accuracy of 2%.

5.120 Verification shall be undertaken for the accuracy of the tensioning equipment by calibration, ensuring that the tensioning equipment is capable of measuring force and elongations within an accuracy of 2%.

5.121 The frequency of calibration shall be once no more than 4 weeks prior to the tensioning operations for the works, and subsequently once at intervals not exceeding 6 months.

5.122 The requirements for "Verification" in Section 14 of GC 101 [Ref 44.N] shall apply to calibration of the tensioning equipment.

5.123 The following Documentation shall be submitted for the tensioning equipment prior to the commencement of tensioning operations for the works: calibration certificate.

5.124 Documentation of calibration certification shall be submitted no later than 7 days prior to the commencement of tensioning operations for the works.

5.125 Cutting of tendons used for prestressing of structural concrete shall only be carried out after the tension in the tendons to be cut has been released in a controlled manner.

5.126 Cutting operations shall be executed using a high-speed abrasive cutting wheel, friction saw or equivalent mechanical method at a distance no less than one tendon diameter from the anchor.

Tensioning requirements specific to pre-tensioning of structural concrete

5.127 Structural elements to be prestressed by pre-tensioning shall be concreted no later than 4 weeks after the tendons have been installed in their formwork and no later than 2 weeks after the tendons have been tensioned.

5.128 The tension in the tendons for pre-tensioning of structural concrete shall be maintained constant during the period between tensioning and release.

5.129 Tendons for pre-tensioning of structural concrete shall be released in a controlled manner and not cut whilst tensioned, to ensure transfer of stress to the concrete through an appropriate transmission length.

5.130 In long-line pre-tensioning, locator plates shall be distributed through the length of the prestressing bed in a manner that ensures the tendons remain within their positional tolerance during concreting.

5.131 Where a number of structural elements are made in line in long-line pre-tensioning, the structural elements shall be free to slide in the

direction of their length to permit transfer of the stress to the concrete along the whole line.

5.132 Moulds used in pre-tensioning of structural concrete in single mould systems shall be able to provide the reaction to the tensioning operations without distortions that could be detrimental to the prestressing.

5.133 When prestressing steel wires and strands for pre-tensioning of structural concrete are to be deflected within the structural element, the deflectors shall have a radius of no less than 5 times the tendon diameter for wires, or 10 times the tendon diameter for strands, respectively.

5.134 When prestressing steel wires and strands for pre-tensioning of structural concrete are to be deflected within the structural element, the angle of deflection at each deflector shall not exceed 15°.

5.135 When prestressing steel wires and strands for pre-tensioning of structural concrete are to be deflected within the structural element, the mechanisms for holding down or holding up the tendons shall allow the tendons to move freely in line with the tendon so that frictional losses are minimised.

5.136 When prestressing steel wires and strands for pre-tensioning of structural concrete are to be deflected within the structural element, the transfer of the prestressing force to the concrete shall be undertaken concurrently with the release of the hold-down and hold-up forces at the deflectors.

5.137 Elongations of the tendons used for pre-tensioning of structural concrete shall be measured during tensioning operations to an accuracy within 2% of the total tendon elongation or 2 mm, whichever is the greater.

5.138 Verification shall be undertaken for the tensioning operations in pre-tensioning of structural concrete by checking that: the measured elongation of a single tendon is within 5% of the calculated value specified in CC 482/WSR/005; the measured average of the strains of all tendons in a cross-section of the structural element is within 3% of the calculated value specified in CC 482/WSR/005.

5.139 The frequency of the measurement of the elongation of every tendon shall be once, when the maximum applied force is reached.

5.140 The requirements for "Verification" in Section 14 of GC 101 [Ref 44.N] shall apply to the measurement of the prestressing force and elongation in pre-tensioning of structural concrete.

5.141 When the measured elongation or average of strains of the pre-tensioning tendons fails to meet the requirement of being within 5% or 3%

respectively of the calculated values specified in CC 482/WSR/005, the tendons shall be released, any adjustments made and the tensioning operations restarted until compliance is achieved.

5.142 The tension in tendons used for pre-tensioning of structural concrete shall only be released and transferred to the hardened concrete when the concrete has reached the minimum compressive strength specified in CC 482/WSR/005.

5.143 Verification shall be undertaken for the compressive strength of concrete before it can be stressed by the pre-tensioning tendons by determining, in accordance with BS EN 12390-3 [Ref 116.N]with test specimens made and cured in accordance with BS EN 12390-2 [Ref 118.N]and stored under environmental conditions representative of those of the concrete in the structural element, the compressive strength of samples taken in accordance with Annex B.3 of BS 8500-1 [Ref 23.N]and Annex B.2(4) of BS EN 206 [Ref 21.N]and tested at different ages and checking that the pre-tensioning tendons are not released until the compressive strength of the samples meets the identity criteria in Annex B.7 of BS 8500-1 [Ref 23.N]in relation to the minimum compressive strength specified in CC 482/WSR/005.

5.144 The frequency of determination of the compressive strength of concrete before it can be stressed by the pre-tensioning tendons shall be every 24 hours after concrete placing and until the compressive strength reaches the minimum value specified, using four test specimens made from one sample for each age of testing taken randomly from an amount of concrete representing no more than the lesser of 2 batches or 12 m^3, but with no less than one sample per day of concreting.

5.145 The requirements for "Verification" in Section 14 of GC 101 [Ref 44.N] shall apply to determination of the compressive strength of concrete before it can be stressed by the pre-tensioning tendons.

5.146 The following Documentation for compressive strength testing at transfer for pre-tensioning of structural concrete shall be submitted as continuous records: certificate with test results confirming achievement of the required minimum concrete compressive strength at transfer.

5.147 The requirements of "Records" in Section 3 of GC 101 [Ref 44.N] shall apply to certificate with test results confirming achievement of the required minimum concrete compressive strength at transfer.

5.148 The following Documentation for the tensioning operations in pre-tensioning of structural concrete shall be submitted as continuous records: report summarising the tensioning operations, including measurement of the prestressing force/tendon elongation; age of the concrete, in hours, at the release and transfer of the tension.

5.149 The requirements of "Records" in Section 3 of GC 101 [Ref 44.N] shall apply to the report summarising the tensioning operations for pre-tensioning of structural concrete.

Tensioning requirements specific to post-tensioning of structural concrete

5.150 Where post-tensioning tendons are not stressed simultaneously, spacers that are in accordance with the post-tensioning system manufacturer's instructions shall be provided to permit the movement of the components of the post-tensioning system relative to one another.

5.151 When prestressing tendons for post-tensioning of structural concrete are to be deflected within the structural element, the deflector shall have a radius of not less than 50 times the tendon diameter.

5.152 When prestressing tendons for post-tensioning of structural concrete are to be deflected within the structural element, the angle of deflection at each deflector shall not exceed 15°.

5.153 Before commencement of the tensioning operations, the tendons installed in the ducts shall be pulled back and forth inside each duct for 250 mm to verify they are free to move within the duct.

5.154 Tensioning operations in post-tensioning of structural concrete shall only commence when the concrete has reached the minimum compressive strength specified in CC 482/WSR/005.

5.155 Verification shall be undertaken for the compressive strength of concrete before it can be stressed by post-tensioning by determining, in accordance with BS EN 12390-3 [Ref 116.N]with test specimens made and cured in accordance with BS EN 12390-2 [Ref 118.N]and stored under environmental conditions representative of those of the concrete in the structural element, the compressive strength of samples taken in accordance with Annex B.3 of BS 8500-1 [Ref 23.N]and Annex B.2(4) of BS EN 206 [Ref 21.N]and tested at different ages and checking that the post-tensioning tendons are not stressed until the compressive strength of the samples meets the identity criteria in Annex B.7 of BS 8500-1 [Ref 23.N]in relation to the minimum compressive strength specified in CC 482/WSR/005.

5.156 The frequency of determination of the compressive strength of concrete before it can be stressed by post-tensioning shall be every 24 hours after concrete placing and until the compressive strength reaches the minimum value specified, using four test specimens made from one concrete sample for each age of testing taken randomly from an amount of concrete representing no more than the lesser of 2 batches or 12m^3, but with no less than one sample per day of concreting.

5.157 The requirements for "Verification" in Section 14 of GC 101 [Ref 44.N] shall apply to determination of the compressive strength of concrete before it can be stressed by post-tensioning.

5.158 The following Documentation for compressive strength testing at transfer for post-tensioning of structural concrete shall be submitted as continuous records: certificate with test results confirming achievement of the required minimum concrete compressive strength at transfer.

5.159 The requirements of "Records" in Section 3 of GC 101 [Ref 44.N] shall apply to certificate with test results confirming achievement of the required minimum concrete compressive strength at transfer.

5.160 Tensioning operations in post-tensioning of structural concrete shall be carried out in a controlled way that ensures that the stresses in the post-tensioning tendons and the concrete increase at a steady rate, preventing any shock that could damage the post-tensioning system and the concrete.

5.161 Tensioning operations in post-tensioning of structural concrete shall not be carried out at temperatures below 0°C.

5.162 The applied tensioning force in post-tensioning of structural concrete shall take into account the anticipated losses due to friction in the jack and in the anchorages and due to the draw-in at anchorages.

5.163 Elongations of the tendons for post-tensioning of structural concrete shall be measured during tensioning operations to an accuracy within 2% of the total tendon elongation or 2 mm, whichever is the greater.

5.164 Measurement of the elongation of the tendons for post-tensioning of structural concrete during tensioning operations shall take into account the draw-in of the post-tensioning system at anchorages.

5.165 Measurement of the draw-in of the post-tensioning system at anchorages during tensioning operations shall not commence until any slack in the post-tensioning system has been taken up.

5.166 The measured value of the elastic modulus of tendons for post-tensioning of structural concrete shall be obtained by measuring the force-elongation relationship of a 1 m or greater gauge length of tendon.

5.167 Verification shall be undertaken for the tensioning operations in post-tensioning of structural concrete by checking that: the measured elongation of each individual tendon is within 15% of the calculated value in accordance with the design documentation in CC 482/WSR/005, when the measured value of the elastic modulus of the tendon is used; the measured average of the strains of all tendons in a cross-section of the structural element is within 5% of the calculated value in accordance with

the design documentation in CC 482/WSR/005, when the measured value of the elastic modulus of the tendons is used.

5.168 The frequency of the measurement of the elongation of every tendon shall be throughout the tensioning process and until the maximum applied force is reached, by providing at least 5 data measurements on the force/elongation curve, with the data measurements equally spaced in time to a tolerance of 10% of the applied force.

5.169 The requirements for "Verification" in Section 14 of GC 101 [Ref 44.N] shall apply to measurement of the prestressing force and elongation in post-tensioning of structural concrete.

5.170 When the measured elongation or average of strains of the post-tensioning tendons fails to meet the requirement of being within 15% or 5% of the calculated values in accordance with the design documentation in CC 482/WSR/005, the tendons shall be released, any adjustments made and the tensioning operations restarted until compliance is achieved.

5.171 The force in the post-tensioning tendon during tensioning operations shall not exceed 80% of the characteristic maximum tensile strength of the tendon.

5.172 Anchoring of the post-tensioning system shall only be effected once the tensioning force has reached the value specified in CC 482/WSR/005.

5.173 After the post-tensioning system has been anchored, the tension in the tendons shall be released in a controlled manner to avoid sudden release of energy that could damage the post-tensioning system.

5.174 The force in the post-tensioning tendon immediately after anchoring shall not exceed 70% of the characteristic maximum tensile strength of the tendon.

5.175 Cutting of post-tensioning tendons, grouting operations and any other work which prevents the possibility of re-tensioning of the post-tensioning system shall not be undertaken until the causes of any deviation from the planned performance of the post-tensioning system during tensioning have been investigated.

5.176 The following Documentation for the tensioning operations in post-tensioning of structural concrete shall be submitted as continuous records: report summarising the tensioning operations, including measurement of the prestressing force/tendon elongation; measurement of the draw-in at anchorages; measurement of elastic modulus of tendons; age of the concrete, in hours, at the start of the tensioning operations.

5.177 The requirements of "Records" in Section 3 of GC 101 [Ref 44.N] shall apply to the report summarising the tensioning operations for post-tensioning of structural concrete.

Grouting, greasing/waxing and other protective measures for post-tensioning of structural concrete

General requirements for grouting and greasing/waxing for post-tensioning of structural concrete

5.178 Grouting of ducts in post-tensioning systems for structural concrete shall be compliant with BS EN 446 [Ref 46.N]as amended and complemented by this document.

5.179 The Inspection Class for grouting of ducts in post-tensioning systems for structural concrete, that is related to the Execution Class defined in BS EN 13670 [Ref 38.N], shall be Class 3 in accordance with Section 9 of BS EN 446 [Ref 46.N].

5.180 Greasing/waxing of ducts in post-tensioning systems for structural concrete shall be compliant with 7.6.6 of BS EN 13670 [Ref 38.N].

5.181 Grouting and greasing/waxing of ducts in post-tensioning systems for structural concrete shall be undertaken no later than 12 weeks after the post-tensioning tendons have been fabricated, no later than 4 weeks after they have been installed in the duct and no later than 2 weeks after they have been tensioned.

5.182 Grouting of ducts in post-tensioning systems for structural concrete shall be as specified in CC 482/WSR/005.

Grouting of ducts in post-tensioning systems for structural concrete

Structure ID	Structural element reference	Description of structural element	Drawing/ model reference(s)	Duct reference	Grout type	Maximum water/cement ratio of grout
(a)	(b)	(c)	(d)	(e)	(f)	(g)

1. Enter a unique reference.

2. Enter text, to identify the structural element reference.

3. Enter text, to describe the structural element and/or its part prestressed by post-tensioning with grouted ducts.

4. Enter a unique reference, to provide reference of drawing(s) or model(s) for the structural element and/or its part prestessed by

post-tensioning with grouted ducts which include the layout of the post-tensioning system comprising tendons, anchorages, caps, ducts, vents, drains, inlets, outlets.

5. Enter a unique reference, to identify the reference of the duct to be grouted in the structural element and/or its part.

6. Enter a value, from options site batched, pre-bagged, to identify the type of grout used for grouting of the duct in the structural element and/or its part.

7. Enter a number, to identify the maximum permissible water/cement ratio of the grout used for grouting of the duct in the structural element and/or its part.

Grouting of ducts in post-tensioning systems for structural concrete (continued)

Structure ID	Grout admixture requirements	Type of grout admixture (where applicable)	Maximum dosage of admixture (where applicable)	Grouting pressure range	Maximum rate of grouting of the duct	Minimum volume of grout to be expelled at vent	Full-scale grouting trials required
(a)	(h)	(i)	(j)	(k)	(l)	(m)	(n)

1. Enter text, to identify the need and reason for a grout admixture for the grout used for grouting of the duct in the structural element and/or its part.

2. Enter text, to identify the type of grout admixture for the grout used for grouting of the duct in the structural element and/or its part, such as expanding in powder form; non-expanding in powder form; non-expanding in liquid form; or other,.

3. Enter a number in units of , to state the maximum dosage of admixture in percentage by mass of cement for the grout used for grouting of the duct in the structural element and/or its part.

4. Enter a number range (e.g. "40-60") in units of , to identify the minimum and maximum pressure to be applied when grouting the duct in the structural element and/or its part.

5. Enter a number in units of , to identify the maximum permissible rate of grouting of the duct in the structural element and/or its part.

6. Enter a number in units of , to identify the minimum volume of grout to be expelled from each vent during grouting of the duct in the structural element and/or its part.

7. Enter a value, from options yes, no, to identify whether full-scale trials of the grouting operations are required for the structure and/or the structural element and/or its part.

5.183 Verification shall be undertaken for grouting of ducts in post-tensioning systems for structural concrete by inspection prior, during and after grouting in accordance with Tables 2, 3 and 4 of Section 9 of BS EN 446 [Ref 46.N], with the grout acceptance testing criteria modified in order to comply with the performance requirements of BS EN 447 [Ref 48.N]as amended by tables 5.39 and 5.44 of this document.

5.184 The frequency of the inspection of grouting of ducts in post-tensioning systems for structural concrete shall be in accordance with BS EN 446 [Ref 46.N]for Inspection Class 3.

5.185 The requirements for "Verification" in Section 14 of GC 101 [Ref 44.N] shall apply to inspection of grouting of ducts in post-tensioning systems for structural concrete in accordance with BS EN 446 [Ref 46.N].

5.186 The following Documentation for grouting and greasing/waxing of ducts in post-tensioning systems for structural concrete shall be submitted as continuous records: inspection records for grouting of ducts in post-tensioning systems for structural concrete; records for greasing/waxing operations of ducts/sheaths in post-tensioning systems for structural concrete, confirming that the operations have been undertaken in accordance with the manufacturer's instructions.

5.187 The requirements of "Records" in Section 3 of GC 101 [Ref 44.N] shall apply to : inspection records for grouting of ducts in post-tensioning systems for structural concrete; records for greasing/waxing operations of ducts in post-tensioning systems for structural concrete.

Grout batching and mixing requirements for post-tensioning of structural concrete

5.188 The maximum water/cement ratio of the grout shall be 0.35, unless otherwise stated in CC 482/WSR/005.

5.189 The dosage of admixtures shall not exceed 5% by mass of the cement, unless otherwise stated in CC 482/WSR/005.

5.190 The dosage of admixtures shall be within the range recommended by the manufacturer.

5.191 All materials shall be batched by mass, except water and liquid admixtures for which batching by both mass and volume is permitted.

5.192 Cement, additions and any powder or liquid admixtures shall be batched to an accuracy of ± 2%.

5.193 Mixing water shall be batched to an accuracy of ± 1%.

5.194 The total amount of mixing water for batching shall include the water content of any liquid admixtures.

5.195 Admixtures shall not be added to pre-bagged grouts.

5.196 For site batched grouts, admixtures shall be added to the mixer on site in accordance with the manufacturer's instructions.

5.197 Pre-bagged grouts shall be mixed in accordance with the manufacturer's instructions.

5.198 The minimum mixing time in accordance with the manufacturer's instructions or as determined from grout suitability testing shall be adhered to.

5.199 The temperature of freshly mixed grout shall be between 5°C and 35°C.

5.200 The suitability of the grout proposed for use in the permanent works shall be confirmed by suitability testing in accordance with Section 6 of BS EN 446 [Ref 46.N]as amended and complemented by this document.

5.201 Verification shall be undertaken for the adequacy of the proposed water/cement ratio, the proposed dosage of any added admixtures and the other grout properties by: performing suitability testing, in accordance with Table 1 of BS EN 446 [Ref 46.N], on a grout prepared using the same materials, equipment and personnel proposed for use in the works and checking that the resulting grout properties comply with the performance requirements of BS EN 447 [Ref 48.N]as amended by table 5.39 and table 5.44 of this document.

5.202 The frequency of suitability testing for grouts shall be : once, no later than 28 days prior the commencement of the grouting operations for the works and with the number of tests in accordance with Table 1 of BS EN 446 [Ref 46.N]performed each at no less than two different temperatures, representing a minimum and maximum of the expected range of temperatures at the time of the grouting operations for the works.

5.203 The requirements for "Verification" in Section 14 of GC 101 [Ref 44.N] shall apply to suitability testing of the grout for grouting of ducts in post-tensioning systems for structural concrete.

5.204 The following Documentation for suitability testing of grout for the grouting of ducts in post-tensioning systems for structural concrete shall be submitted as continuous records: grout suitability testing report.

5.205 The requirements of "Records" in Section 3 of GC 101 [Ref 44.N] shall apply to test report for grout suitability testing.

5.206 In the event of the outcomes of the suitability testing failing to meet the required performance requirements, adjustment to the materials, equipment and personnel shall be made, the method statement revised and the suitability testing repeated until compliance is achieved.

Grouting operations requirements for post-tensioning of structural concrete

5.207 The grout shall be kept in continuous agitation in the mixer of the grouting equipment to ensure it is homogeneous when pumped into the duct.

5.208 Standby grouting equipment shall be provided during grouting operations to allow for equipment breakdown or other unforeseen events.

5.209 If grouting operations are disrupted before completion or grouting equipment breaks down, the duct shall be completely flushed out to remove all grout using flushing-out plant.

5.210 Grouting equipment shall be washed through with clean water after every grouting operation and in any case no less frequently than every three hours, so that is kept free from build-up of adhering material contaminating the grout.

5.211 Ducts shall not be warmed with steam prior to grouting.

5.212 Grouting of ducts shall be undertaken from one end of the duct only, in a way that ensures the grout completely fills the duct and surrounds the prestressing tendons.

5.213 The maximum rate of grouting of ducts shall be 10 m/min, unless otherwise stated in CC 482/WSR/005.

5.214 The grouting pressure shall be as stated in CC 482/WSR/005.

5.215 Verification shall be undertaken for the grouting of ducts by measurement of the quantity of grout injected and expelled from vents

using a suitable device such as a flow meter for comparison with the volume of the spaces to be filled in the duct.

5.216 The frequency of measurement of the quantity of grout injected and expelled from vents shall be continuous during grouting operations.

5.217 The requirements for "Verification" in Section 14 of GC 101 [Ref 44.N] shall apply to measurement of the quantity of grout injected and expelled from vents.

5.218 During grouting operations, once the fluidity of the grout flowing from the vents is the same as the grout being injected, 5 litres of grout at each vent shall be vented into a clean receptacle and discarded, unless otherwise stated in CC 482/WSR/005.

5.219 To prevent leakage of grout or accidental reopening of the vents, after venting of the grout it shall be ensured that vent openings are closed in sequence, starting closest to the point of grout installation and proceeding in the direction of the flow, except that at intermediate crests the vent downstream from the crest is closed before the vent at the crest.

5.220 When all vents are closed, injection tubes shall be sealed off under a pressure of 0.5 MPa maintained for at least one minute and followed by immediate reopening of the vents at high points while grout is still fluid, to check that there is no unintended escape of air, water or grout from the reopened vents.

5.221 Any escape of air, water or grout from the reopened vents at high points shall be recorded and reported in writing detailing location and material escaping.

5.222 Following reopening of vents at high points, a further pumping of grout shall be carried out with the vents open one at a time sequentially in the direction of grouting and a further 5 litres being released at each vent, to expel bleed water and/or entrapped air.

5.223 After all vents are closed again, a pressure of 0.5 MPa shall be maintained for at least one minute to confirm there are no unintended losses due to leakages in the grouted duct.

5.224 If the pressure cannot be maintained without pumping further grout, therefore indicating a leakage in the system, the leakage shall be located, the system cleared of grout and, upon adjustment/repair of the cause of the leakage, the method statement revised and grouting operations repeated until pressure is maintained for at least one minute, to confirm there are no unintended losses due to leakage in the grouted duct.

5.225 The filled ducts shall not be subjected to shock or vibration for at least 24 hours from the time of grouting, to ensure that no segregation, cracking or weak spots are induced in immature grout.

5.226 After completion of grouting, all anchorages shall be provided with sealed caps.

5.227 Verification shall be undertaken for anchorages by visual inspection at the vent locations and light tapping of the caps to check there is no evidence of voids in the grout at the anchorage.

5.228 The frequency of visual inspection at the vent locations and light tapping of the caps shall be once, no less than 3 days after the completion of grouting operations.

5.229 The requirements for "Verification" in Section 14 of GC 101 [Ref 44.N] shall apply to visual inspection at the vent locations and light tapping of the caps.

5.230 If evidence of voids in the grout is apparent at anchorages, all anchorage caps shall be removed, measurements of the extent of voids taken and photographic records prepared.

5.231 Verification shall be undertaken for the adequacy of grouting at anchorages where voids in the grout have been identified at their vents by checking that no void in the grout at anchorages has a dimension greater than 5% of the diameter of the anchorage for circular anchorages, or 5% of the smallest dimension of non-circular anchorages, measured in the radial direction of the anchorage for circular anchorages, or perpendicular to the longitudinal axis of the anchorage for non-circular anchorages.

5.232 The frequency of the void measurement shall be once after completion of grouting, for all anchorages where visual inspection of the opened vents has revealed apparent voids in the grout.

5.233 The requirements for "Verification" in Section 14 of GC 101 [Ref 44.N] shall apply to the measurement of voids in the grout at anchorages.

5.234 Anchorage caps which have been removed shall be replaced and sealed to prevent contamination of the grout.

5.235 The following Documentation for grouting of ducts in post-tensioning systems for structural concrete shall be submitted as continuous records: grouting records for each duct including the actual water/cement ratio of the grout used in the works; the type and dosage of any admixture used in the works; volume of spaces in the ducts to be filled and actual grout volume injected and expelled from the vents; record of any escape of air, water or grout from reopened high vents during grouting operations; visual inspection record of grouting at

anchorage cap vents; photographic record and measurement of grout voids at anchorage caps, when undertaken.

5.236 The requirements of "Records" in Section 3 of GC 101 [Ref 44.N] shall apply to grouting records for grouting of ducts in post-tensioning systems for structural concrete.

5.237 Verification shall be undertaken for grouting in cold or hot weather by measuring, when the ambient temperature on the day of grouting and up to 48 hours after is expected to fall below 5°C or to exceed 30°C: the ambient temperature; the temperature of the air within ducts for post-tensioning systems with external tendons; the temperature of the concrete structure adjacent to the tendon for post-tensioning systems with internal tendons; and ensuring that grouting is only undertaken when the measured temperatures fall within the range permitted in 8.3 of BS EN 446 [Ref 46.N].

5.238 The frequency of temperature measurement shall be every 6 hours on the day of grouting and for 48 hours thereafter.

5.239 The requirements for "Verification" in Section 14 of GC 101 [Ref 44.N] shall apply to measurement of temperatures for grouting in cold or hot weather.

5.240 The following Documentation for grouting in cold or hot weather shall be submitted as continuous records: measurement of the maximum and minimum ambient air temperature; measurement of the temperature of the air within ducts in post-tensioning systems with external tendons; measurement of the temperature of the structural element containing the duct in post-tensioning systems with internal tendons.

5.241 The requirements of "Records" in Section 3 of GC 101 [Ref 44.N] shall apply to measurement of temperatures for grouting in cold or hot weather.

Full-scale trials requirements for the grouting operations for post-tensioning of structural concrete

5.242 Verification shall be undertaken for the grouting of ducts for post-tensioning systems by full-scale trials of the grouting operations, unless otherwise stated in CC 482/WSR/005, to demonstrate that, with the proposed grouting methods and procedures, the grout is able to fill the ducts and surround the prestressing tendons.

5.243 The frequency of the full-scale grouting trials shall be once, at least 56 days prior to the installation of the post-tensioning system in the works unless otherwise stated in CC 482/WSR/005.

5.244 The requirements for "Verification" in Section 14 of GC 101 [Ref 44.N] shall apply to the full-scale trials of the grouting operations for grouting of ducts for post-tensioning systems.

5.245 The full-scale trials of the grouting operations shall incorporate representative details of tendons, sheathing, anchorages, ducts, couplings, deviators, vents, drains, tendon support devices, connectors and caps with systems, methods and materials equivalent to those submitted in the method statement for the works.

5.246 The details of the assembly to be constructed for the full-scale trials of the grouting operations shall be as stated in CC 482/WSR/005.

5.247 During the full-scale trials of grouting operations, the prestressing tendons shall be sufficiently tensioned such that the bars/wires/strands take up an alignment consistent with that which is anticipated in the works under full tensioning.

5.248 Full-scale trials of the grouting operations for grouting of ducts for post-tensioning systems shall be as specified in CC 482/WSR/005.

Full-scale trials of the grouting operations for grouting of ducts for post-tensioning systems

Structure ID	**Structural element reference**	**Description of structural element**	**Grouting trial ID**	**Grouting trial assembly drawing/model reference(s)**	**Grouting trial assembly design documentation reference(s)**	**Minimum number of days prior to the installation of the post-tensioning system in the works at which the full-scale grouting trial is to be undertaken**	**Concrete compressive strength class for the trial (where applicable)**
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)

1. Enter a unique reference.

2. Enter a unique reference, to identify the structural element in the permanent works that is subject to the grouting trial.

3. Enter text, to describe the structural element and/or its part in the permanent works that is subject to the grouting trial.

4. Enter a unique reference.

5. Enter a unique reference, to provide reference of drawing(s) or model(s) for the assembly to be constructed for the grouting trial, showing the size of all elements forming the assembly, layout and cover of ducts/tendons/reinforcement, any detail of the post-tensioning system necessary to construct the assembly and all locations of sections cuts/cores to be undertaken following the grouting operations.

6. Enter a unique reference, to provide reference(s) of the design documentation for the assembly to be constructed for the grouting trial.

7. Enter a number in units of , to identify how many days in advance of the installation of the post-tensioning system in the permanent works the full-scale grouting trial has to be performed.

8. Enter text, to identify the required compressive strength class of the concrete to be used in the trial assembly, selecting from the classes in Tables 12 and 13 of BS EN 206 [Ref 21.N]and Table A.3 of BS 8500-2 [Ref 24.N].

Full-scale trials of the grouting operations for grouting of ducts for post-tensioning systems (continued)

Structure ID	**Section cuts/cores locations and dimensions**	**Additional requirements for the grouting trial**
(a)	(i)	(j)

1. Enter text, to identify the location and dimensions, also with reference to the drawing(s)/model(s), of the sections to be cut and cores to be taken from the trial assembly for checking the adequacy of grout after the grouting operations, typically comprising of a combination of transverse and longitudinal sections of the ducts in representative locations such as near anchorages, couplings and high and low points.

2. Enter text, to identify any other additional requirements for the grouting trial, including requirements for the disposal of the trial assembly.

5.249 Three days after the completion the grouting operations, section cuts/cores shall be undertaken in the locations specified in CC 482/WSR/005 to check the adequacy of the grouting.

5.250 Verification shall be undertaken for adequacy of grouting after full-scale trials by checking that no void in the grout in the ducts at the section cuts/cores undertaken has a dimension greater than 5% of the diameter of the duct, or 5% of the smallest dimension of non-circular ducts, measured in the radial direction of the duct or, for non-circular ducts, perpendicular to the longitudinal axis of the duct.

5.251 The frequency of void measurement shall be once, on the section cuts/cores undertaken, no less than 3 days after the completion of the grouting operations.

5.252 The requirements for "Verification" in Section 14 of GC 101 [Ref 44.N] shall apply to measurement of voids in the grout in the ducts at the section cuts/cores undertaken.

5.253 The following Documentation shall be submitted for the full-scale trials of grouting operations for grouting of ducts for post-tensioned systems prior to the commencement of the installation of the post-tensioned systems in the works: grouting trial report including records of full details of the system, method, materials, layout and the grouting trial operations; results of any void measurements and any additional testing performed; photographs of the exposed sections/cores; record of location of any voids with respect to grout vents; record of grout vents grouting and sealing; record of the disposition of the tendons within the body of the grout.

5.254 Documentation for records of the the full-scale grouting trials shall be submitted within 14 days of completing the full-scale trials.

5.255 Full-scale trials of grouting operations shall be repeated if there are changes from the sources of the materials used for the trials or changes from the procedures used for the trials.

Other protective measures requirements for post-tensioning of structural concrete

5.256 After the grouting/greasing/waxing operations are fully completed, the ends of ducts shall be sealed at anchorages to prevent escape of grout/grease/wax and to protect the ducts from ingress of water and contaminants.

5.257 Buried anchorages shall be provided with sealed grouted caps and have any recess concreted with non-shrink flowable concrete complying with CC 484 [Ref 22.N]leaving at least 50 mm of concrete cover to the anchorage/tendon ends.

5.258 Recesses for buried anchorages shall be protected with a liquid applied waterproofing membrane complying with CC 488 [Ref 126.N].

5.259 Exposed anchorages shall be provided with sealed grouted caps that are removable, to aid future inspection of anchorages.

5.260 Exposed anchorages and caps shall be protected with a liquid applied waterproofing membrane complying with CC 488 [Ref 126.N].

5.261 After the grouting/greasing/waxing operations, all vents shall be cut off or drilled out and sealed, with any recess made good with non-shrink repair mortar complying with CC 484 [Ref 22.N].

5.262 Recesses for vents that have been made good with non-shrink repair mortar shall be protected with a double layer of liquid applied waterproofing membrane.

6. Concreting of structural concrete

General requirements for concreting of structural concrete

6.1 Concreting of structural concrete shall be compliant with Section 8 of BS EN 13670 [Ref 38.N]as amended and complemented by this document.

6.2 Structural concrete shall be a 'designed concrete' conforming to BS EN 206 [Ref 21.N], BS 8500-1 [Ref 23.N]and BS 8500-2 [Ref 24.N]as amended and complemented by this document.

6.3 The designed concrete for structural concrete shall meet the performance characteristics stated in CC 482/WSR/006.

6.4 The requirements for Product certification schemes in Section 11 of GC 101 [Ref 44.N] shall apply to designed concrete for structural concrete.

6.5 Product certification schemes for designed concrete for structural concrete shall have the following features:.

1. The scheme covers assessment, surveillance and certification of production control in accordance with Section 9 and Annex C of BS EN 206 [Ref 21.N]and Annex A.1 of BS 8500-2 [Ref 24.N]

2. The scheme complies with the requirements in 6.2 of BS 8500-2 [Ref 24.N]

3. The scheme covers certification of conformity control in accordance with Section 8 of BS EN 206 [Ref 21.N]and Annex A.4 of BS 8500-2 [Ref 24.N]

4. Assessment of supplier processes and of concrete production procedures is carried out by qualified management systems assessors who also have qualifications and experience in concrete technology

5. Annual inspection and ongoing surveillance of concrete static/mobile production plant and production system is carried out

6. Annual inspection of laboratory testing facilities and review of test procedures are carried out to ensure test results are accurately reported

7. The scheme covers a procedure for assuring that review of mix designs and re-testing of mixes following any change to source of raw materials used for concrete production is carried out

8. The scheme has a technical supervisory panel, with documented structure and governance, made up of relevant industry experts, highway structures owners and product users

9. The scheme documentation, including the assessment criteria, is publicly available and is reviewed at least bi-annually

10. The scheme has a documented list of concrete suppliers and concrete static and mobile batching plants that hold current registration and certification with the scheme

11. The scheme carries out a surveillance assessment at least annually of the supplier's quality control procedures for concrete production and supply, including frequency of internal audits and management of non-conformances

12. Surveillance assessment of the supplier's conformity control is carried out at least annually to confirm concrete has been supplied accurately in accordance with the customer specification and purchase orders, with prompt reporting to supplier and customer of non-conformances

6.6 Designed concrete for structural concrete shall only be supplied by organisations holding current registration to, and from concrete static and/or mobile batching plants holding current plant-specific certificates of conformity with, a product certification scheme compliant with this document.

6.7 The following Documentation shall be submitted for designed concrete for structural concrete prior to the commencement of the concreting works: current concrete supplier certificate of registration to the product certification scheme; current concrete static/mobile batching plant certificates of conformity with the scheme for the batching plant(s) that are to be used to supply concrete for the concreting works.

6.8 The requirements for "Documentation" in Section 2 of GC 101 [Ref 44.N] shall apply to : concrete supplier certificate of registration to the scheme; concrete static/mobile batching plant certificates of conformity with the scheme.

6.9 Designed concrete for structural concrete shall be as specified in CC 482/WSR/006.

Designed concrete for structural concrete

Structure ID	Structural element reference	Description of structural element	Drawing/ model reference(s)	Designed concrete mix reference	Intended working life	Nominal cover to reinforcement	Concrete compressive strength class
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)

1. Enter a unique reference.

2. Enter a unique reference, to identify the structural element reference.

3. Enter text, to describe the structural element and/or its part subject to concreting.

4. Enter a unique reference, to provide reference of drawing(s) or model(s) where the structural element and/or its part subject to concreting, including the specified nominal cover to reinforcement, is shown.

5. Enter a unique reference, to identify the reference of the designed concrete mix to be used for concreting of the structural element and/or its part.

6. Enter a number in units of , to identify the intended working life of the structural element and/or its part, with the term 'intended working life' treated as being synonymous with 'design working life', 'design service life' and 'design life'.

7. Enter a number in units of , to identify the nominal cover to reinforcement required for the structural element and/or its part.

8. Enter text, to identify the required compressive strength class of the concrete to be used for concreting of the structural element and/or its part, selecting from the classes in Tables 12 and 13 of BS EN 206 [Ref 21.N]and Table A.3 of BS 8500-2 [Ref 24.N].

Designed concrete for structural concrete (continued)

Structure ID	Concrete compressive strength compliance age	Applicable exposure classes	DC-class (where applicable)	Additional protective measures (where applicable)	Required type of cement (or equivalent combination)
(a)	(i)	(j)	(k)	(l)	(m)

1. Enter a number in units of , to identify the age at which the compressive strength of the concrete is evaluated for compliance with the specified class for the structural element and/or its part.

2. Enter text, to identify all the exposure classes related to the environmental conditions relevant for the structural element and/or its part, selecting from the exposure classes in Tables A.1 and A.2 of BS 8500-1 [Ref 23.N].

3. Enter text, to identify the DC-class for buried/partially buried concrete relevant for the structural element and/or its part, selecting from the DC-classes in Table A.10 of BS 8500-1 [Ref 23.N]and including any adjustment in class as a result of specifying APM1 (enhanced concrete quality).

4. Enter one or more values, from options APM1, APM2, APM3, APM4, APM5, to identify any required additional protective measure(s) for buried/partially buried concrete relevant for the structural element and/or its part, selected from Table A.11 of BS 8500-1 [Ref 23.N].

5. Enter text, to identify the notation or the combined performance category for the required type of cement (or equivalent combination) to be used for concreting of the structural element and/or its part, selecting from the cements/combinations in Table 1 of BS 8500-2 [Ref 24.N]or the combined performance categories in Table A.6 of BS 8500-1 [Ref 23.N] and including for any low heat common cement or very low heat special cement notation.

Designed concrete for structural concrete (continued)

Structure ID	**Requirements for low heat common cement or very low heat special cement (where applicable)**	**Cement compressive strength class (where applicable)**	**Loss on ignition for fly ash (where applicable)**	**Fineness for fly ash (where applicable)**	**Pigments required**	**Colour requirements for pigments (where applicable)**
(a)	(n)	(o)	(p)	(q)	(r)	(s)

1. Enter text, to identify any specific requirement, in the concrete to be used for concreting of the structural element and/or its part, for low heat common cement to BS EN 197-1 [Ref 14.N]or very low heat special cement to BS EN 14216 [Ref 15.N].

2. Enter text, to identify the required compressive strength class of the cement to be used for concreting of the structural element and/or its part, selecting from the classes in Table 3 of BS EN 197-1 [Ref 14.N], or Table 2 of BS EN 14216 [Ref 15.N]for very low heat special cement.

3. Enter a value, from options A, B, C, to identify the required category of loss on ignition for the fly ash to be used for concreting of the structural element and/or its part, selecting from the categories in 5.2.2 of BS EN 450-1 [Ref 42.N].

4. Enter a value, from options N, S, to identify the required category of fineness for the fly ash to be used for concreting of the structural element and/or its part, selecting from the categories in 5.3.1 of BS EN 450-1 [Ref 42.N].

5. Enter a value, from options yes,no, to identify whether concrete colouring pigments are required for concreting of the structural element and/or its part.

6. Enter text, to identify any specific requirement for the colour of pigments to be used for concreting of the structural element and/or its part.

Designed concrete for structural concrete (continued)

Structure ID	**Pigment category (where applicable)**	**Nominal maximum aggregate size**	**Recycled aggregates permitted**	**Maximum recycled aggregates content in percentage by mass (where applicable)**	**Permitted range for the secant modulus of elasticity in compression of concrete with recycled aggregates (where applicable)**	**Freeze-thaw resisting aggregates required**	**Specific requirements for aggregate (where applicable)**
(a)	(t)	(u)	(v)	(w)	(x)	(y)	(z)

1. Enter a value, from options A, B, to identify the required category of the concrete colouring pigment to BS EN 12878 2005 [Ref 60.N]to be used for concreting of the structural element and/or its part.

2. Enter a number in units of , to identify the nominal maximum permitted size of aggregate in the concrete to be used for concreting of the structural element and/or its part.

3. Enter a value, from options yes, no, to identify whether recycled aggregates, in the form of coarse crushed concrete aggregates (CCA), are permitted in the concrete to be used for concreting of the structural element and/or its part.

4. Enter a number in units of , to identify the maximum permitted percentage of replacement, by mass, of the total amount of coarse aggregates with recycled aggregates (coarse CCA) in the concrete to be used for concreting of the structural element and/or its part.

5. Enter a number range (e.g. "40-60") in units of , to identify the minimum and maximum permitted value of the secant modulus of elasticity in compression of the concrete containing recycled aggregates to be used for concreting of the structural element and/or its part.

6. Enter a value, from options yes, no, to identify whether freeze-thaw resisting aggregates are required in the concrete to be used for concreting of the structural element and/or its part.

7. Enter text, to identify any specific additional requirement for the aggregate in the concrete to be used for concreting of the structural element and/or its part, such as required/restricted aggregates source, special aggregate type when high strength concrete is specified or aggregates with low coefficients of thermal expansion.

Designed concrete for structural concrete (continued)

Structure ID	**Admixture(s) other than air entraining required**	**Type(s) of admixture other than air-entraining (where applicable)**	**Air-entraining admixture required**	**Minimum air content in percentage by volume**	**Fibres required**	**Type(s) of fibres (where applicable)**
(a)	(aa)	(ab)	(ac)	(ad)	(ae)	(af)

1. Enter a value, from options yes, no, to identify whether admixtures other than air-entraining are required in the concrete to be used for concreting of the structural element and/or its part.

2. Enter text, to identify the type(s) of admixture, other than air-entraining, required in the concrete to be used for concreting of the structural element and/or its part, selecting from those in Table 1 of BS EN 934-2 [Ref 3.N]and in clause 4.3 of BS 8443 [Ref 86.N], with the exception of foaming admixtures and semi-dry concrete admixtures that are not covered by this document.

3. Enter a value, from options yes, no, to identify whether air entrainment is required in the concrete to be used for concreting of the structural element and/or its part.

4. Enter a number in units of , to identify the minimum required air content, by percentage of air content by volume, in the concrete to be used for concreting of the structural element and/or its part.

5. Enter a value, from options yes, no, to identify whether steel fibres to BS EN 14889-1 [Ref 41.N] or polymer fibres to BS EN 14889-2 [Ref 40.N]are required in the concrete to be used for concreting of the structural element and/or its part.

6. Enter one or more values, from options steel fibres, polymer mono-filamented micro-fibres, polymer fibrillated micro-fibres, polymer macro-fibres, to identify the type(s) of fibres, to BS EN 14889-1 [Ref 41.N]and/or BS EN 14889-2 [Ref 40.N], required in the concrete to be used for concreting of the structural element and/or its part.

Designed concrete for structural concrete (continued)

Structure ID	Dosage of steel fibres by mass per concrete volume (where applicable)	Dosage of polymer micro-fibres by mass per concrete volume (where applicable)	Dosage of polymer macro-fibres by mass per concrete volume (where applicable)	Minimum cement content by mass per concrete volume	Maximum cement content by mass per concrete volume	Maximum effective water/cement ratio	Chloride content class
(a)	(ag)	(ah)	(ai)	(aj)	(ak)	(al)	(am)

1. Enter a number range (e.g. "40-60") in units of , to identify the minimum and maximum permitted dosage, by mass per concrete volume, of the specified steel fibres in the concrete to be used for concreting of the structural element and/or its part.

2. Enter a number range (e.g. "40-60") in units of , to identify the minimum and maximum permitted dosage, by mass per concrete volume, of the specified polymer micro-fibres in the concrete to be used for concreting of the structural element and/or its part.

3. Enter a number range (e.g. "40-60") in units of , to identify the minimum and maximum permitted dosage, by mass per concrete volume, of the specified polymer macro-fibres in the concrete to be used for concreting of the structural element and/its part.

4. Enter a number in units of , to identify the minimum permitted cement content, by mass per concrete volume, in the concrete to be used for concreting of the structural element and/or its part.

5. Enter a number in units of , to identify the maximum permitted cement content, by mass per concrete volume, in the concrete to be used for concreting of the structural element and/or its part.

6. Enter a number, to identify the maximum permitted effective water/cement ratio in the concrete to be used for concreting of the structural element and/or its part.

7. Enter a value, from options Cl 0,10, Cl 0,20, Cl 0,30, Cl 1,00, to identify the required chloride content class for the concrete to be used for concreting of the structural element and/or its part.

Designed concrete for structural concrete (continued)

Structure ID	Concrete target density	Lightweight concrete density class (where applicable)	Consistence class - slump (where applicable)	Target slump (where applicable)	Consistence class - degree of compactability (where applicable)	Target degree of compactability (where applicable)	Consistence class - flow (where applicable)
(a)	(an)	(ao)	(ap)	(aq)	(ar)	(as)	(at)

1. Enter a number in units of , to identify the target density for the concrete to be used for concreting of the structural element and/or its part, taken in accordance with 5.5.2 of BS EN 206 [Ref 21.N]for normal-weight, heavy-weight or lightweight concrete as appropriate.

2. Enter a value, from options D1,0, D1,2, D1,4, D1,6, D1,8, D2,0, to identify the required density class for the lightweight concrete to be used for concreting of the structural element and/or its part, in accordance with Table 14 of BS EN 206 [Ref 21.N].

3. Enter a value, from options S1, S2, S3, S4, S5, to identify the required consistence class expressed by slump, in accordance with Table 3 of BS EN 206 [Ref 21.N], for the concrete to be used for concreting of the structural element and/or its part.

4. Enter a number in units of , to identify the target value of the slump, when tested to BS EN 12350-2 [Ref 115.N], for the concrete to be used for concreting of the structural element and/or its part.

5. Enter a value, from options C0, C1, C2, C3, C4, to identify the required consistence class expressed by degree of compactability, in accordance with Table 4 of BS EN 206 [Ref 21.N], for the concrete to be used for concreting of the structural element and/or its part.

6. Enter a number, to identify the target value of the degree of compactability, when tested to BS EN 12350-4 [Ref 108.N], for the concrete to be used for concreting of the structural element and/or its part.

7. Enter a value, from options F1, F2, F3, F4, F5, F6, to identify the required consistence class expressed by flow diameter, in accordance with Table 5 of BS EN 206 [Ref 21.N], for the concrete to be used for concreting of the structural element and/or its part.

8. Enter a number in units of , to identify the target value of the flow diameter, when tested to BS EN 12350-5 [Ref 109.N], for the concrete to be used for concreting of the structural element and/or its part.

9. Enter a number in units of , to identify the required characteristic tensile splitting strength of the concrete to be used for concreting of the structural element and/or its part.

Designed concrete for structural concrete (continued)

Structure ID	Minimum temperature of fresh concrete	Maximum temperature of fresh concrete	Requirements for consistence retention (where applicable)	Requirements for digital monitoring and measurement of fresh concrete properties (where applicable)	Digital monitoring and measurement of fresh concrete properties documentation reference(s) (where applicable)	Self-compacting concrete required	Consistence class slump flow self-compacting concrete (where applicable)
(a)	(aw)	(ax)	(ay)	(az)	(ba)	(bb)	(bc)

1. Enter a number in units of , to identify the minimum permitted temperature of fresh concrete after initial mixing and prior to placing for the concrete to be used for concreting of the structural element and/or its part.

2. Enter a number in units of , to identify the maximum permitted temperature of fresh concrete after initial mixing and prior to placing for the concrete to be used for concreting of the structural element and/or its part.

3. Enter text, to identify any requirement for the consistence retention, expressed as the minimum required consistence, by class or target, for a given consistence type and for a specified time after loading at the mixer, after arrival on site for delivery or after placing in the formwork, for the concrete to be used for concreting of the structural element and/or its part.

4. Enter text, to describe, for the concrete to be used for concreting of the structural element and/or its part, any specific requirement for digital monitoring and measurement of fresh concrete properties by calibrated systems installed on delivery vehicles, including the minimum production records and performance characteristics required.

5. Enter a unique reference, to provide reference(s) of the documentation containing the detailed specification requirements for any specifed digital monitoring and measurement of fresh concrete properties for the concrete to be used for concreting of the structural element and/or its part.

6. Enter a value, from options yes, no, to identify whether self-compacting concrete is to be used for concreting of the structural element and/or its part.

7. Enter a value, from options SF1, SF2, SF3, to identify the required consistence class of self-compacting concrete expressed by slump-flow, in accordance with Table 6 of BS EN 206 [Ref 21.N], for the concrete to be used for concreting of the structural element and/or its part.

Designed concrete for structural concrete (continued)

Structure ID	Target slump-flow of self-compacting concrete (where applicable)	Viscosity class (t_{500}) of self-compacting concrete (where applicable)	Target viscosity (t_{500}) of self-compacting concrete	Viscosity class (t_v) of self-compacting concrete (where applicable)	Target viscosity (t_v) of self-compacting concrete (where applicable)	Passing ability class (L-box) of self-compacting concrete (where applicable)	Minimum passing ability ratio (L-box) of self-compacting concrete (where applicable)	Pa ab cla rir se co ng co (w ap e)
(a)	(bd)	(be)	(bf)	(bg)	(bh)	(bi)	(bj)	(bl

1. Enter a number in units of , to identify the target value for the slump-flow of self-compacting concrete, when tested to BS EN 12350-8 [Ref 110.N], for the concrete to be used for concreting of the structural element and/or its part.

2. Enter a value, from options VS1, VS2, to identify the required viscosity class (t_{500}) of self-compacting concrete, in accordance with Table 7 of BS EN 206 [Ref 21.N], for the concrete to be used for concreting of the structural element and/or its part.

3. Enter a number in units of , to identify the target value for the viscosity (t_{500}) of self-compacting concrete, when tested to BS EN 12350-8 [Ref 110.N], for the concrete to be used for concreting of the structural element and/or its part.

4. Enter a value, from options VF1, VF2, to identify the required viscosity class (t_v) of self-compacting concrete, in accordance with Table 8 of BS EN 206 [Ref 21.N], for the concrete to be used for concreting of the structural element and/or its part.

5. Enter a number in units of , to identify the target value for the viscosity (t_v) of self-compacting concrete, when tested to BS EN 12350-9 [Ref 114.N], for the concrete to be used for concreting of the structural element and/or its part.

6. Enter a value, from options PL1, PL2, to identify the required passing ability class (L-box) of self-compacting concrete, in

accordance with Table 9 of BS EN 206 [Ref 21.N], for the concrete to be used for concreting of the structural element and/or its part.

7. Enter a number, to identify the required minimum passing ability ratio (L-box) of self- compacting concrete, when tested to BS EN 12350-10 [Ref 112.N], for the concrete to be used for concreting of the structural element and/or its part.

8. Enter a value, from options PJ1, PJ2, to identify the required passing ability class (J-ring) of self-compacting concrete, in accordance with Table 10 of BS EN 206 [Ref 21.N], for the concrete to be used for concreting of the structural element and/or its part.

9. Enter a number in units of , to identify the required maximum passing ability (J-ring) of self-compacting concrete, when tested to BS EN 12350-12 [Ref 111.N], for the concrete to be used for concreting of the structural element and/or its part.

Designed concrete for structural concrete (continued)

Structure ID	Sieve segregation resistance class of self-compacting concrete (where applicable)	Maximum segregated portion for the sieve segregation resistance of self-compacting concrete (where applicable)	Any other requirement and/or constraint (where applicable)
(a)	(bm)	(bn)	(bo)

1. Enter a value, from options SR1, SR2, to identify the required sieve segregation resistance class of self-compacting concrete, in accordance with Table 11 of BS EN 206 [Ref 21.N], for the concrete to be used for concreting of the structural element and/or its part.

2. Enter a number in units of , to identify the required maximum percentage of segregated portion for the sieve segregation resistance of self-compacting concrete, when tested to BS EN 12350-11 [Ref 113.N], for the concrete to be used for concreting of the structural element and/or its part.

3. Enter text, to identify any other additional specific requirement and/or constraint for concreting of the structural element and/or its part, such as specific requirements to control early-age thermal cracking or delayed ettringite formation; specific restrictions on cements/combination types, dosage rates of admixtures, concrete strength development, concrete placing or heat development during hydration; specific requirements for

resistance to water penetration or abrasion; site constraints; limitations on drainage for buried concrete; or other.

Requirements for constituent materials of structural concrete

Cements, combinations and additions for structural concrete

6.10 Cements, combinations and additions for structural concrete shall be compliant with BS 8500-2 [Ref 24.N]as amended and complemented by this document.

6.11 Common cement for structural concrete shall be compliant with BS EN 197-1 [Ref 14.N].

6.12 The common cement for structural concrete shall meet the performance characteristics as stated in table 6.12.

Table 6.12 Characteristics and performance requirements for common cement for structural concrete

Characteristic	Performance requirement
Common cement constituents and composition	In accordance with Tables 1 and 2 of BS EN 197-1 [Ref 14.N]for the cement type specified in CC 482/WSR/006
Compressive strength (of cement)	As required in CC 482/WSR/006 in relation to the classes in Table 3 of BS EN 197-1 [Ref 14.N]
(Initial) setting time	As required in Table 3 of BS EN 197-1 [Ref 14.N]for the cement compressive strength class specified in CC 482/WSR/006
Insoluble residue (only for CEM I and CEM III)	As required in Table 4 of BS EN 197-1 [Ref 14.N] for the cement type specified in CC 482/WSR/006
Loss on ignition (only for CEM I and CEM III)	As required in Table 4 of BS EN 197-1 [Ref 14.N] for the cement type specified in CC 482/WSR/006
Soundness - expansion	As required in Table 3 of BS EN 197-1 [Ref 14.N]for the cement compressive strength class specifed in CC 482/WSR/006
Soundness - SO_3 content	As required in Tables 4 and 5 of BS EN 197-1 [Ref 14.N]for the cement type and cement compressive strength class specified in CC 482/WSR/006
Heat of hydration (only for low heat cement)	≤ 270 J/g, determined in accordance with either BS EN 196-8 [Ref 54.N](at 7 days) or BS EN 196-9 [Ref 53.N](at 41 hours)
Chloride content	As required in Table 4 of BS EN 197-1 [Ref 14.N]
Pozzolanicity (for pozzolanic cement only)	As required in Tables 4 and 5 of BS EN 197-1 [Ref 14.N]for the cement type specified in CC 482/WSR/006

C_3A in clinker (for sulfate-resisting cement only)	As required in Table 5 of BS EN 197-1 [Ref 14.N]for the cement type specified in CC 482/WSR/006
Total content of alkalis	Declared mean value in accordance with Annex NA of BS EN 197-1 [Ref 14.N]

6.13 The requirements of "Designated standards" in Section 10 of GC 101 [Ref 44.N] shall apply to common cement for structural concrete.

6.14 Portland-composite cement CEM II/C-M and Composite cement CEM VI for structural concrete shall be compliant with BS EN 197-5 [Ref 16.N].

6.15 The Portland-composite cement CEM II/C-M and Composite cement CEM VI for structural concrete shall meet the performance characteristics as stated in table 6.15.

Table 6.15 Characteristics and performance requirements for Portland-composite cement CEM II/C-M and Composite cement CEM VI for structural concrete

Characteristic	Performance requirement
Portland-composite cement CEM II/C-M and Composite cement CEM VI constituents and composition	In accordance with Table 1 of BS EN 197-5 [Ref 16.N] for the cement type specified in CC 482/WSR/006
Compressive strength (of cement)	As required in CC 482/WSR/006 in relation to the classes in Table 3 of BS EN 197-1 [Ref 14.N]
(Initial) setting time	As required in Table 3 of BS EN 197-1 [Ref 14.N]for the cement compressive strength class specified in CC 482/WSR/006
Soundness - expansion	As required in Table 3 of BS EN 197-1 [Ref 14.N]for the cement compressive strength class specifed in CC 482/WSR/006
Sulfate content (as SO_3)	As required in Table 2 of BS EN 197-5 [Ref 16.N]
Heat of hydration (only for low heat cement)	≤ 270 J/g, determined in accordance with either BS EN 196-8 [Ref 54.N] (at 7 days) or BS EN 196-9 [Ref 53.N] (at 41 hours)
Chloride content	As required in Table 2 of BS EN 197-5 [Ref 16.N]
Total content of alkalis	Declared mean value in accordance with Annex NA of BS EN 197-1 [Ref 14.N]

6.16 The following Documentation shall be submitted for Portland-composite cement CEM II/C-M and Composite cement CEM VI for structural

concrete prior to the commencement of the concreting works: certificate of conformity in accordance with Section 8 of BS EN 197-5 [Ref 16.N]demonstrating that the Portland-composite cement CEM II/C-M and Composite cement CEM VI for structural concrete meet the specification requirements.

6.17 The requirements for "Documentation" in Section 2 of GC 101 [Ref 44.N] shall apply to certificate of conformity for Portland-composite cement CEM II/C-M and Composite cement CEM VI for structural concrete.

6.18 Very low heat special cements for structural concrete shall be compliant with BS EN 14216 [Ref 15.N].

6.19 The very low heat special cements for structural concrete shall meet the performance characteristics as stated in table 6.19.

Table 6.19 Characteristics and performance requirements for very low heat special cements for structural concrete

Characteristic	Performance requirement
Very low heat special cements constituents and composition	In accordance with Table 1 of BS EN 14216 [Ref 15.N] for the cement type specified in CC 482/WSR/006
Compressive strength (of cement)	As required in Table 2 of BS EN 14216 [Ref 15.N]
(Initial) setting time	As required in Table 2 of BS EN 14216 [Ref 15.N]
Insoluble residue (only for VLH III)	As required in Table 3 of BS EN 14216 [Ref 15.N]
Loss on ignition (only for VLH III)	As required in Table 3 of BS EN 14216 [Ref 15.N]
Soundness - expansion	As required in Table 2 of BS EN 14216 [Ref 15.N]
Soundness - SO_3 content	As required in Table 3 of BS EN 14216 [Ref 15.N] for the cement type specified in CC 482/WSR/006
Chloride content	As required in Table 3 of BS EN 14216 [Ref 15.N]
Pozzolanicity (for pozzolanic cement only)	As required in Table 3 of BS EN 14216 [Ref 15.N]
Heat of hydration	≤ 220 J/g, determined in accordance with either BS EN 196-8 [Ref 54.N] (at 7 days) or BS EN 196-9 [Ref 53.N] (at 41 hours)
Total content of alkalis	Declared mean value in accordance with Annex NA of BS EN 197-1 [Ref 14.N]

6.20 The requirements of "Designated standards" in Section 10 of GC 101 [Ref 44.N] shall apply to very low heat special cements for structural concrete.

6.21 Ground granulated blast-furnace slag (GGBS) for structural concrete shall be compliant with BS EN 15167-1 [Ref 45.N].

6.22 The ground granulated blast-furnace slag for structural concrete shall meet the performance characteristics as stated in table 6.22.

Table 6.22 Characteristics and performance requirements for ground granulated blast-furnace slag for structural concrete

Characteristic	Performance requirement
Compressive strength (activity index)	As required in 5.3.2.3 of BS EN 15167-1 [Ref 45.N]
Initial setting time	As required in 5.3.2.2 of BS EN 15167-1 [Ref 45.N]
Fineness	As required in 5.3.1 of BS EN 15167-1 [Ref 45.N]
Composition - magnesium oxide	As required in Table 1 of BS EN 15167-1 [Ref 45.N]
Composition - sulfide	As required in Table 1 of BS EN 15167-1 [Ref 45.N]
Composition - sulfate	As required in Table 1 of BS EN 15167-1 [Ref 45.N]
Composition - loss on ignition	As required in Table 1 of BS EN 15167-1 [Ref 45.N]
Composition - chloride	As required in Table 1 of BS EN 15167-1 [Ref 45.N]
Composition - moisture	As required in Table 1 of BS EN 15167-1 [Ref 45.N]
Total content of alkalis	Declared mean value in accordance with 5.5 of BS EN 15167-1 [Ref 45.N]

6.23 The requirements of "Designated standards" in Section 10 of GC 101 [Ref 44.N] shall apply to ground granulated blast-furnace slag for structural concrete.

6.24 Fly ash for structural concrete shall be compliant with BS EN 450-1 [Ref 42.N].

6.25 The fly ash for structural concrete shall meet the performance characteristics as stated in table 6.25.

Table 6.25 Characteristics and performance requirements for fly ash for structural concrete

Characteristic	Performance requirement
Activity index (compressive strength)	As required in 5.3.2 of BS EN 450-1 [Ref 42.N]
Fineness	As required in WSR 482/006 in relation to the categories in 5.3.1 of

	BS EN 450-1 [Ref 42.N]
Soundness - expansion	As required in 5.3.3 of BS EN 450-1 [Ref 42.N]
Soundness - free CaO	≤ 2.5% by mass determined in accordance with 5.2.5 of BS EN 450-1 [Ref 42.N]
Loss on ignition	As required in WSR 482/006 in relation to the categories in 5.2.2 of BS EN 450-1 [Ref 42.N]
Composition: sum of contents of silicon dioxide, aluminium oxide and iron oxide	As required in 5.2.8 of BS EN 450-1 [Ref 42.N]
Composition: total content of alkalis	As required in 5.2.9 of BS EN 450-1 [Ref 42.N]
Composition: reactive silicon dioxide	As required in 5.2.7 of BS EN 450-1 [Ref 42.N]
Composition: sulphate content	As required in 5.2.4 of BS EN 450-1 [Ref 42.N]
Composition: chloride	As required in 5.2.3 of BS EN 450-1 [Ref 42.N]
Composition: reactive calcium oxide	As required in 5.2.6 of BS EN 450-1 [Ref 42.N]
Composition: magnesium oxide	As required in 5.2.10 of BS EN 450-1 [Ref 42.N]
Composition: soluble phosphate	As required in 5.2.11 of BS EN 450-1 [Ref 42.N]
Composition: total phosphate	As required in 5.2.11 of BS EN 450-1 [Ref 42.N]
Particle density	As required in 5.3.4 of BS EN 450-1 [Ref 42.N] in relation to the declared value
Initial setting time	As required in 5.3.5 of BS EN 450-1 [Ref 42.N]
Water requirement (only for fly ash with fineness category S)	As required in 5.3.6 of BS EN 450-1 [Ref 42.N]

6.26 The requirements of "Designated standards" in Section 10 of GC 101 [Ref 44.N] shall apply to fly ash for structural concrete.

6.27 Silica fume for structural concrete shall be compliant with BS EN 13263-1 [Ref 81.N].

6.28 The silica fume for structural concrete shall meet the performance characteristics as stated in table 6.28.

Table 6.28 Characteristics and performance requirements for silica fume for structural concrete

Characteristic	Performance requirement
Silicon dioxide (SiO_2) content	Class 1 in accordance with 5.2.1 of BS EN 13263-1 [Ref 81.N]
Elemental silicon (Si) content	As required in 5.2.2 of BS EN 13263-1 [Ref 81.N]
Free calcium oxide (CaO) content	As required in 5.2.3 of BS EN 13263-1 [Ref 81.N]
Sulphate content (as SO_3)	As required in 5.2.4 of BS EN 13263-1 [Ref 81.N]
Chloride content	As required in 5.2.6 of BS EN 13263-1 [Ref 81.N]
Loss on ignition	As required in 5.2.7 of BS EN 13263-1 [Ref 81.N]
Fineness - specific surface	As required in 5.3.1 of BS EN 13263-1 [Ref 81.N]
Effects on concrete properties - activity index	As required in 5.3.3 of BS EN 13263-1 [Ref 81.N]
Total content of alkalis	Declared mean value in accordance with 5.2.5 of BS EN 13263-1 [Ref 81.N]

6.29 The requirements of "Designated standards" in Section 10 of GC 101 [Ref 44.N] shall apply to silica fume for structural concrete.

6.30 Limestone fines for structural concrete shall be compliant with BS 7979 [Ref 88.N].

6.31 The limestone fines for structural concrete shall meet the performance characteristics as stated in table 6.31.

Table 6.31 Characteristics and performance requirements for limestone fines for structural concrete

Characteristic	Performance requirement
Calcium carbonate content	As required in 4.2.1 of BS 7979 [Ref 88.N]
Chloride content	As required in 4.2.2 of BS 7979 [Ref 88.N]
Compressive strength	As required in 6.1 and 6.2 of BS 7979 [Ref 88.N]
Fineness	As required in 7.1 of BS 7979 [Ref 88.N]
Initial setting time	As required in 7.2 of BS 7979 [Ref 88.N]
Soundness	As required in 7.3 of BS 7979 [Ref 88.N]
Total sulfur content	As required in 4.2.3 of BS 7979 [Ref 88.N]
Clay content	As required in 4.2.4 of BS 7979 [Ref 88.N]
Organic material content	As required in 4.2.5 of BS 7979 [Ref 88.N]
Moisture content	As required in Section 5 of BS 7979 [Ref 88.N]
Total content of alkalis	Declared mean value in accordance with 9.2 of BS 7979 [Ref 88.N]

6.32 The following Documentation shall be submitted for limestone fines for structural concrete prior to the commencement of the concreting works: test report certificate in accordance with 9.1 and 9.2 of BS 7979 [Ref 88.N]demonstrating that the limestone fines meet the specification requirements.

6.33 The requirements for "Documentation" in Section 2 of GC 101 [Ref 44.N] shall apply to the test report certificate for limestone fines for structural concrete.

6.34 Natural pozzolana and natural calcined pozzolana for structural concrete shall be compliant with BS 8615-1 [Ref 90.N].

6.35 The natural pozzolana and natural calcined pozzolana for structural concrete shall meet the performance characteristics as stated in table 6.35.

Table 6.35 Characteristics and performance requirements for natural pozzolana and natural calcined pozzolana for structural concrete

Characteristic	Performance requirement
Activity index	As required in 5.2 of BS 8615-1 [Ref 90.N]
Fineness	As required in 5.1 of BS 8615-1 [Ref 90.N]
Soundness	As required in 5.3 of BS 8615-1 [Ref 90.N]
Loss on ignition	As required in 4.3.2 of BS 8615-1 [Ref 90.N]
Particle density	As required in 5.4 of BS 8615-1 [Ref 90.N] in relation to the declared value
Initial setting time	As required in 5.5 of BS 8615-1 [Ref 90.N]
Water requirement	As required in 5.6 of BS 8615-1 [Ref 90.N]
Sum of contents of silicon dioxide, aluminium oxide and iron oxide	As required in 4.3.8 of BS 8615-1 [Ref 90.N]
Chloride	As required in 4.3.3 of BS 8615-1 [Ref 90.N]
Sulfate content	As required in 4.3.4 of BS 8615-1 [Ref 90.N]
Free calcium oxide	As required in 4.3.5 of BS 8615-1 [Ref 90.N]
Reactive calcium oxide	As required in 4.3.6 of BS 8615-1 [Ref 90.N]
Reactive silicon dioxide	As required in 4.3.7 of BS 8615-1 [Ref 90.N]
Total alkali content	Declared mean value in accordance with 4.3.9 of BS 8615-1 [Ref 90.N]
Magnesium oxide	As required in 4.3.10 of BS 8615-1 [Ref 90.N]
Phosphate content	As required in 4.3.11 of BS 8615-1 [Ref 90.N]
Clay and organic carbon content	As required in 4.3.12 of BS 8615-1 [Ref 90.N]

6.36 The following Documentation shall be submitted for natural pozzolana and natural calcined pozzolana for structural concrete prior to the commencement of the concreting works: test report certificate in

accordance with 7.1 and 7.2 of BS 8615-1 [Ref 90.N] demonstrating that the natural pozzolana and natural calcined pozzolana meet the specification requirements.

6.37 The requirements for "Documentation" in Section 2 of GC 101 [Ref 44.N] shall apply to the test report certificate for natural pozzolana and natural calcined pozzolana for structural concrete.

6.38 High reactivity natural calcined pozzolana for structural concrete shall be compliant with BS 8615-2 [Ref 89.N].

6.39 The high reactivity natural calcined pozzolana for structural concrete shall meet the performance characteristics as stated in table 6.39.

Table 6.39 Characteristics and performance requirements for high reactivity natural calcined pozzolana for structural concrete

Characteristic	Performance requirement
Activity index	As required in 5.2 of BS 8615-2 [Ref 89.N]
Fineness	As required in 5.1 of BS 8615-2 [Ref 89.N]
Soundness	As required in 5.3 of BS 8615-2 [Ref 89.N]
Loss on ignition	As required in 4.3.3 of BS 8615-2 [Ref 89.N]
Particle density	As required in 5.4 of BS 8615-2 [Ref 89.N] in relation to the declared value
Initial setting time	As required in 5.5 of BS 8615-2 [Ref 89.N]
Water requirement	As required in 5.6 of BS 8615-2 [Ref 89.N]
Sum of contents of silicon dioxide, aluminium oxide and iron oxide	As required in 4.3.9 of BS 8615-2 [Ref 89.N]
Pozzolanic activity	As required in 4.3.2 of BS 8615-2 [Ref 89.N]
Chloride	As required in 4.3.4 of BS 8615-2 [Ref 89.N]
Sulfate content	As required in 4.3.5 of BS 8615-2 [Ref 89.N]
Free calcium oxide	As required in 4.3.6 of BS 8615-2 [Ref 89.N]
Reactive calcium oxide	As required in 4.3.7 of BS 8615-2 [Ref 89.N]
Reactive silicon dioxide	As required in 4.3.8 of BS 8615-2 [Ref 89.N]
Total alkali content	Declared mean value in accordance with 4.3.10 of BS 8615-2 [Ref 89.N]
Magnesium oxide	As required in 4.3.11 of BS 8615-2 [Ref 89.N]
Phosphate content	As required in 4.3.12 of BS 8615-2 [Ref 89.N]

6.40 The following Documentation shall be submitted for high reactivity natural calcined pozzolana for structural concrete prior to the commencement of the concreting works: test report certificate in accordance with 7.1 and 7.2 of BS 8615-2 [Ref 89.N]demonstrating that the high reactivity natural calcined pozzolana meets the specification requirements.

6.41 The requirements for "Documentation" in Section 2 of GC 101 [Ref 44.N] shall apply to the test report certificate for high reactivity natural calcined pozzolana for structural concrete.

6.42 Pigments for structural concrete shall be compliant with BS EN 12878 2005 [Ref 60.N].

6.43 The pigments for structural concrete shall meet the performance characteristics as stated in table 6.43.

Table 6.43 Characteristics and performance requirements for pigments for structural concrete

Characteristic	Performance requirement
Setting time	As required in 4.1.2 of BS EN 12878 2005 [Ref 60.N]
Compressive strength	As required in 4.1.3 of BS EN 12878 2005 [Ref 60.N] for the pigment category specified in CC 482/WSR/006
Composition of the pigments	As required in 4.2.2 of BS EN 12878 2005 [Ref 60.N]
Water soluble substances	As required in 4.2.3 of BS EN 12878 2005 [Ref 60.N]for the pigment category specified in CC 482/WSR/006
Soluble chloride	As required in 4.2.4 of BS EN 12878 2005 [Ref 60.N]for the pigment category specified in CC 482/WSR/006
Total chlorine	As required in 4.2.5 of BS EN 12878 2005 [Ref 60.N]for the pigment category specified in CC 482/WSR/006
Loss on ignition	Declared value in accordance with 4.3 of BS EN 12878 2005 [Ref 60.N]

6.44 The requirements of "Designated standards" in Section 10 of GC 101 [Ref 44.N] shall apply to pigments for structural concrete.

Aggregates for structural concrete

6.45 Non-lightweight aggregates for structural concrete shall be compliant with BS EN 12620 2002+A1:2008 [Ref 4.N], BS 8500-2 [Ref 24.N]and PD 6682-1 [Ref 5.N]as amended and complemented by this document.

6.46 The non-lightweight aggregates for structural concrete shall meet the performance characteristics as stated in table 6.46.

Table 6.46 Characteristics and performance requirements for aggregates for structural concrete

Characteristic	Performance requirement
Particle shape, size and density - aggregate size	- Designation to be in accordance with 4.2 of BS EN 12620 2002+A1:2008 [Ref 4.N], PD 6682-1 [Ref 5.N]and the nominal maximum aggregate size specified in CC 482/WSR/006 - For recycled aggregates in the form of

	coarse crushed concrete aggregates (CCA), the additional requirement in Table 4 of BS 8500-2 [Ref 24.N] applies for the coarse CCA size
Particle shape, size and density - grading	In accordance with 4.3 of BS EN 12620 2002+A1:2008 [Ref 4.N] and PD 6682-1 [Ref 5.N]for the designated aggregate size
Particle shape, size and density - shape of coarse aggregate	-The required flakiness index category of crushed and uncrushed natural, manufactured or recycled aggregates used in structural concrete with compressive strength class above C12/15 is FI_{35}, with the exception of uncrushed natural aggregates used in structural concrete with compressive strengh class of C32/40 or below, for which the required flakiness index category is FI_{50} -The required flakiness index category of crushed and uncrushed natural, manufactured or recycled aggregates used in structural concrete with compressive strength class C12/15 or below is FI_{NR}
Particle shape, size and density - particle density and water absorption	Declared value in accordance with 5.5 of BS EN 12620 2002+A1:2008 [Ref 4.N], with the oven dried particle density to be no less than 2100 kg/m^3
Cleanliness - shell content of coarse aggregate	Category SC_{10}
Cleanliness - fines	- The required categories for maximum values of fines content to be as per Table 4 of PD 6682-1 [Ref 5.N] - For recycled aggregates in the form of coarse CCA, the additional requirement in Table 4 of BS 8500-2 [Ref 24.N]applies for maximum value of fines of coarse CCA
Resistance to fragmentation/crushing (of coarse aggregate)	Category LA_{40}
Resistance to polishing/abrasion/wear - resistance to wear of coarse aggregate	Category $M_{DE}NR$
Resistance to polishing/abrasion/wear - resistance to polishing	Category PSV_{NR}
Resistance to polishing/abrasion/wear -	Category AAV_{NR}

reistance to surface abrasion	
Resistance to polishing/abrasion/wear - resistance to abrasion from studded tyres	Category $A_V NR$
Composition/content - constituents of coarse recycled aggregates	The required categories for the constituents of coarse recycled aggregates, as defined in Table 20 of BS EN 12620 2002+A1:2008 [Ref 4.N], to be as per Table 4 of BS 8500-2 [Ref 24.N] for coarse CCA
Composition/content - chlorides	Declared values, in accordance with 6.2 of BS EN 12620 2002+A1:2008 [Ref 4.N], of the water-soluble chloride ion content (for non-recycled aggregates) and the acid-soluble chloride content (for recycled aggregates)
Composition/content - acid-soluble sulfates	The required categories for maximum values of acid-soluble sulfate content to be as per Table 5 of PD 6682-1 [Ref 5.N]
Composition/content - total sulfur	As required in 6.3.2 of BS EN 12620 2002+A1:2008 [Ref 4.N]
Composition/content - water-soluble sulfate content of recycled aggregates	Category $SS_{0,2}$
Composition/content - constituents of natural aggregates which alter the rate of setting and hardening of concrete	As required in 6.4.1 of BS EN 12620 2002+A1:2008 [Ref 4.N]
Composition/content - influence on initial setting time of cement (recycled aggregates)	Category A_{40}
Volume stability - drying shrinkage	≤ 0.075%, determined in accordance with 5.7.2 of BS EN 12620 2002+A1:2008 [Ref 4.N]
Volume stability - constituents which affect the volume stability of air-cooled blastfurnace slag	As required in 6.4.2 of BS EN 12620 2002+A1:2008 [Ref 4.N]
Water absorption - particle density and water absorption	Declared value in accordance with 5.5 of BS EN 12620 2002+A1:2008 [Ref 4.N], with the oven dried particle density to be no less than 2100 kg/m^3
Durability against freeze-thaw - freeze-thaw resistance of	The required categories for maximum magnesium sulfate soundness, as defined

coarse aggregate	in Table 19 of BS EN 12620 2002+A1:2008 [Ref 4.N] , to be as per Table 2 of BS 8500-2 [Ref 24.N]when freeze-thaw resisting aggregates are specified in CC 482/WSR/006 for XF3 and XF4 exposure classes
Durability against alkali-silica reactivity - alkali-silica reactivity	Declared value of the aggregate reactivity in accordance with Annex C.4 of BS 8500-2 [Ref 24.N]
Bulk density (for air-cooled blastfurnace slag and recycled aggregates)	Declared value in accordance with clause 5.6 of BS EN 12620 2002+A1:2008 [Ref 4.N]

6.47 The requirements of "Designated standards" in Section 10 of GC 101 [Ref 44.N] shall apply to non-lightweigth aggregates for structural concrete.

6.48 Lightweight aggregates for structural concrete shall be compliant with BS EN 13055-1 2002 [Ref 52.N], BS 8500-2 [Ref 24.N] and PD 6682-4 [Ref 6.N]as amended and complemented by this document.

6.49 The lightweight aggregates for structural concrete shall meet the performance characteristics as stated in table 6.49.

Table 6.49 Characteristics and performance requirements for lightweight aggregates for structural concrete

Characteristic	Performance requirement
Particle shape, size and density - aggregate size	Designation to be in accordance with 4.3.1 of BS EN 13055-1 2002 [Ref 52.N] and the nominal maximum aggregate size specified in CC 482/WSR/006 - Sieve which 100% material passes to be declared
Particle shape, size and density - particle density	Declared value in accordance with 4.2.2 of BS EN 13055-1 2002 [Ref 52.N]
Particle shape, size and density - loose bulk density	Declared value in accordance with 4.2.1 of BS EN 13055-1 2002 [Ref 52.N]
Particle shape, size and density - grading	Declared value in accordance with 4.4 of BS EN 13055-1 2002 [Ref 52.N]
Particle shape, size and density - particle shape	Particle shape to be described and declared
Percentage of crushed particles - crushed particles	Declared value in accordance with 4.11 of BS EN 13055-1 2002 [Ref 52.N]
Cleanliness - organic contaminators	As required in 5.5 and Annex E.3 of BS EN 13055-1 2002 [Ref 52.N]
Resistance to	Declared value in accordance with 4.10 of BS

fragmentation/crushing - bulk crushing resistance	EN 13055-1 2002 [Ref 52.N]
Composition/content - chloride	Declared value, in accordance with 5.2 of BS EN 13055-1 2002 [Ref 52.N], of the water-soluble chloride ion content
Composition/content - acid-soluble sulfate	Category $AS_{0,8}$ as defined in Table 21 of BS EN 12620 2002+A1:2008 [Ref 4.N], determined in accordance with 5.3.1 of BS EN 13055-1 2002 [Ref 52.N]
Composition/content - total sulfur	≤ 0.8%, determined in accordance with 5.3.2 of BS EN 13055-1 2002 [Ref 52.N]
Loss on ignition (for furnace bottom ash and furnace clinker)	≤ 10%, determined in accordance with 5.4 of BS EN 13055-1 2002 [Ref 52.N]
Volume stability - resistance to disintegration	Declared value in accordance with 4.12 of BS EN 13055-1 2002 [Ref 52.N]
Volume stability - drying shrinkage	≤ 0.075%, determined in accordance with 5.7.2 of BS EN 12620 2002+A1:2008 [Ref 4.N]
Water absorption - water absorption	- Declared value in accordance with 4.8 of BS EN 13055-1 2002 [Ref 52.N](for coarse lightweight aggregate). - Declared value and declared method of determination (for fine lightweight aggregate)
Durability against freeze-thaw - freezing and thawing resistance	Performance to be demonstrated by record of successful use in freeze-thaw conditions, as required in 4.3.6.2 of BS 8500-2 [Ref 24.N], when freeze-thaw resisting aggregates are specified in CC 482/WSR/006 for XF3 and XF4 exposure classes
Durability against alkali-silica reactivity - alkali-silica reactivity	Declared value of the aggregate reactivity in accordance with Annex C.4 of BS 8500-2 [Ref 24.N]

6.50 The requirements of "Designated standards" in Section 10 of GC 101 [Ref 44.N] shall apply to lightweight aggregates for structural concrete.

6.51 The nominal maximum size of aggregates for structural concrete shall be 20mm, unless otherwise stated in CC 482/WSR/006.

6.52 Aggregates for structural concrete containing detectable quantities of opal, borosilicate glass, opaline silica or calcined flint shall not be permitted, as they are classed 'extremely reactive' in accordance with Annex C of BS 8500-2 [Ref 24.N]and pose too high a risk for the occurrence of damaging alkali-silica reaction in concrete.

6.53 Aggregates for structural concrete shall not contain amounts of lignite or reactive iron sulfides (pyrite) that can cause staining, discoloration, swelling or pop-outs if present close to the concrete surface.

6.54 Only coarse crushed concrete aggregates (CCA) shall be permitted as recycled aggregates for structural concrete, with coarse recycled aggregates (RA), fine CCA, fine RA and reclaimed aggregates not permitted.

6.55 Recycled aggregates for structural concrete shall only be produced in compliance with, and sourced from producers demonstrating compliance with, the WRAP Quality Protocol [Ref 127.N]for the production of aggregates from inert waste.

6.56 The following Documentation shall be submitted for recycled aggregates for structural concrete prior to the commencement of concreting of structural concrete containing recycled aggregates: delivery documentation confirming that the recycled aggregates have been produced in compliance with the WRAP Quality Protocol [Ref 127.N]for the production of aggregates from inert waste; delivery records including supply details, details of the source concrete material and results of any tests performed on the recycled aggregate and on the source concrete material.

6.57 The requirements for "Documentation" in Section 2 of GC 101 [Ref 44.N] shall apply to the delivery documentation and records for recycled aggregates for structural concrete.

6.58 Verification shall be undertaken for the suitability of recycled aggregates when proposed for use in prestressed concrete or when, in non-prestressed concrete, the proposed percentage of replacement by mass of the total amount of coarse aggregates with recycled aggregates (coarse CCA) exceeds 30% by determining, in accordance with BS EN 12390-13 [Ref 117.N] using moulded test specimens, the secant modulus of elasticity in compression of a sample of concrete with the same constituents, composition and percentage of replacement of recycled aggregates as that specified in CC 482/WSR/006 for each concrete mix of the concrete to be used in the works, and checking that the value of the secant modulus of elasticity is within the range permitted in CC 482/WSR/006 for each concrete mix.

6.59 The frequency of suitability testing for structural concrete by determination of the secant modulus of elasticity shall be once for each concrete mix, on four test specimens made from one sample, tested no later than 42 days prior to the commencement of the concreting works.

6.60 The requirements for "Verification" in Section 14 of GC 101 [Ref 44.N] shall apply to the suitability testing of recycled aggregates for structural concrete by determination of the secant modulus of elasticity.

6.61 The following Documentation shall be submitted for suitability testing of recycled aggregates for structural concrete by determination of the secant modulus of elasticity prior to the commencement of the concreting works: test report for the determination of the secant modulus of elasticity.

6.62 The requirements for "Documentation" in Section 2 of GC 101 [Ref 44.N] shall apply to the test report for the determination of the secant modulus of elasticity.

Admixtures for structural concrete

6.63 General purpose admixtures for structural concrete, as defined in Table 1 of BS EN 934-2 [Ref 3.N], shall be compliant with BS EN 934-1 [Ref 2.N] and BS EN 934-2 [Ref 3.N].

6.64 The general purpose admixtures for structural concrete shall meet the performance characteristics as stated in table 6.64.

Table 6.64 Characteristics and performance requirements for general purpose admixtures for structural concrete

Characteristic	Performance requirement
Chloride ion content (for all admixtures)	Water soluble chloride content to be as required in Table 1 of BS EN 934-1 [Ref 2.N], with manufacturer's stated value to be declared
Alkali content (for all admixtures)	Alkali content to be as required in Table 1 of BS EN 934-1 [Ref 2.N], with manufacturer's stated value to be declared
Corrosion behaviour (for all admixtures)	As required in Section 5 of BS EN 934-1 [Ref 2.N], with all substances contained in the admixture listed
Compressive strength (for all admixtures)	As required in Tables 2, 3.1, 3.2, 4, 5, 6, 7, 8, 9, 10, 11.1, 11.2, 12 and 13 of BS EN 934-2 [Ref 3.N] for the respective admixture type
Air content (for all admixtures except air-entraining admixtures)	Test mix ≤ 2% by volume of control mix in accordance with Tables 2, 3.1, 3.2, 4, 6, 7, 8, 9, 10, 11.1, 11.2, 12 and 13 of BS EN 934-2 [Ref 3.N]for the respective admixture type

Air content - entrained air (for air-entraining admixtures)	As required in Table 5 of BS EN 934-2 [Ref 3.N]
Air void characteristic (for air-entraining admixtures)	As required in Table 5 of BS EN 934-2 [Ref 3.N]
Water reduction (for water-reducing/plasticizing admixtures, high range water-reducing/super-plasticizing admixtures, set-retarding/water-reducing/plasticizing admixtures, set-retarding/high range water-reducing/super-plasticizing admixtures, set-accelerating/water-reducing/plasticizing admixtures)	As required in Tables 2, 3.1, 10, 11.1 and 12 of BS EN 934-2 [Ref 3.N] for the respective admixture type
Bleeding (for water-reducing admixtures)	As required in Table 4 of BS EN 934-2 [Ref 3.N]
Setting time (for set-accelerating admixtures, set-retarding admixtures, set-retarding/water reducing/plasticizing admixtures, set-retarding/high range water-reducing/super-plasticizing admixtures, set-accelerating/water reducing/plasticizing admixtures)	As required in Tables 6, 8, 10, 11.1 and 12 of BS EN 934-2 [Ref 3.N]for the respective admixture type
Hardening time/strength development (for set-accelerating admixtures, hardening-accelerating admixtures, set-retarding admixtures, set-retarding/water-reducing/plasticizing admixtures, set-retarding/high range water-reducing/super-plasticizing admixtures)	As required in Tables 6, 7, 8, 10 and 11.1 of BS EN 934-2 [Ref 3.N]for the respective admixture type
Capillary absorption (for water resisting admixtures)	As required in Table 9 of BS EN 934-2 [Ref 3.N]
Consistency - increase/retention (for high range water-reducing/super-plasticizing admixtures, set-retarding/high range water-reducing/super-plasticizing admixtures)	As required in Tables 3.2 and 11.2 of BS EN 934-2 [Ref 3.N]for the respective admixture type
Segregated portion (for viscosity modifying/cohesion improving admixtures)	As required in Table 13 of BS EN 934-2 [Ref 3.N]

6.65 The requirements of "Designated standards" in Section 10 of GC 101 [Ref 44.N] shall apply to general purpose admixtures for structural concrete.

6.66 Foaming admixtures and semi-dry concrete admixtures shall not be used as admixtures for structural concrete.

6.67 Special purpose admixtures for structural concrete, as defined in 4.3 of BS 8443 [Ref 86.N] shall be compliant with BS 8443 [Ref 86.N].

6.68 The special purpose admixtures for structural concrete shall meet the performance characteristics as stated in table 6.68.

Table 6.68 Characteristics and perfomance requirements for special purpose admixtures for structural concrete

Characteristic	Performance requirement
Chloride ion content (for all admixtures)	Water soluble chloride content to be as required in Table 1 of BS 8443 [Ref 86.N], with manufacturer's stated value to be declared
Alkali content (for all admixtures)	Alkali content to be as required in Table 1 of BS 8443 [Ref 86.N], with manufacturer's stated value to be declared
Effect on setting (for all admixtures)	As required in Table 1 of BS 8443 [Ref 86.N]
Compressive strength (for all admixtures)	As required in Tables 2, 3, 4, 5 and 6 of BS 8443 [Ref 86.N]for the respective admixture type
Air content (for shrinkage reducing admixtures, corrosion inhibiting admixtures and pumping aids)	As required in Tables 3, 4 and 5 of BS 8443 [Ref 86.N]for the respective admixture type
Consistence (for underwater admixtures)	As required in Table 2 of BS 8443 [Ref 86.N]
Washout (for underwater admixtures)	As required in Table 2 of BS 8443 [Ref 86.N]
Plastic density (for underwater admixtures)	As required in Table 2 of BS 8443 [Ref 86.N]
Shrinkage reduction (for shrinkage reducing admixtures)	As required in Table 3 of BS 8443 [Ref 86.N]
Setting time (for corrosion inhibiting admixtures)	As required in Table 4 of BS 8443 [Ref 86.N]
Segregation (for segregation reducing admixtures)	As required in Table 6 of BS 8443 [Ref 86.N]

6.69 The following Documentation shall be submitted for special purpose admixtures for structural concrete prior to the commencement of the concreting works: certificate of conformity with BS 8443 [Ref 86.N] demonstrating that the special purpose admixtures meet the specification requirements.

6.70 The requirements for "Documentation" in Section 2 of GC 101 [Ref 44.N] shall apply to the certificate of conformity for special purpose admixtures for structural concrete.

6.71 Admixtures for structural concrete shall be used in accordance with the manufacturer's instructions.

6.72 Verification shall be undertaken for the suitability of any air-entraining admixture for structural concrete proposed for use in the works by testing, in accordance with BS EN 12350-7 [Ref 107.N]and for each concrete mix, the air content of a sample of concrete with the same constituents and composition specified in CC 482/WSR/006 for the concrete to be used in works containing the same type and amount of air-entraining admixture as proposed for the works, and checking that for each concrete mix no test result is more than 0.5% below, or more than 5% above, the minimum air content specified in CC 482/WSR/006.

6.73 The frequency of suitability testing of any air-entraining admixture for structural concrete proposed for use in the concrete for the works shall be once for each concrete mix, no later than 42 days prior to the commencement of the concreting works, performed at both the lower and upper limits of the concrete consistence class specified in CC 482/WSR/006 and, for both limits, at no less than two temperatures representing a minimum and maximum of the expected range of temperatures at the time of the concreting works.

6.74 The requirements for "Verification" in Section 14 of GC 101 [Ref 44.N] shall apply to suitability testing of any air-entraining admixture for structural concrete proposed for use in the works.

6.75 The following Documentation shall be submitted for suitability testing of any air-entraining admixture for structural concrete proposed for use in the works prior to the commencement of the concreting works: air-entraining admixture suitability testing report(s).

6.76 The requirements for "Documentation" in Section 2 of GC 101 [Ref 44.N] shall apply to test report(s) for air-entraining admixture suitability testing.

6.77 Verification shall be undertaken for the compatibility of any air-entrainment admixture for structural concrete proposed for use in the works in combination with other admixtures for structural concrete proposed for use in the works concrete by testing the combination of admixtures in accordance with 4.4.3 of BS 8500-2 [Ref 24.N].

6.78 The frequency of compatibility testing of the combination of admixtures shall be once for each concrete mix, no later than 42 days prior to the commencement of the concreting works.

6.79 The requirements for "Verification" in Section 14 of GC 101 [Ref 44.N] shall apply to compatibility testing of the combination of admixtures for structural concrete.

6.80 The following Documentation shall be submitted for compatibility testing of any air-entraining admixture proposed for use in the works in combination with other admixtures for structural concrete proposed for

use in the works prior to the commencement of the concreting works: compatibility testing report(s) for the combination of admixtures.

6.81 The requirements for "Documentation" in Section 2 of GC 101 [Ref 44.N] shall apply to compatibility testing report(s) for the combination of admixtures.

Fibres for structural concrete

6.82 Steel fibres for structural concrete shall only be permitted for 'non-structural' use as defined in Section 1 of BS EN 14889-1 [Ref 41.N].

6.83 Steel fibres for structural concrete shall be compliant with BS EN 14889-1 [Ref 41.N].

6.84 The steel fibres for structural concrete shall meet the performance characteristics as stated in table 6.84.

Table 6.84 Characteristics and performance requirements for steel fibres for structural concrete

Characteristic	Performance requirement
Tensile strength	Declared value in accordance with 5.3 of BS EN 14889-1 [Ref 41.N]
Modulus of elasticity	Declared value in accordance with 5.4 of BS EN 14889-1 [Ref 41.N]
Effect on consistence (workability) of concrete	- Effect on consistence, determined in accordance with 5.7 of BS EN 14889-1 [Ref 41.N], is to be declared - Amount of fibres and any type/amount of admixture added to reach the declared effect on consistence is to be declared
Effect on strength of concrete - general (fibre group type, shape, bundling and coating)	- Group type, in accordance with 5.1 of BS EN 14889-1 [Ref 41.N], is to be declared - Only 'deformed' shape type permitted - Bundling type/size to be declared - No zinc coating permitted
Effect on strength of concrete - dimensions and tolerances	- Length, equivalent diameter and aspect ratio of fibres of group types I and II to be declared and to be as required in 5.2 of BS EN 14889-1 [Ref 41.N] - Range of lengths, equivalent diameters and aspect ratios of fibres of group types III, IV and V to be declared and to be as required in 5.2 of BS EN 14889-1 [Ref 41.N]
Effect on strength of concrete - effect on the strength of concrete	The unit volume of fibres that imparts the required effect on the strength of concrete in accordance with 5.8 of BS EN 14889-1 [Ref 41.N]is to be declared

6.85 The requirements of "Designated standards" in Section 10 of GC 101 [Ref 44.N] shall apply to steel fibres for structural concrete.

6.86 Polymer fibres for structural concrete shall only be permitted for 'non-structural' use as defined in Section 1 of BS EN 14889-2 [Ref 40.N].

6.87 Polymer fibres for structural concrete shall be compliant with BS EN 14889-2 [Ref 40.N].

6.88 The polymer fibres for structural concrete shall meet the performance characteristics as stated in table 6.88.

Table 6.88 Characteristics and performance requirements for polymer fibres for structural concrete

Characteristic	Performance requirement
Tensile properties	- Declared value of tenacity for class I fibres in accordance with 5.4.1 of BS EN 14889-2 [Ref 40.N] - Declared value of tensile strength for class II fibres in accordance with 5.4.2 of BS EN 14889-2 [Ref 40.N]
Modulus of elasticity	Declared value in accordance with 5.5 of BS EN 14889-2 [Ref 40.N]
Effect on consistence (workability) of concrete	- Effect on consistence, determined in accordance with 5.7 of BS EN 14889-2 [Ref 40.N], is to be declared - Amount of fibres and any type/amount of admixture added to reach the declared effect on consistence is to be declared
Effect on strength of concrete - general (polymer type, shape, bundling and coating)	- Polymer type and class, in accordance with 5.1 and 5.2 of BS EN 14889-2 [Ref 40.N], is to be declared - Only 'deformed' shape type permitted - Bundling type/size to be declared - Type/quantity of fibre treatment/coating to be declared
Effect on strength of concrete - dimensions and tolerances	- Length, diameter and aspect ratio of fibres to be declared and to be as required in 5.3 of BS EN 14889-2 [Ref 40.N] - Linear density of class I fibres to be declared and to be as required in 5.3 of BS EN 14889-2 [Ref 40.N]
Effect on strength of concrete - effect on the strength of concrete	The unit volume of fibres that imparts the required effect on the strength of concrete in accordance with 5.8 of BS EN 14889-2 [Ref 40.N]is to be declared

6.89 The requirements of "Designated standards" in Section 10 of GC 101 [Ref 44.N] shall apply to polymer fibres for structural concrete.

6.90 Fibres for structural concrete shall be used in accordance with the manufacturer's instructions.

6.91 Fibres for structural concrete shall be protected, prior to their use, from environmental conditions that can affect their strength and performance.

Mixing water for structural concrete

6.92 Mixing water for structural concrete shall be compliant with BS EN 1008 [Ref 56.N].

6.93 The mixing water for structural concrete shall meet the following performance characteristics: those required in Section 4 of BS EN 1008 [Ref 56.N].

6.94 Sea water and brackish water shall not be used as mixing water for structural concrete.

6.95 The following Documentation shall be submitted for mixing water for structural concrete prior to the commencement of the concreting works when non-potable water to BS EN 1008 [Ref 56.N] is used as mixing water: test report certificate in accordance with Section 7 of BS EN 1008 [Ref 56.N] demonstrating that the mixing water for structural concrete meets the specification requirements.

6.96 The requirements for "Documentation" in Section 2 of GC 101 [Ref 44.N] shall apply to the test report certificate for mixing water for structural concrete.

Product requirements for structural concrete

General product requirements for structural concrete

6.97 The constituent materials of structural concrete shall be selected so that the resulting concrete meets all the requirements specified in CC 482/WSR/006.

6.98 The age at which the compressive strength of the concrete is evaluated for compliance with the class specified in CC 482/WSR/006 for the structural element and/or its part shall be 28 days, unless otherwise stated in CC 482/WSR/006.

6.99 The maximum cement content of structural concrete shall not exceed 550 kg/m^3, unless otherwise stated in CC 482/WSR/006.

6.100 Dosage and method of dispensing of admixtures for structural concrete shall be in accordance with the manufacturer's instructions.

6.101 Mixing and method of dispensing of fibres for structural concrete shall be in accordance with the manufacturer's instructions.

6.102 The maximum total chloride content for structural concrete shall be in accordance with table 6.102 and CC 482/WSR/006.

Table 6.102 Chloride content class for structural concrete

Chloride content class	Maximum total chloride content (% chloride ion by mass of cement including any addition)
Cl 0,10	0.10%
Cl 0,20	0.20%
Cl 0,30	0.30%
Cl 1,00	1.00%

6.103 Verification shall be undertaken for the chloride content of structural concrete by calculating, in accordance with 5.2 of BS 8500-2 [Ref 24.N] and 5.2.8 of BS EN 206 [Ref 21.N], the total chloride content of each concrete mix and checking that the total chloride content of each concrete mix is within the limits specified in CC 482/WSR/006 for the structural element and/or its part the concrete mix relates to.

6.104 The frequency of calculation of the chloride content of structural concrete shall be once per each concrete mix as part of the initial testing in accordance with 9.5, Table 29 and Annex A of BS EN 206 [Ref 21.N].

6.105 The requirements for "Verification" in Section 14 of GC 101 [Ref 44.N] shall apply to the calculation of the chloride content of structural concrete.

6.106 The following Documentation shall be submitted for the chloride content of structural concrete prior to the commencement of the concreting works: certificate including calculation of the total chloride content for each concrete mix confirming that the chloride content meets the requirements of the specification.

6.107 The requirements for "Documentation" in Section 2 of GC 101 [Ref 44.N] shall apply to the certificate including calculation of the total chloride content for each concrete mix.

6.108 The risk of damaging alkali-silica reaction in structural concrete shall be minimised in accordance with Annex C of BS 8500-2 [Ref 24.N].

6.109 Verification shall be undertaken for the minimisation of risk of damaging alkali-silica reaction in structural concrete by determining the

alkali content of each concrete mix in accordance with Annex C.2 and C.3 of BS 8500-2 [Ref 24.N]and the reactivity of the aggregates to be used in each concrete mix in accordance with Annex C.4 of BS 8500-2 [Ref 24.N], and checking conformity with any one of the requirements in Annex C.5 to C.11 of BS 8500-2 [Ref 24.N]for each concrete mix.

6.110 The frequency of the check for the minimisation of risk of damaging alkali-silica reaction in structural concrete shall be once per each concrete mix, repeated any time there is a change in quantities of constituent materials of more than allowed by Table A.1 of BS 8500-2 [Ref 24.N]when batching less than 1 m^3 of concrete, or by Table 27 of BS EN 206 [Ref 21.N] when batching 1 m^3 of concrete or more.

6.111 The requirements for "Verification" in Section 14 of GC 101 [Ref 44.N] shall apply to the check for the minimisation of risk of damaging alkali-silica reaction in structural concrete.

6.112 The following Documentation shall be submitted for the minimisation of risk of damaging alkali-silica reaction in structural concrete prior to the commencement of the concreting works: certificate including determination of the alkali content of each concrete mix and the reactivity of the aggregates to be used in each concrete mix, confirming that the risk of damaging alkali-silica reaction is minimised in accordance with Annex C of BS 8500-2 [Ref 24.N] for each concrete mix.

6.113 The requirements for "Documentation" in Section 2 of GC 101 [Ref 44.N] shall apply to the certificate confirming the risk of alkali-silica reaction is minimised for each concrete mix.

Additional product requirements for self-compacting concrete for structural concrete

6.114 Self-compacting concrete for structural concrete shall , without vibration or other agitation, self-compact and fill all spaces within the formwork under its own weight whilst maintaining homogeneity.

6.115 Self-compacting concrete for structural concrete shall , without vibration or other agitation, flow through and around all reinforcement, prestressing systems, cover blocks, embedded monitoring/corrosion protection systems, formwork or any other items within the concrete pour with no segregation or blocking.

Production and conformity requirements for structural concrete

6.116 Structural concrete shall be subject to production control in accordance with Section 9 of BS EN 206 [Ref 21.N] and Annex A.1 of BS 8500-2 [Ref 24.N].

6.117 The mix proportions and grading of the constituent materials for structural concrete during production control shall be maintained constant for each concrete mix, with changes in quantities of constituent materials no more than allowed by Table A.1 of BS 8500-2 [Ref 24.N] when batching less than 1 m^3 of concrete, or by Table 27 of BS EN 206 [Ref 21.N] when batching 1 m^3 of concrete or more.

6.118 Verification shall be undertaken for structural concrete by initial testing of each concrete mix in accordance with 9.5, Table 29 and Annex A of BS EN 206 [Ref 21.N]and checking that each concrete mix satisfies the requirements specified in CC 482/WSR/006.

6.119 The frequency of initial testing for structural concrete shall be in accordance with Annex A.3 of BS EN 206 [Ref 21.N]for each concrete mix, repeated any time there is a change in quantities of constituent materials of more than allowed by Table A.1 of BS 8500-2 [Ref 24.N]when batching less than 1 m^3 of concrete, or by Table 27 of BS EN 206 [Ref 21.N] when batching 1 m^3 of concrete or more.

6.120 The requirements for "Verification" in Section 14 of GC 101 [Ref 44.N] shall apply to initial testing of concrete mixes for structural concrete.

6.121 Verification shall be undertaken for structural concrete by conformity testing of each concrete mix in accordance with 8.2 of BS EN 206 [Ref 21.N] and Annex A.4 of BS 8500-2 [Ref 24.N] and checking that each concrete mix satisfies the requirements specified in CC 482/WSR/006 in relation to the conformity criteria in 8.2 of BS EN 206 [Ref 21.N]and Annex A.4 of BS 8500-2 [Ref 24.N].

6.122 The frequency of conformity testing for structural concrete for each concrete mix shall be equal to the frequency of conformity testing for 'concrete with production control certification in accordance with Tables 17, 21 and 22 of BS EN 206 [Ref 21.N].

6.123 The requirements for "Verification" in Section 14 of GC 101 [Ref 44.N] shall apply to conformity testing of concrete mixes for structural concrete.

6.124 Verification shall be undertaken for fresh concrete properties of structural concrete, where specified in CC 482/WSR/006, by digital monitoring and measurement of fresh concrete properties in accordance with the specification requirements detailed in the documentation referenced in CC 482/WSR/006 and checking that the fresh concrete properties satisfy the requirements specified in CC 482/WSR/006.

6.125 The frequency of digital monitoring and measurement of fresh concrete properties shall be in accordance with the specification requirements detailed in the documentation referenced in CC

482/495/006 for digital monitoring and measurement of fresh concrete properties.

6.126 The requirements for "Verification" in Section 14 of GC 101 [Ref 44.N] shall apply to digital monitoring and measurement of fresh concrete properties.

6.127 The following Documentation shall be submitted for production of structural concrete prior to the commencement of the concreting works: report identifying the nature, source and quantity per cubic meter of concrete of all constituent material for each concrete mix; report containing results of initial testing for each concrete mix in accordance with 9.5, Table 29 and Annex A of BS EN 206 [Ref 21.N]with information on the concrete strength development, confirming that each concrete mix meets the requirements of the specification.

6.128 The requirements for "Documentation" in Section 2 of GC 101 [Ref 44.N] shall apply to the report identifying the nature, source and quantities of constituent materials for each concrete mix; report with results of initial testing for each concrete mix.

6.129 The following Documentation shall be submitted for conformity of structural concrete prior to the commencement of the concreting works and monthly thereafter: report containing results of conformity testing for each concrete mix in accordance with 8.2 of BS EN 206 [Ref 21.N]and Annex A.4 of BS 8500-2 [Ref 24.N]including certificate of conformity for combinations to Annex B of BS 8500-2 [Ref 24.N], confirming that each concrete mix meets the requirements of the specification.

6.130 Documentation for conformity of structural concrete shall be submitted no later than 14 days prior to the commencement of the concreting works and monthly thereafter.

6.131 The following Documentation for digital monitoring and measurement of fresh concrete properties, where specified in CC 482/WSR/006, shall be submitted as continuous records: report with results of digital monitoring and measurement of fresh concrete properties, confirming that the fresh concrete properties meet the requirement of the specification.

6.132 The requirements of "Records" in Section 3 of GC 101 [Ref 44.N] shall apply to the report with results of digital monitoring and measurement of fresh concrete properties.

Requirements for pre-concreting trials for structural concrete

General requirements for pre-concreting trials for structural concrete

6.133 Requirements for pre-concreting trials for structural concrete shall be as specified in CC 482/WSR/006.

Requirements for pre-concreting trials for structural concrete

Structure ID	Structural element	Description of structural element	Drawing/ model references(s)	Designed concrete mix reference	Trial panels for surface finish required	Trial pours for self-compacting concrete required
(a)	(b)	(c)	(d)	(e)	(f)	(g)

1. Enter a unique reference.

2. Enter a unique reference, to identify the structural element reference.

3. Enter text, to describe the structural element and/or its part the pre-concreting trial refers to.

4. Enter a unique reference, to provide reference of drawing(s) or model(s) where the structural element and/or its part the pre-concreting trial refers to is shown.

5. Enter a unique reference, to identify the reference of the designed concrete mix used for concreting of the structural element and/or its part the pre-concreting trial refers to.

6. Enter a value, from options yes, no, to identify whether trial panels are required, for the concrete to be used for concreting of the structural element and/or its part, to demonstrate that the specified surface finish can be achieved by the proposed formwork, concrete mix and concreting methods.

7. Enter a value, from options yes, no, to identify whether trial pours are required, for the structural element and/or its part subject to concreting with self-compacting concrete, to demonstrate the suitability of the proposed self-compacting concrete mix and concreting methods.

Pre-concreting trial panels for the surface finish of structural concrete

6.134 Verification shall be undertaken for the achievability of the specified surface finish for structural concrete by casting, when required in CC 482/WSR/006 and for each concrete mix, trial panels constructed using the same formwork, concrete mix and concreting methods proposed for the permanent works and containing reinforcement representative of the

reinforcement sizes and spacing in the sections of the permanent works the panels refer to, and checking, after formwork removal following completion of compaction and curing, that the concrete surfaces of the trial panels are free from visible defects, are of uniform colour and comply with the surface finish requirements in CC 482/WSR/006.

6.135 The frequency of casting of trial panels for the surface finish of structural concrete shall be once for each concrete mix and for each specified surface finish of the structural element and/or its part, no less than 56 days prior to the commencement of concreting of the permanent works, unless otherwise stated in CC 482/WSR/006.

SI.6.135 The frequency of casting of trial panels for the surface finish of structural concrete shall be [enter free text].

6.136 The requirements for "Verification" in Section 14 of GC 101 [Ref 44.N] shall apply to the casting of trial panels for the surface finish of structural concrete.

6.137 Trial panels for the surface finish of structural concrete shall be as specified in CC 482/WSR/006.

Trial panels for the surface finish of structural concrete

Structure ID	**Structural element reference**	**Description of structural element in the permanent works**	**Trial panel reference**	**Trial panel drawing/model reference(s)**	**Designed concrete mix reference for the trial panel**	**Surface finish class of the trial panel**	**Trial panel size**
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)

1. Enter a unique reference.

2. Enter a unique reference, to identify the structural element reference.

3. Enter text, to describe the structural element and/or its part in the permanent works the trial panel refers to.

4. Enter a unique reference, to identify the trial panel reference.

5. Enter a unique reference, to provide reference of drawing(s) or model(s) for the trial panel where the panel dimensions and the layout of the reinforcement in the panel are shown.

6. Enter a unique reference, to identify the reference of the designed concrete mix used for concreting of the trial panel.

7. Enter a value, from options F1, F2, F3, F4, F5, U1, U2, U3, U4, U5, other, to identify the required class of the surface finish for the trial panel.

8. Enter text, to identify the required dimensions of the trial panel in terms of length, width and depth, to be representative of the size of the structural element and/or its part in the permanent works that the surface finish trial refers to, including incorporation of horizontal and vertical joints representative of the pattern of surface finish of the structural element and/or its part.

Trial panels for the surface finish of structural concrete (continued)

Structure ID	Trial panel reinforcement diameter(s) and spacing(s)	Nominal cover to reinforcement	Special requirements for the surface finish trial panel (where applicable)
(a)	(i)	(j)	(k)

1. Enter text, to identify the required layout of reinforcement to be installed within the trial panel to be cast, to be representative of the most heavily congested zones of reinforcement in the structural element and/or its part the surface finish trial refers to.

2. Enter a number in units of , to identify the nominal cover to reinforcement required for the trial panel.

3. Enter text, to describe any special requirement for the surface finish trial panel.

6.138 Where the concrete surfaces of the trial panels have visible defects, are not of uniform colour or do not comply with the surface finish requirements in CC 482/WSR/006, the proposed formwork, concrete mix and concreting methods shall be revised and new trial panels produced until compliance is achieved before concreting of the permanent works can proceed.

6.139 The following Documentation shall be submitted for the achievability of the specified surface finish of structural concrete prior to the commencement of the concreting works: report with records of casting and inspection of the trial panel(s) for the surface finish of structural concrete.

6.140 The requirements for "Documentation" in Section 2 of GC 101 [Ref 44.N] shall apply to the report with records of casting and inspection of the trial panel(s) for the surface finish of structural concrete.

Pre-concreting trial pours for self-compacting concrete for structural concrete

6.141 Verification shall be undertaken for the suitability of the proposed self-compacting concrete mix and concreting methods by executing, when required in CC 482/WSR/006, trial pours that reproduce a representative portion of the structural element and/or its part in the permanent works for each concrete mix in accordance with CC 482/WSR/006 using the same formwork, concrete mix, concreting methods, depth of pour and surface finish proposed for the permanent works and containing reinforcement representative of the reinforcement sizes and spacing in the permanent works, and checking, after formwork removal following completion of curing, that the concrete surfaces of the trial pours for each concrete mix are of uniform colour, comply with the surface finish requirements in CC 482/WSR/006 and are, together with any surface of the trial pour saw-cuts in accordance with CC 482/WSR/006, free from voids, honeycombing, segregation, cracking and other visible defects.

6.142 The frequency of the execution of trial pours for the suitability of the proposed self-compacting concrete mix and concreting methods shall be once for each concrete mix and for each specified surface finish of the structural element and/or its part, at a temperature no more than 5°C higher nor 5°C lower than the expected temperature range at the time of concreting of the permanent works, no less than 56 days prior to the commencement of concreting of the permanent works, unless otherwise stated in CC 482/WSR/006.

SI.6.142 The frequency of the execution of trial pours for the suitability of the proposed self-compacting concrete mix and concreting methods shall be [enter free text].

6.143 The requirements for "Verification" in Section 14 of GC 101 [Ref 44.N] shall apply to the execution of trial pours for the suitability of the proposed self-compacting concrete mix and concreting methods.

6.144 Trial pours for self-compacting concrete for structural concrete shall be as specified in CC 482/WSR/006.

Trial pours for self-compacting concrete for structural concrete

Structure ID	Structural element reference	Description of structural element in the permanent works	Trial pour reference	Trial pour drawing/model reference(s)	Designed concrete mix reference for the trial pour	Maximum permitted time from initial mixing to placing for the trial pour	Surface finish class of the trial pour
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)

1. Enter a unique reference.

2. Enter a unique reference, to identify the structural element reference.

3. Enter text, to describe the structural element and/or its part in the permanent works the trial pour for self-compacting concrete represents.

4. Enter a unique reference, to identify the trial pour reference.

5. Enter a unique reference, to provide reference of drawing(s) or model(s) for the trial pour for self-compacting concrete where the pour dimensions, the layout of the reinforcement in the pour, the location, extent and orientation of any saw-cuts, the location, size and orientation of any cores and the location and size of any transparent acrylic windows to be incorporated into formwork are shown.

6. Enter a unique reference, to identify the reference of the designed concrete mix used for the trial pour for self-compacting concrete.

7. Enter a number in units of , to identify, for the self-compacting concrete to be used for the trial pour, the maximum time that is permitted from the introduction of the cement to the aggregates at initial mixing to the commencement of placing into the forrmwork.

8. Enter a value, from options F1, F2, F3, F4, F5, U1, U2, U3, U4, U5, Other, to identify the required class of the surface finish for the trial pour for self-compacting concrete, selected to be

consistent with the surface finish of the structural element and/or its part in the permanent works the trial pour represents.

Trial pours for self-compacting concrete for structural concrete (continued)

Structure ID	Trial pour size	Trial pour reinforcement diameter(s) and spacing	Nominal cover to reinforcement	Transparent acrylic windows to be incorporated into formwok for the trial pour required	Location and size of any transparent acrylic window to be incorporated into formwork for the trial pour (where applicable)	Trial pour saw-cuts required
(a)	(i)	(j)	(k)	(l)	(m)	(n)

1. Enter text, to identify the required dimensions of the trial pour for self-compacting concrete in terms of length, width and depth, to be representative of the size of the structural element and/or its part the trial pour refers to.

2. Enter text, to identify the required layout of reinforcement to be installed within the trial pour for self-compacting concrete, to be representative of the most heavily congested zones of reinforcement in the structural element and/or its part the trial pour refers to.

3. Enter a number in units of , to identify the nominal cover to reinforcement required for the trial pour for self-compacting concrete.

4. Enter a value, from options yes, no, to identify whether transparent acrylic windows are required to be incorporated into the formwork to allow visual monitoring of the adequacy of the flow of the self-compacting concrete during the trial pour.

5. Enter text, to define the location within the formwork and the dimensions of any transparent acrylic window to be incorporated into the formwork for the trial pour for self-compacting concrete.

6. Enter a value, from options yes, no, to identify whether any saw-cuts are required to the hardened concrete of the trial pour for self-compacting concrete to facilitate the visual inspection of the

concrete matrix at the locations most representative for demonstrating the suitability of the self-compacting concrete mix and concreting methods.

Trial pours for self-compacting concrete for structural concrete (continued)

Structure ID	Location, extent and orientation of any saw-cuts (where applicable)	Cores for compressive strength testing taken from the hardened concrete of the trial pour required	Number, location, size and orientation of any concrete cores for compressive strength testing (where applicable)	Minimum age after placing of the trial pour before concrete cores for compressive strength testing can be extracted (where applicable)	Special requirements for the trial pours for self-compacting concrete for structural concrete (where applicable)
(a)	(o)	(p)	(q)	(r)	(s)

1. Enter text, to define the location, extent and orientation of any saw-cut required to the hardened concrete of the trial pour for self-compacting concrete.

2. Enter a value, from options yes, no, to identify whether any cores are required to be extracted from the hardened concrete of the trial pour for self-compacting concrete for compressive strength testing.

3. Enter text, to define the number, location, size and orientation of any concrete cores required to be extracted from the hardened concrete of the trial pour for self-compacting concrete for subsequent testing.

4. Enter a number in units of , to identify how many days after placing of the trial pour have to pass before cores for compressive strength testing can be extracted from the hardened concrete of the trial pour.

5. Enter text, to describe any special requirement for the trial pours for self-compacting concrete for structural concrete.

6.145 The hardened concrete of trial pours for self-compacting concrete shall be saw-cut at horizontal and/or vertical surfaces in accordance with CC 482/WSR/006 to facilitate the visual inspection of the concrete matrix at the locations most representative for demonstrating the suitability of

the self-compacting concrete mix and concreting methods, unless otherwise stated in CC 482/WSR/006.

6.146 Verification shall be undertaken for the compressive strength of cores extracted from trial pours for self-compacting concrete for each concrete mix, where required and specified in CC 482/WSR/006, by determining, in accordance with BS EN 12504-1 [Ref 105.N], the compressive strength of cores and checking that the determined compressive strength meets the identity criteria in Annex B.7 of BS 8500-1 [Ref 23.N]in relation to the concrete compressive strength class specified in CC 482/WSR/006 for the structural element and/or its part the concrete mix of the trial pour for self-compacting concrete relates to.

6.147 The frequency of determination of the compressive strength of cores extracted from trial pours for self-compacting concrete shall be once for each concrete mix, on four cores for each trial pour tested at no less than 28 days after placing of the trial pour unless otherwise stated in CC 482/WSR/006.

SI.6.147 The frequency of determination of the compressive strength of cores extracted from trial pours shall be [enter free text].

6.148 The requirements for "Verification" in Section 14 of GC 101 [Ref 44.N] shall apply to determination of the compressive strength of cores extracted from trial pours for self-compacting concrete.

6.149 Verification for compressive strength of cores taken from trial pours for self-compacting concrete shall be undertaken by an accredited testing laboratory in compliance with "Accredited laboratory" in Section 16 of GC 101 [Ref 44.N].

6.150 Where the concrete surfaces or the saw-cuts of the trial pours are not of uniform colour, do not comply with the surface finish requirements in CC 482/WSR/006, contain voids, honeycombing, segregation, cracking or other visible defects or where the compressive strength of cores does not meet the requirements of the specification, the self-compacting concrete mix and/or the concreting methods used shall be amended and the trial pours repeated until compliance is achieved before concreting of the permanent works with self-compacting concrete can proceed.

6.151 The following Documentation shall be submitted for trial pours of self-compacting concrete for structural concrete prior to the commencement of concreting with self-compacting concrete in the permanent works: report with record of findings of the visual inspection of the trial pour concrete surfaces and the trial pour saw-cut planes; report with results of the compressive strength testing of the cores; report containing any recommendations for amendments to the concreting methods.

6.152 The requirements for "Documentation" in Section 2 of GC 101 [Ref 44.N] shall apply to the report with record of findings of the visual inspection of the trial pour; report with results of the compressive strength testing of the cores; report with any recommended amendments to the concreting methods.

Installation requirements for structural concrete

6.153 The following Documentation shall be submitted for installation of structural concrete prior to the commencement of the concreting works: concreting plan including method statements for concrete placing, compaction, curing and protection.

6.154 The requirements for "Documentation" in Section 2 of GC 101 [Ref 44.N] shall apply to the concreting plan.

Transport and delivery of fresh concrete for structural concrete

6.155 Fresh concrete for structural concrete shall be transported, unloaded and conveyanced in a way that prevents the occurrence of segregation, loss of constituents, change in entrained air content, unintended ingress of water/foreign matter and ensures the workability of the mix is maintained.

6.156 Fresh concrete for structural concrete shall not come into contact with aluminium alloy.

6.157 The addition of water, admixtures, pigments or fibres to the concrete mix following initial mixing and before delivery shall only be permitted:.

1. Under the direction of the concrete producer; and

2. When the concrete remains in compliance with the specification; and

3. When a documented procedure for undertaking the process exists and conformity control, in the form of identity testing, is carried out on a sample of the delivered concrete in accordance with 7.5 of BS EN 206 [Ref 21.N]

6.158 The following Documentation for the addition of water, admixtures, pigments or fibres to the concrete mix following initial mixing and before delivery shall be submitted as continuous records: record of quantities of water, admixtures, pigments or fibres added to the concrete mix following initial mixing and before delivery; report containing results of identity testing confirming the delivered concrete meets the specification.

6.159 The requirements of "Records" in Section 3 of GC 101 [Ref 44.N] shall apply to the record of quantities of water, admixtures, pigments or fibres added to the concrete mix following initial mixing and before delivery and to the report containing results of identity testing on the delivered concrete.

6.160 Delivery information for fresh concrete for structural concrete shall be in the form of a delivery ticket in accordance with 7.3 and 7.4 of BS EN 206 [Ref 21.N] and Annex A.3 of BS 8500-2 [Ref 24.N].

6.161 The following Documentation for fresh concrete for structural concrete shall be submitted as continuous records: delivery ticket for each batch/load of fresh concrete for structural concrete.

6.162 The requirements of "Records" in Section 3 of GC 101 [Ref 44.N] shall apply to the delivery ticket.

Formation of construction joints in structural concrete

6.163 Construction joints in structural concrete shall be as specified in CC 482/WSR/006.

Construction joints in structural concrete

Structure ID	Structural element reference	Description of structural element	Drawing/ model reference(s)	Design documentation reference(s)	Construction joint(s) surface preparation required	Open-mesh permanent formwork for the formation of construction joints required	Specifi requirements for constru on join
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)

1. Enter a unique reference.

2. Enter a unique reference, to identify the structural element reference.

3. Enter text, to describe the structural element and/or its part containing the construction joint(s).

4. Enter a unique reference, to provide reference of drawing(s) or model(s) where the structural element and/or its part containing the construction joint(s) is shown.

5. Enter a unique reference, to provide reference of the design documentation for the structural element and/or its part containing the construction joint(s), including any design documentation covering shear at the interface between concrete cast at different times and use of open-mesh permanent formwork.

6. Enter a value, from options yes, no, to identify the need, due to a non-prepared surface between concrete cast at different times not satisfying the interface shear requirements of 6.2.5 of BS EN 1992-1-1 [Ref 35.N], for the construction joint(s) surface to be prepared in the structural element and/or its part containing the construction joint(s).

7. Enter a value, from options yes, no, to identify the need, due to a non-prepared surface between concrete cast at different times not satisfying the interface shear requirements of 6.2.5 of BS EN 1992-1-1 [Ref 35.N], for the construction joint(s) surface to have open mesh permanent formwork for the formation of construction joints installed in the structural element and/or its part containing the construction joint(s).

8. Enter text, to identify any specific requirement for the construction joint(s) for the structural element and/or its part containing the construction joint(s).

6.164 Construction joints shall either be prepared to provide a 'rough surface' to 6.2.5 of BS EN 1992-1-1 [Ref 35.N]or be formed by the use of open-mesh permanent formwork for the formation of construction joints in accordance with "Falsework and formwork for structural concrete" in Section 3 of this document, in accordance with CC 482/WSR/006.

6.165 The preparation of a construction joint to provide a 'rough surface' to 6.2.5 of BS EN 1992-1-1 [Ref 35.N] shall ensure that either:.

1. The outer mortar skin of the hardening concrete surface is removed and the larger aggregate is exposed without disturbing it, such as by spraying the surface with a fine spray of water or by brushing the surface with a stiff brush; or

2. The hardened surface skin and laitance is removed without hacking the hardened concrete and the larger aggregate is exposed without disturbing it, such as by grit blasting or with a needle gun

6.166 Open-mesh permanent formwork for the formation of construction joints shall be installed in accordance with the manufacturer's instructions.

6.167 Construction joint surfaces shall be clean and damp but free of standing water before fresh concrete is placed against them.

6.168 Concreting shall be carried out continuously up to each construction joint.

6.169 Vertical construction joints shall be formed against a stop end.

6.170 When concreting vertical or sloping members, the lifts of concrete shall finish at right angles to the axis of the member to ensure construction joint lines are perpendicular to the member axis.

6.171 The construction joint lines shall match features of the finished works or be formed by grout checks.

6.172 When concreting elements from the ground or from a lift of concrete from a construction joint below, kickers at least 70 mm high shall be constructed integrally with the lift of concrete below to ensure correct alignment for the construction of the elements.

6.173 The construction joint lines shall prevent rain water becoming trapped within them, as freezing of trapped water can cause damage to the concrete.

6.174 The finished surface of a structural concrete pour shall not be governed by its angle of repose, with or without vibration.

Placing of fresh concrete for structural concrete

6.175 Before placing of fresh concrete for structural concrete, all surfaces that come into contact with fresh concrete shall be clear of deleterious substances and any loose materials including labels or tags which could compromise the durability, bonding properties, mechanical characteristics or chemical properties of the works.

6.176 Fresh concrete for structural concrete shall not be dropped into place from a height higher than 1 m.

6.177 Fresh concrete for structural concrete shall not be allowed to heap or accumulate on the formwork for:.

1. A total height of more than three times the concrete thickness, i.e. to a surcharge corresponding to two times the concrete thickness, for concrete thicknesses up to 300 mm

2. A surcharge corresponding to 600 mm, for concrete thicknesses greater than 300 mm

6.178 Fresh concrete for structural concrete shall not be allowed to flow to an outer perimeter that is not bound by shuttering or other physical barriers.

6.179 Fresh concrete for structural concrete shall not be placed through aluminium alloy conduits.

6.180 Water not intended to be included in the concrete mix shall be prevented from entering concrete pours during placing of fresh concrete for structural concrete.

6.181 When concreting structural concrete bridge decks, the whole thickness of the deck shall be placed in one pass.

6.182 Placing of concrete shall not displace reinforcement, prestressing systems, cover blocks, embedded monitoring/corrosion protection systems, formwork, void formers or any other items within the pour, nor damage the faces of formwork.

6.183 When items within the pour have been displaced or the faces of formwork have been damaged during concrete placing, the placed concrete shall be removed before it sets, any damaged formwork repaired/replaced and cleaned, the displaced items repositioned and a new concrete pour placed.

6.184 Where lightweight aggregate concrete is to be placed by pumping, the risk for the pumping operations to adversely affect the properties of the hardened lightweight aggregate concrete shall be minimised by ensuring that:.

1. Aggregate is pre-soaked to mitigate the loss of slump caused by pressure during pumping driving water into the aggregate pores; and

2. Air content, aggregate content, admixture content and consistence of the concrete mix is adjusted, within the limits permitted by "Concreting of structural concrete" in Section 6 of this document, to improve pumpability and mitigate the risk of water being squeezed in and out of the aggregates resulting in the weakening of the transition zone between the aggregates and the cement paste; and

3. The proposed pumping system and procedures are supported by evidence of successful previous projects or trials

6.185 The following Documentation shall be submitted for lightweight aggregate concrete to be placed by pumping prior to the commencement of placing of lightweight aggregate concrete into the works by pumping: report containing evidence of previous projects or trials where lightweight

aggregate concrete with the same constituents and composition of that to be used in the works, and placed with the same proposed pumping system and procedures, has been placed successfully by pumping.

6.186 The requirements for "Documentation" in Section 2 of GC 101 [Ref 44.N] shall apply to the report containing evidence of successful previous projects or trials placing of lightweight aggregate concrete by pumping.

6.187 Fresh concrete shall not be placed against concrete that has been placed for more than 30 minutes unless a construction joint is formed, unless otherwise stated in CC 482/WSR/006.

6.188 Placing of fresh concrete for structural concrete against previously placed concrete shall be as specified in CC 482/WSR/006.

Placing of fresh concrete for structural concrete against previously placed concrete

Structure ID	Structural element reference	Description of structural element(s)	Designed concrete mix reference	Maximum permitted time delay for placing fresh concrete against previously placed concrete
(a)	(b)	(c)	(d)	(e)

1. Enter a unique reference.

2. Enter a unique reference, to identify the structural element reference.

3. Enter text, to describe the structural element and/or its part subject to concreting.

4. Enter a unique reference, to identify the reference of the designed concrete mix to be used for concreting of the structural element and/or its part.

5. Enter a number in units of , to identify, for the concrete to be used for concreting of the structural element and/or its part, the maximum permitted delay in placing of a layer of fresh concrete against a previously placed layer of concrete without the need for the formation of a construction joint.

6.189 The temperature of fresh concrete for structural concrete shall not be less than 5°C, unless otherwise stated in CC 482/WSR/006.

6.190 Where structural concrete is made using CEM I or CEM II/A or equivalent combination, the fresh concrete temperature shall not be more than 30°C, unless otherwise stated in CC 482/WSR/006.

6.191 Where structural concrete is made using CEM II/B, CEM II/C, CEM III, CEM IV or CEM VI or equivalent combination, the fresh concrete temperature shall not be more than 35°C, unless otherwise stated in CC 482/WSR/006.

6.192 Verification shall be undertaken for the temperature of fresh concrete for structural concrete by measuring, in accordance with 5.3 of BS 8500-2 [Ref 24.N], the temperature of the fresh concrete and checking that it meets the requirements of the specification.

6.193 The frequency of the measurement of temperature of fresh concrete for structural concrete shall be once for each batch of each concrete mix, measured at the point of placing into the formwork, for concrete mixed on site and for precast concrete where ready-mixed concrete is not used, or at the point of discharge from the producer's delivery vehicle, for ready-mixed concrete and for precast concrete where ready-mixed concrete is used, but no more than one hour prior to placing.

6.194 The requirements for "Verification" in Section 14 of GC 101 [Ref 44.N] shall apply to the measurement of temperature of fresh concrete.

6.195 The following Documentation for measurement of the temperature of fresh concrete for structural concrete shall be submitted as continuous records: report containing fresh concrete temperature measurement records.

6.196 The requirements of "Records" in Section 3 of GC 101 [Ref 44.N] shall apply to the report containing fresh concrete temperature measurement records.

6.197 When concrete is placed at air temperatures below 2°C, it shall be ensured that the aggregates and water to be used in the concrete mix and any reinforcement, prestressing systems, formwork, void formers and other surfaces with which the fresh concrete is to be in contact with are all free from snow, ice and frost.

6.198 When concrete is placed at air temperatures below 2°C, the surface temperature of the concrete shall be maintained at a minimum of 5°C until the concrete reaches a minimum compressive strength of 5 MPa to avoid damage from early-age freezing, unless otherwise stated in CC 482/WSR/006.

SI.6.198 The minimum compressive strength of concrete to be reached before the surface temperature of the concrete is allowed to drop below 5°C shall be [enter a number] .

6.199 Measures to maintain the surface temperature of concrete at a minimum of 5°C in cold weather shall include one or more of the following:.

1. Heating the aggregates

2. Heating the the mixing water to a temperature not greater than 60°C, to prevent flash setting of the cement, and mixing the water with the aggregates before adding the cement, to prevent cement balling

3. Increasing the cement content of the mix, to within the limits permitted by "Concreting of structural concrete" in Section 6 of this document and CC 482/WSR/006

4. Using a more rapid hardening cement, to within the limits permitted by "Concreting of structural concrete" in Section 6 of this document and CC 482/WSR/006

5. Covering the top face of slabs and beams with insulating material

6. Providing wind breaks to protect newly placed concrete from cold winds

7. Using heated formwork panels whilst ensuring water evaporation from concrete is minimised

8. Using a heated enclosure surrounding the freshly placed concrete, whilst ensuring water evaporation is controlled, to prevent the concrete properties from being adversely affected.

9. Using admixtures that reduce the setting time and/or increase the rate of strength gain, to within the limits permitted by "Concreting of structural concrete" in Section 6 of this document and CC 482/WSR/006

6.200 Verification shall be undertaken for the surface temperature and the compressive strength of concrete placed at air temperatures below 2°C to avoid damage from early-age freezing by measuring, in accordance with 5.3 of BS 8500-2 [Ref 24.N], the surface temperature of the placed concrete in the structural element and/or its part the concrete mix relates to and by determining, in accordance with BS EN 12390-3 [Ref 116.N]with test specimens made and cured in accordance with BS EN 12390-2 [Ref 118.N] and stored under environmental conditions representative of those of the concrete in the permanent works, the compressive strength of samples taken in accordance with Annex B.3 of BS 8500-1 [Ref 23.N]and Annex B.2(4) of BS EN 206 [Ref 21.N]and tested at different ages and checking that the surface temperature of the concrete is maintained at a minimum of 5°C until the compressive strength of the samples meets the identity criteria in Annex B.7 of BS 8500-1 [Ref 23.N]in relation to the minimum compressive strength specified in CC 482/WSR/006.

6.201 The frequency of measurement of the surface temperature and determination of the compressive strength of concrete placed at air temperatures below 2°C shall be every 24 hours after concrete placing and until the compressive strength reaches the specified minimum value, using four specimens made from one sample for each age of testing taken randomly, for each concrete mix, from an amount of concrete representing no more than the lesser of 4 batches or 24m^3, but with no less than one sample per day of concreting unless otherwise stated in CC 482/WSR/006.

SI.6.201 The frequency of measurement of the surface temperature and determination of the compressive strength of concrete placed at air temperatures below 2°C shall be [enter free text].

6.202 The requirements for "Verification" in Section 14 of GC 101 [Ref 44.N] shall apply to measurement of the surface temperature and the determination of the compressive strength of concrete placed at air temperatures below 2°C.

6.203 The following Documentation for measurement of surface temperature and determination of the compressive strength of concrete placed at air temperatures below 2°C shall be submitted as continuous records: report containing surface temperature measurement and compressive strength testing records.

6.204 The requirements of "Records" in Section 3 of GC 101 [Ref 44.N] shall apply to the report containing surface temperature measurement and compressive strength testing records.

6.205 When concrete is placed at air temperatures higher than 30°C, mitigation measures shall be employed that reduce the risk of stiffening of the fresh concrete between its discharge from the mixer and compaction in its final position and prevent cracking and a loss of workability.

6.206 Measures to mitigate the adverse effects of placing fresh concrete in hot weather shall include one or more of the following:.

1. Keeping the aggregates cool by protecting them against direct sunlight

2. Keeping the aggregates cool by spraying them with water whilst ensuring the moisture content of the mix remains within the limits permitted by "Concreting of structural concrete" in Section 6 of this document and CC 482/WSR/006

3. Keeping the mixing water pipes shaded and insulated

4. Using cement with a slower release of heat of hydration, to within the limits permitted by "Concreting of structural concrete" in Section 6 of this document and CC 482/WSR/006

5. Using admixtures that retard the hydration and/or increase the initial workability, to within the limits permitted by "Concreting of structural concrete" in Section 6 of this document and CC 482/WSR/006

6.207 For concrete made using CEM I or CEM II/A or equivalent combination, where the sectional thickness of the placed concrete is greater than 600 mm or the cement content of the concrete mix exceeds 400 kg/m^3 the peak temperature of the concrete core after placing shall not exceed 65°C.

6.208 For concrete made using CEM II/B, CEM II/C, CEM III, CEM IV or CEM VI or equivalent combination, where the sectional thickness of the placed concrete is greater than 600 mm or the cement content of the concrete mix exceeds 400 kg/m^3 the peak temperature of the concrete core after placing shall not exceed 70°C.

6.209 Measures to mitigate the adverse effects of temperature gain within the concrete shall include one or more of the following:.

1. Using aggregates with low coefficient of thermal expansion

2. Using cement with a slower release of heat of hydration, to within the limits permitted by "Concreting of structural concrete" in Section 6 of this document and CC 482/WSR/006

3. Using admixtures that retard the hydration, to within the limits permitted by "Concreting of structural concrete" in Section 6 of this document and CC 482/WSR/006

6.210 Verification shall be undertaken for the temperature of the concrete core after placing where the sectional thickness of the placed concrete is greater than 600 mm or the cement content of the concrete mix exceeds 400 kg/m^3 by measuring, in accordance with 5.3 of BS 8500-2 [Ref 24.N], the temperature of the concrete core and checking that it meets the requirements of the specification.

6.211 The frequency of the measurement of temperature of the concrete core after placing shall be once every 24 hours for each concrete mix of every structural element where the sectional thickness of the placed concrete is greater than 600mm or the cement content of the concrete mix exceeds 400kg/m^3, until 72 hours after concrete placing or until the concrete core temperature has dropped to 5°C below its peak temperature, whichever occurs first.

6.212 The requirements for "Verification" in Section 14 of GC 101 [Ref 44.N] shall apply to the measurement of temperature of the concrete core after placing.

6.213 The following Documentation for measurement of the temperature of the concrete core after placing when the sectional thickness of the placed concrete is greater than 600 mm or the cement content of the mix exceeds 400 kg/m^3 shall be submitted as continuous records: report containing concrete core temperature measurement records.

6.214 The requirements of "Records" in Section 3 of GC 101 [Ref 44.N] shall apply to the report containing concrete core temperature measurement records.

6.215 Verification shall be undertaken for the adequacy of placing of fresh concrete by visual inspection, checking that no leakage and loss of grout/mortar from the formwork has occurred after placing.

6.216 The frequency of visual inspection to confirm that no leakage and loss of grout/mortar from the formwork has occurred shall be once, after placing of fresh concrete.

6.217 The requirements for "Verification" in Section 14 of GC 101 [Ref 44.N] shall apply to visual inspection of the adequacy of placing of fresh concrete.

6.218 The following Documentation for the adequacy of placing of fresh concrete shall be submitted as continuous records: report with findings and photographic evidence of visual inspection confirming that no leakage and loss of grout/mortar from the formwork has occurred after placing.

6.219 The requirements of "Records" in Section 3 of GC 101 [Ref 44.N] shall apply to the report with visual inspection of the adequacy of placing of fresh concrete.

Additional requirements for placing of self-compacting concrete for structural concrete

6.220 Where self-compacting concrete trial pours have been undertaken, the methods used for placing self-compacting concrete in the permanent works shall be consistent with that of the successful trial pours.

6.221 A concrete technologist provided by the concrete producer with experience in self-compacting concrete shall be available to provide technical advice on site during the placing of self-compacting concrete.

6.222 Self-compacting concrete shall be placed in one continuous pour with placing rates matched to delivery rates.

6.223 The rate of placing of self-compacting concrete shall not exceed the maximum rate specified by the self-compacting concrete producer.

6.224 The length of horizontal flow of the self-compacting concrete shall not exceed 10 m or the maximum length of horizontal flow specified by the self-compacting concrete producer, whichever is the lesser.

6.225 When self-compacting concrete is to be placed upwards, it shall be pumped using a valve opening in the formwork that is subsequently closed and locked once pumping is completed.

6.226 When self-compacting concrete is to be placed upwards, air release and tell-tale outlets shall be provided in accordance with the self-compacting concrete producer's recommendations.

6.227 Self-compacting concrete shall not be placed in water.

6.228 Placing of self-compacting concrete shall commence no later than 2 hours after the introduction of the cement to the aggregates at initial mixing, unless otherwise stated in CC 482/WSR/006.

6.229 Where required in CC 482/WSR/006, transparent acrylic windows shall be incorporated into formwork to allow visual monitoring of the adequacy of the flow of self-compacting concrete through and around reinforcement and other items within the concrete pour during placing.

6.230 Specific requirements for placing of self-compacting concrete for structural concrete shall be as specified in CC 482/WSR/006.

Specific requirements for placing of self-compacting concrete for structural concrete

Structure ID	**Structural element reference**	**Description of structural element**	**Designed concrete mix reference**	**Drawing/ model reference(s)**	**Maximum permitted time from initial mixing to placing**	**Transparent acrylic windows to be incorporated into formwork required**	**Location and size of any transparent acrylic window to be incorporated into formwork (where applicable)**
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)

1. Enter a unique reference.

2. Enter a unique reference, to identify the structural element reference.

3. Enter text, to describe the structural element and/or its part subject to concreting with self-compacting concrete.

4. Enter a unique reference, to identify the reference of the designed concrete mix to be used for concreting of the structural element and/or its part.

5. Enter a unique reference, to provide reference of drawing(s) or model(s) where the structural element and/or its part subject to concreting with self-compacting concrete, including the location and size of any transparent acrylic window to be incorporated into formwork, is shown.

6. Enter a number in units of , to identify, for the self-compacting concrete to be used for concreting of the structural element and/or its part, the maximum time that is permitted from the introduction of the cement to the aggregates at initial mixing to the commencement of placing into the formwork.

7. Enter a value, from options yes, no, to identify whether transparent acrylic windows are required to be incorporated into the formwork to allow visual monitoring of the adequacy of the flow of self-compacting concrete for the structural element and/or its part subject to concreting with self-compacting concrete.

8. Enter text, to define the location within the formwork and the dimensions of any transparent acrylic window to be incorporated into the formwork for the structural element and/or its part subject to concreting with self-compacting concrete.

6.231 Any modification to the self-compacting concrete mix at placing shall only be made:.

1. Through addition of admixtures, with no addition of water; and

2. Under the supervision of a producer's concrete technologist; and

3. When the concrete remains in compliance with "Concreting of structural concrete" in Section 6 of this document and CC 482/WSR/006

6.232 The following Documentation for the addition of admixtures to the self-compacting concrete mix at placing shall be submitted as continuous records: record of type and quantity of admixture added to the concrete mix at placing.

6.233 The requirements of "Records" in Section 3 of GC 101 [Ref 44.N] shall apply to record of type and quantity of admixture added to the concrete mix at placing.

6.234 Self-compacting concrete shall not be vibrated nor disturbed for a minimum of 24 hours after placing.

Compaction of fresh concrete for structural concrete (excluding self-compacting concrete)

6.235 Fresh concrete for structural concrete that is not self-compacting shall be compacted by vibration, pressure, shock or other means during and after placing and worked around reinforcement, prestressing systems, void formers, embedded fixtures and into corners of formwork and at construction joints to form a solid mass free from voids.

6.236 When vibrators are used to compact fresh concrete, vibration shall be applied continuously during the placing of each concrete batch and after all concrete has been placed until the air in the fresh concrete has been expelled.

6.237 During vibration of fresh concrete it shall be ensured that vibrators do not come in contact with the reinforcement or other inserts within the concrete pour.

6.238 Where vibration is applied externally to the formwork, the disposition and operation of vibrators shall ensure efficient compaction and avoidance of the formation of concrete surface blemishes.

6.239 There shall not be segregation in the concrete nor excess water on the top concrete surface on completion of compaction.

6.240 On completion of compaction, any spillage of concrete onto other parts of the permanent works, such as onto structural steelwork, shall be immediately removed and cleaned up.

6.241 Fresh concrete shall not be disturbed for 24 hours after compaction, unless otherwise stated in CC 482/WSR/006.

SI.6.241 The time limit of undertaking recompaction of upper layers of deep lifts in concrete installations to prevent settlement cracking following initial compaction shall be within the range [enter a number] to [enter a number] .

Curing and protection of concrete for structural concrete

6.242 Curing and protection of concrete for structural concrete shall commence with no delay at completion of compaction, to prevent the adverse effects of inadequate curing.

6.243 Curing and protection of concrete for structural concrete shall provide an environment for the concrete to mature that results in the concrete surface remaining permanently wet or with minimal evaporation, to ensure the hardened concrete achieves the specified strength and durability and that plastic shrinkage, distortion and effloresence do not adversely affect the durability, aesthetics or any other property of the concrete.

6.244 Curing of concrete for structural concrete shall be applied for the minimum duration to meet curing class 3 in accordance with 8.5 of BS EN 13670 [Ref 38.N], unless otherwise stated in CC 482/WSR/006.

6.245 The development of the concrete properties in the surface zone related to the specified curing class shall be derived, in accordance with Annex F of BS EN 13670 [Ref 38.N], from the known concrete strength development of the concrete mix obtained from the producer or based on estimates of the relationship between compressive strength and maturity for the concrete mix.

6.246 Concrete shall be protected from drying out and against harmful effects of weather, including heavy rain, rapid temperature changes and frost, for the whole duration of curing.

6.247 Curing of concrete for structural concrete shall be as specified in CC 482/WSR/006.

Curing of concrete for structural concrete

Structure ID	**Structural element reference**	**Description of structural element**	**Designed concrete mix reference**	**Curing class**	**Accelerated curing via elevated-temperature curing required**	**Additional special curing requirements**
(a)	(b)	(c)	(d)	(e)	(f)	(g)

1. Enter a unique reference.

2. Enter a unique reference, to identify the structural element reference.

3. Enter text, to describe the structural element and/or its part subject to concreting.

4. Enter a unique reference, to identify the reference of the designed concrete mix to be used for concreting of the structural element and/or its part.

5. Enter a value, from options 1, 2, 3, 4, to identify the curing class, in accordance with Table 4 of BS EN 13670 [Ref 38.N], to

be assumed for the concrete to be used for concreting of the structural element and/or its part.

6. Enter a value, from options yes, no, to identify whether accelerated curing via elevated-temperature curing is required for the concrete to be used for concreting of the structural element and/or its part.

7. Enter text, to identify any additional special curing requirements for the concrete to be used for concreting of the structural element and/or its part, such as to mitigate against plastic shrinkage cracking when high strength concrete and self-compacting concrete is used, or when concreting in hot weather, cold weather, windy or dry air conditions where no specific protective measures are applied.

6.248 Measures for curing and protection of concrete for structural concrete shall include one or more of the following:.

1. Allowing natural curing in conditions conducive to low water evaporation rates, such as damp and foggy weather and in light rain

2. Insulating the concrete so that the water evaporation rate is kept low and its temperature is controlled

3. Keeping the concrete surface visibly wet

4. Covering the concrete surface with a vapour barrier material, such as a polythene sheet, that is secured at the edges and joints to prevent draughts and is kept clear from the surface to prevent marking the concrete

5. Covering the concrete surface with an absorbent material, such as hessian, that is kept damp and clear from the concrete surface to prevent marking the concrete, whilst keeping the water evaporation rate and temperature of the concrete under control

6. Applying curing liquids, compounds or membranes

6.249 Any curing liquids, compounds or membranes shall be applied, in full accordance with the manufacturer's instructions, in a way that facilitates their optimum breakdown and subsequent removal, by one or more of the following :.

1. Prior wetting or dampening of the concrete surface;

2. Incorporating a dye to aid identification;

3. Closely following the manufacturer's specified sequence and rate of application

6.250 Any curing liquids, compounds or membranes shall be removed, once curing is completed, in a way that does not affect the concrete surface appearance nor the bond between the concrete surface and any waterproofing or surface protection system to be subsequently applied to it.

6.251 During the curing period, patterns of alternate wetting and drying of the concrete conducive to cracking and efflorescence such as letting cold water in contact with the hot concrete surface shall be avoided.

6.252 Accelerated curing other than elevated-temperature curing shall not be permitted.

6.253 Elevated-temperature curing, which includes steam curing, shall only be undertaken, for the concrete to be used for concreting of the structural element and/or its part, when specified in CC 482/WSR/006.

6.254 Elevated-temperature curing shall only be permitted for concrete made using cements CEM I, CEM I-SR 0 or CEM I-SR 3.

6.255 When elevated-temperature curing is used, it shall be ensured that:.

1. The formwork is heated to no more than 20°C; and

2. Once placing of the concrete is complete, a period of no less than 4 hours passes before the concrete is heated; and

3. Concrete is heated at a maximum rate of 10°C every 30 minutes; and

4. The concrete temperature does not exceed 70°C; and

5. The rate of subsequent cooling does not exceed the rate of heating; and

6. All test specimens from concrete samples taken for the purpose of compressive strength testing for removal of formwork, transfer of prestressing or identity testing are manufactured and cured under the same elevated-temperature curing pattern to which the concrete is subjected

6.256 The following Documentation for removal of curing and protection measures shall be submitted as continuous records: report with records of the areas of application and details of removal of curing and protection measures including curing liquids, compounds and membranes.

6.257 The requirements of "Records" in Section 3 of GC 101 [Ref 44.N] shall apply to the report with records of the areas of application and details of removal of curing and protective measures.

Surface finish for structural concrete

6.258 Formwork capable of producing formed surface finish for structural concrete shall comply with "Falsework and formwork for structural concrete" in Section 3 of this document.

6.259 Constituent materials of structural concrete in concrete mixes for structural concrete with formed surface finish shall be selected so to produce uniformity of colour in the resulting formed surface finish.

6.260 Formed surface finish for structural concrete shall be as specified in CC 482/WSR/006.

Formed surface finish for structural concrete

Structure ID	**Structural element reference**	**Description of structural element**	**Drawing/ model reference(s)**	**Designed concrete mix reference**	**Formed surface finish class**	**Special requirements for formed surface finish (where applicable)**
(a)	(b)	(c)	(d)	(e)	(f)	(g)

1. Enter a unique reference.

2. Enter a unique reference, to identify the reference of the structural element with formed surface finish.

3. Enter text, to describe the structural element and/or its part with formed surface finish.

4. Enter a unique reference, to provide reference of drawing(s) or model(s) for the structural element and/or its part with formed surface finish showing the specified formed surface finish class, any special finish requirement including when a class other than F1 to F5 is specified, the position (other than rebates) where internal ties are permitted for class F4 finish, and any requirement for special protection of the formed surface finish from damage.

5. Enter a unique reference, to identify the reference of the designed concrete mix to be used for concreting of the structural element and/or its part with formed surface finish.

6. Enter a value, from options F1, F2, F3, F4, F5, Other, to identify the required class of formed surface finish for the structural element and/or its part.

7. Enter text, to describe any special requirement for the formed surface finish for the structural element and/or its part including specific formed surface finish requirement when a class other than F1 to F5 is specified, such as finish that requires the coarse aggregate to be permanently exposed, the use of special forms or linings, the use of a different concrete mix near the surface, grinding, bush-hammering or other treatment..

Formed surface finish for structural concrete (continued)

Structure ID	**Positions, other than rebates, where internal ties are permitted for class F4 finish (where applicable)**	**Requirements for special protection of formed surface finish (where applicable)**
(a)	(h)	(i)

1. Enter text, to describe the positions, other than rebates, where internal ties are permitted for class F4 finish in the structural element and/or its part with formed surface finish.

2. Enter text, to describe, for the structural element and/or its part, any requirement for special protection of formed surface finish that is vulnerable to damage.

6.261 Formed surface finish classes for structural concrete shall be in accordance with table 6.261.

Table 6.261 Formed surface finish classes for structural concrete

Formed surface finish class	Description
F1	A dense finish with no grout or mortar loss, with the specified cover to embedded metal and achieving the specified dimensional tolerances.
F2	As the requirements of F1 but with formwork panels arranged in a uniform pattern. The finish is intended to be left as struck but imperfections such as fins and surface discolouration are made good. Irregularities in the finish are no greater than those obtained from the use of wrought thicknessed square edged boards.
F3	As the requirements of F1 but the resulting finish is smooth and of uniform texture and appearance. The formwork lining leaves no stain on the concrete and is joined and fixed to its backing so that it imparts no blemishes. The formwork lining is of the

	same type and obtained from a single source throughout any one structure. Any imperfections are made good. Internal ties and embedded metal parts are not permitted.
F4	The requirements for F4 are as for F3 except that internal ties and embedded metal parts are permitted. The ties are positioned only in rebates or in other positions in accordance with CC 482/WSR/006
F5	The resulting finish is smooth and of uniform texture. Any blemishes and imperfections, such as discolouration and fins, are made good. Provision for the embedment of metal parts in the permanent works on a regular spacing is allowed.
Other	Specific requirements in accordance with CC 482/WSR/006

6.262 Permanently exposed concrete surfaces to all classes of finish other than F1 shall be free from rust marks and other stains.

6.263 Unformed surface finish for structural concrete shall be as specified in CC 482/WSR/006.

Unformed surface finish for structural concrete

Structure ID	**Structural element reference**	**Description of structural element**	**Drawing/ model reference(s)**	**Designed concrete mix reference**	**Unformed surface finish class**	**Special requirements for unformed surface finish (where applicable)**
(a)	(b)	(c)	(d)	(e)	(f)	(g)

1. Enter a unique reference.

2. Enter a unique reference, to identify the reference of the structural element with unformed surface finish.

3. Enter text, to describe the structural element and/or its part with unformed surface finish.

4. Enter a unique reference, to provide reference of drawing(s) or model(s) for the structural element and/or its part with unformed surface finish showing the specified unformed finish class, any special finish requirement including when a class other than U1 to U5 is specified and any requirement for special protection of the unformed surface finish from damage.

5. Enter a unique reference, to identify the reference of the designed concrete mix to be used for concreting of the structural element and/or its part with unformed surface finish.

6. Enter a value, from options U1, U2, U3, U4, U5, Other, to identify the required class of unformed surface finish for the structural element and/or its part.

7. Enter text, to describe any special requirement for the unformed surface finish for the structural element and/or its part including specific unformed surface finish requirement when a class other than U1 to U5 is specified, such as finish that requires the coarse aggregate to be permanently exposed, the use of special forms or linings, the use of a different concrete mix near the surface, grinding, bush-hammering or other treatment.

Unformed surface finish for structural concrete (continued)

Structure ID	**Requirements for special protection of unformed surface finish (where applicable)**
(a)	(h)

1. Enter text, to describe, for the structural element and/or its part, any requirement for special protection of unformed surface finish that is vulnerable to damage.

6.264 Unformed surface finishes classes for structural concrete shall be in accordance with table 6.264.

Table 6.264 Unformed surface finish classes for structural concrete

Unformed surface finish class	Description
U1	Concrete is levelled and screeded to produce a uniform surface to the required profile.
U2	As the requirements of U1, but once the concrete has started to harden the finish is prepared, such as by hand or machine floating, to produce a uniform surface free from screed marks.
U3	As the requirements of U1, but once the moisture has disappeared and the concrete has hardened enough to prevent laitance from being worked to the surface the finish is prepared, such as by steel-trowelling under pressure, to produce a dense, smooth uniform surface free from trowel marks.
U4	As the requirements of U1, but once the concrete has hardened enough for bleed water to have evaporated the finish is prepared, such as by trowelling, to produce a hard dense surface free from screed marks and exposed aggregate. The surface is then lightly textured, such as with a wooden float. Alternatively, the concrete is levelled, screeded and floated

	to produce a uniform surface and the finish is prepared, such as by water jetting or grit blasting, to provide a lightly textured finish immediately before waterproofing. The finished surface does not deviate from the required profile by more than 10 mm over a 3 m gauge length or have any abrupt irregularities more than 3 mm.
U5	As the requirements of U1, but once the concrete has hardened enough to prevent laitance from being worked to the surface the finish is prepared, such as by hand or machine floating, to produce a surface free from screed marks and exposed aggregate. The surface is then textured to suit the requirements of any waterproofing and surfacing system to be applied. The finished surface does not deviate from the required profile by more than 5 mm over a 3 m gauge length or have any abrupt irregularities.
Other	Specific requirements in accordance with CC 482/WSR/006

6.265 Verification shall be undertaken for the surface finish for structural concrete by visual inspection of the surfaces of the structural concrete elements, and checking that they are free from visible defects, are of uniform colour and that, also by comparison with any pre-concreting trial panel, they comply with the surface finish requirements of the specification in accordance with CC 482/WSR/006.

6.266 The frequency of the visual inspection of surface finish for structural concrete shall be once on all structural concrete elements, no later than 7 days after removal of the formwork.

6.267 The requirements for "Verification" in Section 14 of GC 101 [Ref 44.N] shall apply to visual inspection of the surface finish for structural concrete.

6.268 The following Documentation for visual inspection of surface finish for structural concrete shall be submitted as continuous records: report with records of visual inspection of the surfaces of the structural concrete elements.

6.269 The requirements of "Records" in Section 3 of GC 101 [Ref 44.N] shall apply to the report with records of visual inspection of the surfaces of the structural concrete elements.

Formation of continuity joints in bridge decks of structural concrete

6.270 When concrete bridge decks are widened, built in stages or reconstructed in stages with continuity joints, either by construction of a new part of the deck attached directly to the existing trafficked deck or by construction of a separate parallel deck followed by a concrete in-fill strip

as a second stage, the deck in the finished state shall be monolithic without any permanent joints or gaps.

6.271 Continuity joints in bridge decks of structural concrete shall be as specified in CC 482/WSR/006.

Continuity joints in bridge decks of structural concrete

Structure ID	Structural element reference of the existing bridge deck	Description of structural element of the existing bridge deck	Type of bridge deck widening construction	Structural element reference of the new bridge deck	Description of structural element of the new bridge deck	Drawing/ model reference(s)
(a)	(b)	(c)	(d)	(e)	(f)	(g)

1. Enter a unique reference.

2. Enter a unique reference, to identify the reference of the structural element that is being widened, built in stages or reconstructed in stages with continuity joints.

3. Enter text, to describe the structural element and/or its part being widened, built in stages or reconstructed in stages with continuity joints.

4. Enter one or more values, from options construction of a new part of the deck which is attached directly to the existing trafficked deck, construction of a separate parallel deck followed by an in-fill strip as a second stage, to identify the type of bridge deck widening construction for the structural element and/or its part being widened, built in stages or reconstructed in stages.

5. Enter a unique reference, to identify the reference of the structural element that is being attached directly to the existing trafficked deck as a new part of the deck, or of the structural element comprising a separate parallel deck followed by an in-fill strip as a second stage.

6. Enter text, to describe the structural element and/or its part that is being attached directly to the existing trafficked deck as a new part of the deck, or comprising a separate parallel deck followed by an in-fill strip as a second stage.

7. Enter a unique reference, to provide reference of drawing(s) or model(s) where the structural element and/or its part being widened, built in stage or reconstructed in stages with

continuity joints and the new part of the deck attached directly to the existing trafficked deck, or the separate parallel deck and the subsequent in-fill strip, are shown, including location, extent and details of the removal of existing concrete and preparation of the concrete substrate for the construction of the continuity joints, any sequencing and constraint to the deck widening construction, and the location of any deflection and vibration measurement points along the interfaces between the new and existing parts of the deck.

Continuity joints in bridge decks of structural concrete (continued)

Structure ID	Design documentation reference	Designed concrete mix reference for the new deck attached directly to the existing trafficked deck (where applicable)	Designed concrete mix reference for the separate parallel deck built as a first phase when the in-fill strip method of construction is used (where applicable)	Designed concrete mix reference for the in-fill strip built as a second phase when the in-fill strip method of construction is used (where applicable)	Extent of concrete removal in the existing deck	Sequencing of concrete removal in the existing deck and construction of the new deck
(a)	(h)	(i)	(j)	(k)	(l)	(m)

1. Enter a unique reference, to provide reference of the design documentation for the structural element and/or its part being widened, built in stages or reconstructed in stages with continuity joints and the new part of the deck attached directly to the existing trafficked deck, or the separate parallel deck and the subsequent in-fill strip, which includes details of the removal of existing concrete and preparation of the concrete substrate for the construction of the continuity joints and details for deflection and vibration measurement along the interfaces between the new and existing parts of the deck.

2. Enter a unique reference, to identify the reference of the designed concrete mix to be used for concreting of the

structural element and/or its part that is being attached directly to the existing trafficked deck as a new part of the deck.

3. Enter a unique reference, to identify the reference of the designed concrete mix to be used for concreting of the structural element and/or its part that is a separate parallel deck built as a first phase when the in-fill strip method of construction is used.

4. Enter a unique reference, to identify the reference of the designed concrete mix to be used for concreting of the structural element and/or its part that is an in-fill strip built as a second phase when the in-fill method of construction is used.

5. Enter text, to identify the required extent, in terms of length, width and depth, of the removal of concrete in the existing deck for the structural element and/or its part to be subsequently prepared for the formation of the continuity joint, ensuring sufficient amount of deck concrete is removed to expose the length of existing reinforcement required to make a continuous connection, unless couplers or systems for post-installed reinforcing bar connections are used for that purpose.

6. Enter text, to describe any requirement and constraint for the phased removal of concrete in the existing deck and for the phased construction of the new deck to ensure the structural integrity of the bridge deck is maintained at all times, including specific requirements for falsework and formwork such as any need for in-fill strip temporary transverse supports spanning from the existing deck.

Continuity joints in bridge decks of structural concrete (continued)

Structure ID	**Constraints on deck widening construction**	**Locations of deflection and vibration measurement points along the interface**	**Minimum accuracy of deflection and vibration measurements**	**Calibration requirements for deflection and vibration measurement equipment**	**Requirements for competency of personnel undertaking deflection and vibration measurements**
(a)	(n)	(o)	(p)	(q)	(r)

1. Enter text, to describe any specific constraints on the construction of the deck widening, such as traffic speed, weight

restrictions, temporary vehicle restraint systems and specific requirements for temporary works or supports.

2. Enter text, to identify where, along the interface between the existing and new parts of the deck, any deflection and vibration measurement points are to be located for the structural element and/or its part being widened, built in stages or reconstructed in stages with continuity joints, also with reference to the drawing(s)/model(s) in CC 482/WSR/006.

3. Enter text, to describe the minimum accuracy required in the measurement of deflections and vibrations along the interface between the existing and new parts of the deck for the structural element and/or its part being widened, built in stages or reconstructed in stages with continuity joints.

4. Enter text, to describe any specific requirement for the calibration of equipment to be used for measuring deflections and vibrations along the interface between the existing and new parts of the deck for the structural element and/or its part being widened, built in stages or reconstructed in stages with continuity joints.

5. Enter text, to identify any requirement for the competency of personnel undertaking deflection and vibration measurements along the interface between the existing and new parts of the deck for the structural element and/or its part being widened, built in stages or reconstructed in stages with continuity joints.

6.272 The requirements for formwork at continuity joints in bridge decks shall comply with "Falsework and formwork for structural concrete" in Section 3 of this document.

6.273 The requirements for steel reinforcement at continuity joints in bridge decks shall comply with "Steel reinforcement for structural concrete" in Section 4 of this document.

6.274 The removal of concrete in the existing deck shall not damage the existing steel reinforcement.

6.275 The removal of concrete in the existing deck and any preparation of the concrete substrate for the formation of the continuity joint shall comply with "Concrete removal and substrate preparation" in Section 3 of CC 484 [Ref 22.N].

6.276 The surface of the exposed concrete substrate at the continuity joint shall be cleaned of all dust and grit using methods including vacuum cleaning, pressurised water jetting or shot blasting which themselves do not add contaminants to the exposed substrate.

6.277 The prepared concrete substrate shall be continuously wetted with potable water for a minimum period of four hours, as a dry substrate will draw water out of the fresh concrete, leaving cement particles closest to the interface incompletely hydrated and hence reduce the interface adhesion strength.

6.278 Any surface water remaining on the concrete breakout surface after completion of wetting shall be removed prior to placing of new concrete.

6.279 Prior to placing of new concrete, the exposed surface of the existing steel reinforcement shall be clean, with only light flash rusting, an oxidation of the reinforcing steel that occurs as wetted carbon steel dries, permitted.

6.280 Verification shall be undertaken for the cleanliness of the exposed surface of the existing steel reinforcement prior to placing of new concrete in the formation of continuity joints by visually inspecting the cleaned steel substrate without magnification and checking that only small quantities of light tan-brown rust discolour the metallic surface, with the discolouration evenly distributed or in patches but tightly adhering and not heavy enough to easily mark a dry cloth brushed against it..

6.281 The frequency of visual inspection of the cleanliness of the exposed surface of the existing steel reinforcement shall be once, prior to the placing of new concrete in the formation of continuity joints.

6.282 The requirements for "Verification" in Section 14 of GC 101 [Ref 44.N] shall apply to the visual inspection of the cleanliness of the exposed surface of the existing steel reinforcement.

6.283 Placing of new concrete shall commence before the existing concrete substrate dries out, no more than one hour after completion of wetting.

6.284 The concrete used for concreting all new parts of the deck in the formation of continuity joints shall have a target value of the slump of 100 mm, as higher slump concrete mixes are sensitive to bleeding and segregation from low-amplitude, low-frequency vibrations during the period of setting and early strength development resulting in lower bond and compressive strengths, unless otherwise stated in CC 482/WSR/006.

SI.6.284 The target value of the slump of the concrete used for concreting all new parts of the deck in the formation of the continuity joint shall be [enter a number] .

6.285 Where the in-fill strip method of construction is used in the formation of continuity joints, the second stage in-fill strip shall not be constructed until the concrete in the first stage separate parallel deck has reached the compressive strength associated to its designed concrete mix

specified in CC 482/WSR/006, or 14 days after placing of the concrete in the first stage separate parallel deck, whichever is later.

6.286 Verification shall be undertaken for the compressive strength of the concrete in the separate parallel deck in the in-fill strip method of construction by determining, in accordance with BS EN 12390-3 [Ref 116.N]with test specimens made and cured in accordance with BS EN 12390-2 [Ref 118.N]and stored under environmental conditions representative of those of the concrete in the separate parallel deck, the compressive strength of samples taken in accordance with Annex B.3 of BS 8500-1 [Ref 23.N] and Annex B.2(4) of BS EN 206 [Ref 21.N]and tested at different ages and checking that the in-fill strip is not constructed until either the compressive strength of the samples meets the identity criteria in Annex B.7 of BS 8500-1 [Ref 23.N]in relation to the compressive strength class of the concrete in the separate parallel deck specified in CC 482/WSR/006, or until 14 days after placing of the concrete in the separate parallel deck, whichever is later.

6.287 The frequency of determination of the compressive strength of the concrete in the separate parallel deck shall be at 14 days after concrete placing and thereafter every 24 hours until the compressive strength reaches the value corresponding to the compressive strength class specified, using two test specimens made from one sample for each age of testing taken randomly from an amount of concrete representing no more than the lesser of 4 batches or 24m^3, but with no less than one sample per day of concreting unless otherwise stated in CC 482/WSR/006.

SI.6.287 The frequency of determination of the compressive strength of the concrete in the separate parallel deck shall be [enter free text].

6.288 The requirements for "Verification" in Section 14 of GC 101 [Ref 44.N] shall apply to determination of the compressive strength of the concrete in the separate parallel deck in the in-fill strip method of construction.

6.289 The following Documentation for compressive strength testing of the concrete in the separate parallel deck in the in-fill strip method of construction shall be submitted as continuous records: report with concrete compressive strength test results and timeline of construction of the separate paralllel deck and the in-fill strip.

6.290 The requirements of "Records" in Section 3 of GC 101 [Ref 44.N] shall apply to the report with concrete compressive strength test results and timeline of construction of the separate parallel deck and the in-fill strip.

6.291 When decks are widened either by attaching a new part of the deck directly to the existing trafficked deck, or by using the in-fill strip method when traffic is running less than 1 m from the interface between the

existing trafficked deck and the concrete in-fill strip, the differential deflection at the interface between the existing trafficked deck and the new part of the deck, or at the interface between the existing trafficked deck and the in-fill strip, shall be measured until the concrete in the new part of the deck or in the in-fill strip has reached the compressive strength associated to its designed concrete mix specified in CC 482/WSR/006, or 7 days after placing of the concrete in the new part of the deck or in the in-fill strip, whichever is later.

6.292 Verification shall be undertaken for the compressive strength of the concrete in the new part of the deck or in the in-fill strip, when decks are widened either by attaching a new part of the deck directly to the existing trafficked deck or by using the in-fill strip method when traffic is running less than 1 m from the interface between the existing trafficked deck and the in-fill strip, by determining, in accordance with BS EN 12390-3 [Ref 116.N]with test specimens made and cured in accordance with BS EN 12390-2 [Ref 118.N]and stored under environmental conditions representative of those of the concrete in the new part of the deck or in the in-fill strip, the compressive strength of samples taken in accordance with Annex B.3 of BS 8500-1 [Ref 23.N]and Annex B.2(4) of BS EN 206 [Ref 21.N]and tested at different ages and checking that the differential deflection at the interface between the existing trafficked deck and the new part of the deck, or at the interface between the existing trafficked deck and the in-fill strip, is measured until either the compressive strength of the samples meets the identity criteria in Annex B.7 of BS 8500-1 [Ref 23.N]in relation to the compressive strength of the concrete in the new part of the deck or in the in-fill strip specified in CC 482/WSR/006, or until 7 days after placing of the concrete in the new part of the deck or in the in-fill strip, whichever is later.

6.293 The frequency of determination of the compressive strength of the concrete in the new part of the deck or in the in-fill strip shall be at 3 and 7 days after concrete placing and thereafter every 24 hours until the compressive strength reaches the value corresponding to the compressive strength class specified, using two test specimens made from one sample for each age of testing taken randomly from an amount of concrete representing no more than the lesser of 4 batches or 24m^3, but with no less than one sample per day of concreting unless otherwise stated in CC 482/WSR/006.

SI.6.293 The frequency of determination of the compressive strength of the concrete in the new part of the deck or in the in-fill strip shall be [enter free text].

6.294 The requirements for "Verification" in Section 14 of GC 101 [Ref 44.N] shall apply to determination of the compressive strength of the concrete in the new part of the deck or in the in-fill strip.

6.295 When decks are widened by attaching a new part of the deck directly to the existing trafficked deck, the differential deflection at the interface between the existing trafficked deck and the new part of the deck shall be limited, to mitigate the risk of defects at the interface, to:.

1. 6 mm due to weight of fresh concrete after the concrete of the new part of the deck is poured

2. 1 mm due to traffic actions

6.296 When decks are widened by using the in-fill strip method and traffic is running less than 1 m from the interface between the existing trafficked deck and the in-fill strip, the differential deflection at the interface between the existing trafficked deck and the in-fill strip due to traffic actions shall be limited to 1 mm, to mitigate the risk of defects at the interface.

6.297 Verification shall be undertaken for the differential deflection at the interface between the existing trafficked deck and the new part of the deck or at the interface between the existing trafficked deck and the in-fill strip, when decks are widened by attaching a new part of the deck to the existing trafficked deck or by using the in-fill strip method when traffic is running less than 1 m from the interface between the existing trafficked deck and the in-fill strip, respectively, by measuring, in accordance with CC 482/WSR/006, the differential deflection at the interface between the existing trafficked deck and the new part of the deck, or at the interface between the existing trafficked deck and the in-fill strip, and checking that the differential deflection does not exceed the requirements of the specification.

6.298 The frequency of measurement of the differential deflection at the interface between the existing trafficked deck and the new part of the deck or at the interface between the existing deck and the in-fill strip shall be continuous, commencing immediately after concrete placing and until the compressive strength of the concrete of the new part of the deck or the in-fill strip reaches the value corresponding to the compressive strength class specified or until 7 days after placing of the concrete, whichever is later, unless otherwise stated in CC 482/WSR/006.

SI.6.298 The frequency of measurement of the differential deflection at the interface between the existing trafficked deck and the new part of the deck or at the interface between the existing deck and the in-fill strip shall be [enter free text].

6.299 The requirements for "Verification" in Section 14 of GC 101 [Ref 44.N] shall apply to measurement of the differential deflection at the interface between the existing trafficked deck and the new part of the deck or at the interface between the existing deck and the in-fill strip.

6.300 The following Documentation for differential deflection measurements of decks widened by attaching a new part of the deck directly to the existing trafficked deck, or by using the in-fill strip method when traffic is running less than 1 m from the interface between the existing trafficked deck and the in-fill strip, shall be submitted as continuous records: report with concrete compressive strength test results and record of differential deflection measurements.

6.301 The requirements of "Records" in Section 3 of GC 101 [Ref 44.N] shall apply to report with concrete compressive strength test results and record of differential deflection measurements.

6.302 When decks are widened either by attaching a new part of the deck directly to the existing trafficked deck or by using the in-fill strip method, the vibration at the interface between the existing trafficked deck and the new part of the deck, or at the interface between the existing trafficked deck and the in-fill strip, shall be measured until the concrete in the new part of the deck or in the in-fill strip has reached the compressive strength associated to its designed concrete mix specified in CC 482/WSR/006, or 7 days after placing of the concrete in the new part of the deck or in the in-fill strip, whichever is later.

6.303 Verification shall be undertaken for the compressive strength of the concrete in the new part of the deck or in the in-fill strip by determining, in accordance with BS EN 12390-3 [Ref 116.N]with test specimens made and cured in accordance with BS EN 12390-2 [Ref 118.N]and stored under environmental conditions representative of those of the concrete in the new part of the deck or in the in-fill strip, the compressive strength of samples taken in accordance with Annex B.3 of BS 8500-1 [Ref 23.N]and Annex B.2(4) of BS EN 206 [Ref 21.N]and tested at different ages and checking that the vibration at the interface between the existing trafficked deck and the new part of the deck, or at the interface between the existing trafficked deck and the in-fill strip, is measured until either the compressive strength of the samples meets the identity criteria in Annex B.7 of BS 8500-1 [Ref 23.N]in relation to the compressive strength of the concrete in the new part of the deck or in the in-fill strip specified in CC 482/WSR/006, or until 7 days after placing of the concrete in the new part of the deck or in the in-fill strip, whichever is later.

6.304 The frequency of determination of the compressive strength of the concrete in the new part of the deck or in the in-fill strip shall be at 3 and 7 days after concrete placing and thereafter every 24 hours until the compressive strength reaches the value corresponding to the compressive strength class specified, using two test specimens made from one sample for each age of testing taken randomly from an amount of concrete representing no more than the lesser of 4 batches or 24m^3, but with no less than one sample per day of concreting unless otherwise stated in CC 482/WSR/006.

SI.6.304 The frequency of determination of the compressive strength of the concrete in the new part of the deck or in the in-fill strip shall be [enter free text].

6.305 The requirements for "Verification" in Section 14 of GC 101 [Ref 44.N] shall apply to determination of the compressive strength of the concrete in the new part of the deck or in the in-fill strip.

6.306 When decks are widened either by attaching a new part of the deck directly to the existing trafficked deck or by using the in-fill strip method, the traffic induced vibration at the interface between the existing trafficked deck and the new part of the deck, or at the interface between the existing trafficked deck and the in-fill strip, shall be limited, to mitigate the risk of reduced anchorage bond due to the reinforcement moving relative to the immature concrete causing cracks in the concrete which can be filled with weak diluted grout, to a peak particle velocity of 5 mm/s.

6.307 Verification shall be undertaken for the traffic induced vibration at the interface between the existing trafficked deck and the new part of the deck or at the interface between the existing trafficked deck and the in-fill strip by measuring, in accordance with CC 482/WSR/006, the peak particle velocity at the interface between the existing trafficked deck and the new part of the deck, or at the interface between the existing trafficked deck and the in-fill strip, and checking that the peak particle velocity does not exceed 5 mm/s.

6.308 The frequency of measurement of the vibration at the interface between the existing trafficked deck and the new part of the deck or at the interface between the existing trafficked deck and the in-fill strip shall be continuous, commencing 5 days prior to the placing of the concrete in the new part of the deck or in the in-fill strip and continued until the compressive strength of the concrete of the new part of the deck or the in-fill strip reaches the value corresponding to the compressive strength class specified or until 7 days after placing of the concrete, whichever is later, unless otherwise stated in CC 482/WSR/006.

SI.6.308 The frequency of measurement of the vibration at the interface between the existing trafficked deck and the new part of the deck or at the interface between the existing trafficked deck and the in-fill strip shall be [enter free text].

6.309 The requirements for "Verification" in Section 14 of GC 101 [Ref 44.N] shall apply to measurement of the vibration at the interface between the existing trafficked deck and the new part of the deck or at the interface between the existing trafficked deck and the in-fill strip.

6.310 The following Documentation for vibration measurements of decks widened by attaching a new part of the deck directly to the existing

trafficked deck, or by using the in-fill strip method, shall be submitted as continuous records: report with concrete compressive strength test results and record of vibration measurements.

6.311 The requirements of "Records" in Section 3 of GC 101 [Ref 44.N] shall apply to report with concrete compressive strength test results and record of vibration measurements.

6.312 When the measured vibrations exceed the limits specified and no specific analysis is available to evaluate their effects on the structural element(s) and/or its/their part(s), measures shall be implemented to reduce the vibrations below the specified limits before proceeding with the works.

6.313 Measures to reduce the vibrations at the interface between the existing trafficked deck and the new part of the deck or at the interface between the existing trafficked deck and the in-fill strip shall include one or more of the following:.

1. Limiting traffic speed on the existing trafficked deck, within the constraints on the deck widening construction specified in CC 482/WSR/006

2. Introducing limitations to the location of running traffic on the existing trafficked deck, within the constraints on the deck widening construction specified in CC 482/WSR/006

3. Providing a smooth riding surface on the existing trafficked deck

4. Providing a smooth transition at expansion joints

5. Use of temporary propping to the existing trafficked deck, within the constraints on the deck widening construction specified in CC 482/WSR/006

Identity testing requirements for structural concrete

General requirements for identity testing of structural concrete

6.314 Identity testing of structural concrete shall be in accordance with Annex B of BS EN 206 [Ref 21.N]and Annex B of BS 8500-1 [Ref 23.N] as amended and complemented by this document.

6.315 Samples/records for identity testing of structural concrete shall be taken/obtained at the point of placing into the formwork, for concrete mixed on site and for precast concrete where ready-mixed concrete is not used, or at the point of discharge from the producer's delivery vehicle, for ready-mixed concrete and for precast concrete where ready-mixed concrete is used, unless otherwise stated in CC 482/WSR/006.

6.316 Identity testing of structural concrete shall be as specified in CC 482/WSR/006.

Identity testing of structural concrete

Structure ID	**Structural element**	**Description of structural element**	**Drawing/ model reference(s)**	**Designed concrete mix reference**	**Point of sampling for identity testing of structural concrete (except for consistence retention)**	**Point and time of sampling for identity testing of structural concrete for consistence retention (where applicable)**
(a)	(b)	(c)	(d)	(e)	(f)	(g)

1. Enter a unique reference.

2. Enter a unique reference, to identify the structural element reference.

3. Enter text, to describe the structural element and/or its part subject to identity testing.

4. Enter a unique reference, to provide reference of drawing(s) or model(s) where the structural element and/or its part subject to identity testing is shown.

5. Enter a unique reference, to identify the reference of the designed concrete mix used for concreting of the structural element and/or its part subject to identity testing.

6. Enter text, to identify the required point where the samples for the concrete used for concreting of the structural element and/or its part subject to identity testing are to be taken, such as at the point of placing into the formwork; at the point of discharge from the producer's delivery vehicle; at the mixer; or other.

7. Enter text, to identify the required point and time where/when the samples for the concrete used for concreting of the structural element and/or its part subject to identity testing for consistence retention are to be taken, in accordance with the

consistence retention requirements specified in CC 482/WSR/006.

Identity testing of structural concrete (continued)

Structure ID	Required type(s) of identity testing for fresh concrete	Required type(s) of identity testing for hardened concrete
(a)	(h)	(i)

1. Enter one or more values, from options slump, degree of compactability, flow, slump-flow (of self-compacting concrete), viscosity t_{500} (of self-compacting concrete), viscosity t_v (of self-compacting concrete), passing ability L-box (of self-compacting concrete), passing ability J-ring (of self-compacting concrete), segregation resistance (of self-compacting concrete), air content, density of fresh concrete, homogeneity of fibre distribution, effective water/cement ratio, consistence retention, to identify the type(s) of identity testing for fresh concrete to be performed on the concrete used for concreting of the structural element and/or its part.

2. Enter one or more values, from options concrete compressive strength, density of hardened concrete, secant modulus of elasticity in compression of hardened concrete, to identify the type(s) of identity testing for hardened concrete to be performed on the concrete used for concreting of the structural element and/or its part.

Identity testing of structural concrete in the fresh state

6.317 Verification shall be undertaken for the consistence (slump) of fresh concrete where required in CC 482/WSR/006 by measuring, in accordance with Annex B.4.1 of BS 8500-1 [Ref 23.N], the slump of samples taken in accordance with Annex B.3 of BS 8500-1 [Ref 23.N]and checking that the measured slump for each concrete mix meets the identity criteria in Annex B.4.2 of BS 8500-1 [Ref 23.N] in relation to the class or target value of slump specified in CC 482/WSR/006 for the structural element and/or its part the concrete mix relates to.

6.318 The frequency of measurement of the consistence (slump) of fresh concrete shall be one sample for each batch of each concrete mix unless otherwise stated in CC 482/WSR/006.

SI.6.318 The frequency of measurement of the consistence (slump) of fresh concrete shall be [enter free text].

6.319 The requirements for "Verification" in Section 14 of GC 101 [Ref 44.N] shall apply to measurement of consistence (slump) of fresh concrete.

6.320 Verification shall be undertaken for the consistence (degree of compactability) of fresh concrete where required in CC 482/WSR/006 by measuring, in accordance with BS EN 12350-4 [Ref 108.N], the degree of compactability of samples taken in accordance with Annex B.3 of BS 8500-1 [Ref 23.N]and checking that the measured degree of compactability for each concrete mix meets the criteria in Tables 4, 21 and 23 of BS EN 206 [Ref 21.N]in relation to the class or target value of degree of compactability specified in CC 482/WSR/006 for the structural element and/or its part the concrete mix relates to.

6.321 The frequency of measurement of the consistence (degree of compactability) of fresh concrete shall be one sample for each batch of each concrete mix unless otherwise stated in CC 482/WSR/006.

SI.6.321 The frequency of measurement of the consistence (degree of compactability) of fresh concrete shall be [enter free text].

6.322 The requirements for "Verification" in Section 14 of GC 101 [Ref 44.N] shall apply to measurement of consistence (degree of compactability) of fresh concrete.

6.323 Verification shall be undertaken for the consistence (flow) of fresh concrete where required in WSR 482/006 by measuring, in accordance with Annex B.4.1 of BS 8500-1 [Ref 23.N], the flow diameter of samples taken in accordance with Annex B.3 of BS 8500-1 [Ref 23.N] and checking that the measured flow diameter for each concrete mix meets the identity criteria in Annex B.4.3 of BS 8500-1 [Ref 23.N] in relation to the class or target value of flow specified in WSR 482/006 for the structural element and/or its part the concrete mix relates to.

6.324 The frequency of measurement of the consistence (flow) of fresh concrete shall be one sample for each batch of each concrete mix unless otherwise stated in CC 482/WSR/006.

SI.6.324 The frequency of measurement of the consistence (flow) of fresh concrete shall be [enter free text].

6.325 The requirements for "Verification" in Section 14 of GC 101 [Ref 44.N] shall apply to measurement of consistence (flow) of fresh concrete.

6.326 Verification shall be undertaken for the consistence (slump-flow of self-compacting concrete) of fresh concrete where required in CC 482/WSR/006 by measuring, in accordance with Annex B.4.1 of BS 8500-1 [Ref 23.N], the slump-flow of self-compacting concrete of samples taken in accordance with Annex B.3 of BS 8500-1 [Ref 23.N]and checking that the measured slump-flow of self-compacting concrete for each concrete mix meets the identity criteria in Annex B.4.4 of BS 8500-1 [Ref 23.N]in relation to the class or target value of slump-flow of self-compacting

concrete specified in CC 482/WSR/006 for the structural element and/or its part the concrete mix relates to.

6.327 The frequency of measurement of the consistence (slump-flow of self-compacting concrete) of fresh concrete shall be one sample for each batch of each concrete mix unless otherwise stated in CC 482/WSR/006.

SI.6.327 The frequency of measurement of the consistence (slump-flow of self-compacting concrete) of fresh concrete shall be [enter free text].

6.328 The requirements for "Verification" in Section 14 of GC 101 [Ref 44.N] shall apply to measurement of consistence (slump-flow of self-compacting concrete) of fresh concrete.

6.329 Verification shall be undertaken for the viscosity (t_{500}) of self-compacting concrete in the fresh state where required in CC 482/WSR/006 by measuring, in accordance with BS EN 12350-8 [Ref 110.N], the viscosity (t_{500}) of self-compacting concrete of samples taken in accordance with Annex B.3 of BS 8500-1 [Ref 23.N] and checking that the measured viscosity (t_{500}) of self-compacting concrete for each concrete mix meets the criteria in Tables 7, 21 and 23 of BS EN 206 [Ref 21.N]in relation to the class or target value of viscosity (t_{500}) of self-compacting concrete specified in CC 482/WSR/006 for the structural element and/or its part the concrete mix relates to.

6.330 The frequency of measurement of the viscosity (t_{500}) of self-compacting concrete in the fresh state shall be one sample for each batch of each concrete mix unless otherwise stated in CC 482/WSR/006.

SI.6.330 The frequency of measurement of the viscosity (t_{500}) of self-compacting concrete in the fresh state shall be [enter free text].

6.331 The requirements for "Verification" in Section 14 of GC 101 [Ref 44.N] shall apply to measurement of the viscosity (t_{500}) of self-compacting concrete in the fresh state.

6.332 Verification shall be undertaken for the viscosity (t_v) of self-compacting concrete in the fresh state where required in CC 482/WSR/006 by measuring, in accordance with BS EN 12350-9 [Ref 114.N], the viscosity (t_v) of self-compacting concrete of samples taken in accordance with Annex B.3 of BS 8500-1 [Ref 23.N]and checking that the measured viscosity (t_v) of self-compacting concrete for each concrete mix meets the criteria in Tables 8, 21 and 23 of BS EN 206 [Ref 21.N]in relation to the class or target value of viscosity (t_v) of self-compacting concrete specified in CC 482/WSR/006 for the structural element and/or its part the concrete mix relates to.

6.333 The frequency of measurement of the viscosity (t_v) of self-compacting concrete in the fresh state shall be one sample for each batch of each concrete mix unless otherwise stated in CC 482/WSR/006.

SI.6.333 The frequency of measurement of the viscosity (t_v) of self-compacting concrete in the fresh state shall be [enter free text].

6.334 The requirements for "Verification" in Section 14 of GC 101 [Ref 44.N] shall apply to measurement of the viscosity (t_v) of self-compacting concrete in the fresh state.

6.335 Verification shall be undertaken for the passing ability (L-box) of self-compacting concrete in the fresh state where required in CC 482/WSR/006 by measuring, in accordance with BS EN 12350-10 [Ref 112.N], the passing ability (L-box) of self-compacting concrete of samples taken in accordance with Annex B.3 of BS 8500-1 [Ref 23.N]and checking that the measured passing ability (L-box) of self-compacting concrete for each concrete mix meets the criteria in Tables 9 and 21 of BS EN 206 [Ref 21.N] in relation to the class or minimum value of passing ability (L-box) of self-compacting concrete specified in CC 482/WSR/006 for the structural element and/or its part the concrete mix relates to.

6.336 The frequency of measurement of the passing ability (L-box) of self-compacting concrete in the fresh state shall be one sample for each batch of each concrete mix unless otherwise stated in CC 482/WSR/006.

SI.6.336 The frequency of measurement of the passing ability (L-box) of self-compacting concrete in the fresh state shall be [enter free text].

6.337 The requirements for "Verification" in Section 14 of GC 101 [Ref 44.N] shall apply to measurement of the passing ability (L-box) of self-compacting concrete in the fresh state.

6.338 Verification shall be undertaken for the passing ability (J-ring) of self-compacting concrete in the fresh state where required in CC 482/WSR/006 by measuring, in accordance with BS EN 12350-12 [Ref 111.N], the passing ability (J-ring) of self-compacting concrete of samples taken in accordance with Annex B.3 of BS 8500-1 [Ref 23.N] and checking that the measured passing ability (J-ring) of self-compacting concrete for each concrete mix meets the criteria in Tables 10 and 21 of BS EN 206 [Ref 21.N] in relation to the class or maximum value of passing ability (J-ring) of self-compacting concrete specified in CC 482/WSR/006 for the structural element and/or its part the concrete mix relates to.

6.339 The frequency of measurement of the passing ability (J-ring) of self-compacting concrete in the fresh state shall be one sample for each batch of each concrete mix unless otherwise stated in CC 482/WSR/006.

SI.6.339 The frequency of measurement of the passing ability (J-ring) of self-compacting concrete in the fresh state shall be [enter free text].

6.340 The requirements for "Verification" in Section 14 of GC 101 [Ref 44.N] shall apply to measurement of the passing ability (J-ring) of self-compacting concrete in the fresh state.

6.341 Verification shall be undertaken for the segregation resistance of self-compacting concrete in the fresh state where required in CC 482/WSR/006 by measuring, in accordance with BS EN 12350-11 [Ref 113.N], the segregation resistance of self-compacting concrete of samples taken in accordance with Annex B.3 of BS 8500-1 [Ref 23.N]and checking that the measured segregation resistance of self-compacting concrete for each concrete mix meets the criteria in Tables 11 and 21 of BS EN 206 [Ref 21.N]in relation to the class or maximum percentage of segregated portion for the sieve segregation resistance of self-compacting concrete specified in CC 482/WSR/006 for the structural element and/or its part the concrete mix relates to.

6.342 The frequency of measurement of the segregation resistance of self-compacting concrete in the fresh state shall be one sample for each batch of each concrete mix unless otherwise stated in CC 482/WSR/006.

SI.6.342 The frequency of measurement of the segregation resistance of self-compacting concrete in the fresh state shall be [enter free text].

6.343 The requirements for "Verification" in Section 14 of GC 101 [Ref 44.N] shall apply to measurement of the segregation resistance of self-compacting concrete in the fresh state.

6.344 Verification shall be undertaken for the air content of fresh concrete where required in CC 482/WSR/006 by measuring, in accordance with Annex B.5.1 of BS 8500-1 [Ref 23.N], the air content of samples taken in accordance with Annex B.3 of BS 8500-1 [Ref 23.N]and checking that the measured air content for each concrete mix meets the identity criteria in Annex B.5.2 of BS 8500-1 [Ref 23.N]in relation to the minimum air content specified in CC 482/WSR/006 for the structural element and/or its part the concrete mix relates to.

6.345 The frequency of measurement of the air content of fresh concrete shall be one sample for each batch of each concrete mix unless otherwise stated in CC 482/WSR/006.

SI.6.345 The frequency of measurement of the air content of fresh concrete shall be [enter free text].

6.346 The requirements for "Verification" in Section 14 of GC 101 [Ref 44.N] shall apply to measurement of the air content of fresh concrete.

6.347 Verification shall be undertaken for the density of fresh concrete where required in CC 482/WSR/006 by measuring, in accordance with Annex B.6.1 of BS 8500-1 [Ref 23.N], the density of samples taken in accordance with Annex B.3 of BS 8500-1 [Ref 23.N] and checking that the measured density for each concrete mix meets the identity criteria in Annex B.6.2 of BS 8500-1 [Ref 23.N]in relation to the class or target value of density specified in CC 482/WSR/006 for the structural element and/or its part the concrete mix relates to.

6.348 The frequency of measurement of the density of fresh concrete shall be one sample for each batch of each concrete mix unless otherwise stated in CC 482/WSR/006.

SI.6.348 The frequency of measurement of the density of fresh concrete shall be [enter a number].

6.349 The requirements for "Verification" in Section 14 of GC 101 [Ref 44.N] shall apply to measurement of the density of fresh concrete.

6.350 Verification shall be undertaken for the homogeneity of fibre distribution in fresh concrete where required in CC 482/WSR/006 by measuring, in accordance with Annex B.5 of BS EN 206 [Ref 21.N]for steel fibres and polymer macro-fibres, the homogeneity of fibre distribution of samples taken in accordance with Annex B.5 of BS 8500-1 [Ref 23.N]or recording, in accordance with clause 5.4.4 of BS EN 206 [Ref 21.N]and Annex A4.3.4 of BS 8500-2 [Ref 24.N]for polymer micro-fibres, the amount of fibres added to the mix and checking that the measured fibre content (for steel fibres and polymer macro-fibres) or the recorded fibres content (for polymer micro-fibres) for each concrete mix meets the identity criteria in Table B.2 of BS EN 206 [Ref 21.N]in relation to the dosage of fibres specified in CC 482/WSR/006 for the structural element and/or its part the concrete mix relates to.

6.351 The frequency of measurement/recording of the homogeneity of fibre distribution in fresh concrete shall be three samples for each load of each concrete mix unless otherwise stated in CC 482/WSR/006.

SI.6.351 The frequency of measurement/recording of the homogeneity of fibre distribution in fresh concrete shall be [enter free text].

6.352 The requirements for "Verification" in Section 14 of GC 101 [Ref 44.N] shall apply to measurement/recording of the homogeneity of fibre distribution in fresh concrete.

6.353 Verification shall be undertaken for the effective water/cement ratio in fresh concrete where required in CC 482/WSR/006 by determining, in accordance with clause 5.4.2 of BS EN 206 [Ref 21.N], the effective water/cement ratio and checking that the determined effective water/cement ratio for each concrete mix meets the criteria in Table 22 of

BS EN 206 [Ref 21.N] in relation to the maximum value of the effective water/cement ratio specified in CC 482/WSR/006 for the structural element and/or its part the concrete mix relates to.

6.354 The frequency of determination of the effective water/cement ratio of fresh concrete shall be once for each batch of each concrete mix unless otherwise stated in CC 482/WSR/006.

SI.6.354 The frequency of determination of the effective water/cement ratio of fresh concrete shall be [enter free text].

6.355 The requirements for "Verification" in Section 14 of GC 101 [Ref 44.N] shall apply to determination of the effective water/cement ratio of fresh concrete.

6.356 Verification shall be undertaken for the consistence retention of fresh concrete where required in CC 482/WSR/006 by measuring, in accordance with Annex B.8 of BS 8500-1 [Ref 23.N]and BS EN 12350-2 [Ref 115.N], BS EN 12350-4 [Ref 108.N], BS EN 12350-5 [Ref 109.N] or BS EN 12350-8 [Ref 110.N] for slump, degree of compactability, flow or slump-flow of self-compacting concrete respectively, the consistence of samples taken in accordance with Annex B.8.2 of BS 8500-1 [Ref 23.N]at the time and for the consistence type specified in CC 482/WSR/006 and checking that the measured consistence for each concrete mix meets the requirements for consistence retention specified in CC 482/WSR/006 for the structural element and/or its part the concrete mix relates to.

6.357 The frequency of measurement of the consistence retention of fresh concrete shall be three samples for each batch of each concrete mix unless otherwise stated in CC 482/WSR/006.

SI.6.357 The frequency of measurement of the consistence retention of fresh concrete shall be [enter free text].

6.358 The requirements for "Verification" in Section 14 of GC 101 [Ref 44.N] shall apply to measurement of the consistence retention of fresh concrete.

6.359 Verification for structural concrete in the fresh state by identity testing shall be undertaken by an accredited testing laboratory in compliance with "Accredited laboratory" in Section 16 of GC 101 [Ref 44.N].

6.360 The following Documentation for identity testing of structural concrete in the fresh state shall be submitted as continuous records: report(s) containing results of the identity testing of fresh concrete.

6.361 The requirements of "Records" in Section 3 of GC 101 [Ref 44.N] shall apply to report(s) containing results of the identity testing of fresh concrete.

Identity testing of structural concrete in the hardened state

6.362 Verification shall be undertaken for the compressive strength of concrete in the hardened state within a reinforced concrete structural element where required in CC 482/WSR/006 by determining, in accordance with BS EN 12390-3 [Ref 116.N]with test specimens made and cured in accordance with BS EN 12390-2 [Ref 118.N] and stored under environmental conditions representative of those of the concrete in the permanent works, the compressive strength of samples taken in accordance with Annex B.3 of BS 8500-1 [Ref 23.N]and Annex B.2(4) of BS EN 206 [Ref 21.N]and checking that the determined compressive strength for each concrete mix meets the identity criteria in Annex B.7 of BS 8500-1 [Ref 23.N]in relation to the concrete compressive strength class specified in CC 482/WSR/006 for the structural element and/or its part the concrete mix relates to.

6.363 The frequency of determination of the compressive strength of concrete in the hardened state within a reinforced concrete structural element shall be four test specimens made from one sample taken randomly, for each concrete mix, from an amount of concrete representing no more than the lesser of 4 batches or 24m^3,but with no less than one sample taken per day of concreting, and tested at 28 days, unless otherwise stated in CC 482/WSR/006.

SI.6.363 The frequency of determination of the compressive strength of concrete in the hardened state within a reinforced concrete structural element shall be [enter free text].

6.364 The requirements for "Verification" in Section 14 of GC 101 [Ref 44.N] shall apply to determination of the compressive strength of concrete in the hardened state within a reinforced concrete structural element.

6.365 Verification shall be undertaken for the compressive strength of concrete in the hardened state within a prestressed concrete structural element where required in CC 482/WSR/006 by determining, in accordance with BS EN 12390-3 [Ref 116.N]with test specimens made and cured in accordance with BS EN 12390-2 [Ref 118.N]and stored under environmental conditions representative of those of the concrete in the permanent works, the compressive strength of samples taken in accordance with Annex B.3 of BS 8500-1 [Ref 23.N]and Annex B.2(4) of BS EN 206 [Ref 21.N]and checking that the determined compressive strength for each concrete mix meets the identity criteria in Annex B.7 of BS 8500-1 [Ref 23.N]in relation to the concrete compressive strength class specified in CC 482/WSR/006 for the structural element and/or its part the concrete mix relates to.

6.366 The frequency of determination of the compressive strength of concrete in the hardened state within a prestressed concrete structural element shall be four test specimens made from one sample taken randomly, for each concrete mix, from an amount of concrete representing no more than the lesser of 2 batches or 12m^3 ,but with no less than one sample taken per day of concreting, and tested at 28 days unless otherwise stated in CC 482/WSR/006.

SI.6.366 The frequency of determination of the compressive strength of concrete in the hardened state within a prestressed concrete structural element shall be [enter free text].

6.367 The requirements for "Verification" in Section 14 of GC 101 [Ref 44.N] shall apply to determination of the compressive strength of concrete in the hardened state within a prestressed concrete structural element.

6.368 Verification shall be undertaken for the compressive strength of concrete in the hardened state within an unreinforced concrete structural element where required in CC 482/WSR/006 by determining, in accordance with BS EN 12390-3 [Ref 116.N]with test specimens made and cured in accordance with BS EN 12390-2 [Ref 118.N] and stored under environmental conditions representative of those of the concrete in the permanent works, the compressive strength of samples taken in accordance with Annex B.3 of BS 8500-1 [Ref 23.N]and Annex B.2(4) of BS EN 206 [Ref 21.N]and checking that the determined compressive strength for each concrete mix meets the identity criteria specified in Annex B.7 of BS 8500-1 [Ref 23.N]in relation to the concrete compressive strength class specified in CC 482/WSR/006 for the structural element and/or its part the concrete mix relates to.

6.369 The frequency of determination of the compressive strength of concrete in the hardened state within an unreinforced concrete structural element shall be four test specimens made from one sample taken randomly, for each concrete mix, from an amount of concrete representing no more than the lesser of 25 batches or 150m^3 ,but with no less than one sample taken per day of concreting, and tested at 28 days unless otherwise stated in CC 482/WSR/006.

SI.6.369 The frequency of determination of the compressive strength of concrete in the hardened state within an unreinforced concrete structural element shall be [enter free text].

6.370 The requirements for "Verification" in Section 14 of GC 101 [Ref 44.N] shall apply to determination of the compressive strength of concrete in the hardened state within an unreinforced concrete structural element.

6.371 Verification shall be undertaken for the density of hardened concrete where required in CC 482/WSR/006 by determining, in accordance with Annex B.6.1 of BS 8500-1 [Ref 23.N]with test specimens

made and cured in accordance with BS EN 12390-2 [Ref 118.N]and stored under environmental conditions representative of those of the concrete in the permanent works, the density of samples taken in accordance with Annex B.3 of BS 8500-1 [Ref 23.N]and checking that the determined density for each concrete mix meets the identity criteria in Annex B.6.2 of BS 8500-1 [Ref 23.N] in relation to the class or target value of density specified in CC 482/WSR/006 for the structural element and/or its part the concrete mix relates to.

6.372 The frequency of determination of the density of hardened concreted shall be four test specimens made from one sample taken randomly, for each concrete mix, from an amount of concrete representing no more than the lesser of 4 batches or 24m^3 ,but with no less than one sample taken per day of concreting, and tested at 28 days unless otherwise stated in CC 482/WSR/006.

SI.6.372 The frequency of determination of the density of hardened concrete shall be [enter free text].

6.373 The requirements for "Verification" in Section 14 of GC 101 [Ref 44.N] shall apply to determination of the density of hardened concrete.

6.374 Verification shall be undertaken for the secant modulus of elasticity in compression of hardened concrete where required in CC 482/WSR/006 by determining, in accordance with BS EN 12390-13 [Ref 117.N] using moulded test specimens stored under environmental conditions representative of those of the concrete in the permanent works, the secant modulus of elasticity in compression of samples taken in accordance with Annex B.3 of BS 8500-1 [Ref 23.N] and checking that the value of the secant modulus of elasticity for each concrete mix is within the range permitted in CC 482/WSR/006.

6.375 The frequency of determination of the secant modulus of elasticity in compression of hardened concrete shall be four test specimens made from one sample taken randomly, for each concrete mix, from an amount of concrete representing no more than the lesser of 2 batches of cube samples from the lesser volume of 12m^3 ,but with no less than one sample taken per day of concreting, and tested at 28 days unless otherwise stated in CC 482/WSR/006.

SI.6.375 The frequency of determination of the secant modulus of elasticity in compression of hardened concrete shall be [enter free text].

6.376 The requirements for "Verification" in Section 14 of GC 101 [Ref 44.N] shall apply to determination of the secant modulus of elasticity in compression of hardened concrete.

6.377 Verification for structural concrete in the hardened state by identity testing shall be undertaken by an accredited testing laboratory in

compliance with "Accredited laboratory" in Section 16 of GC 101 [Ref 44.N].

6.378 The following Documentation for identity testing of structural concrete in the hardened state shall be submitted as continuous records: report(s) containing results of the identity testing of hardened concrete.

6.379 The requirements of "Records" in Section 3 of GC 101 [Ref 44.N] shall apply to report(s) containing results of the identity testing of hardened concrete.

7. Precast structural concrete

General requirements for precast structural concrete

7.1 The execution of precast structural concrete shall be compliant with Section 9 of BS EN 13670 [Ref 38.N]as amended and complemented by this document.

7.2 In accordance with the definitions in Section 3 of BS EN 13670 [Ref 38.N], the term 'precast concrete element' shall be intended to mean any precast structural concrete element that is manufactured, in a factory or on site, in a place other than its final location of use.

7.3 In accordance with the definitions in Section 3 of BS EN 13670 [Ref 38.N], the term 'precast concrete product' shall be intended to mean a precast concrete element that is manufactured in compliance with a precast concrete product standard.

7.4 Precast concrete elements shall be installed in the works in accordance with BS EN 13670 [Ref 38.N]as amended and complemented by this document.

7.5 In accordance with Section 9 of BS EN 13670 [Ref 38.N], for precast concrete elements the start of the installation operations shall be intended to mean upon their delivery to site, when manufactured in a factory, or after formwork removal, when manufactured on site.

7.6 Precast concrete elements shall not be dispatched to site, when manufactured in a factory, or leave the manufacturing area, when manufactured on site, until all verification tests associated with their manufacturing have been completed.

7.7 Requirements for precast structural concrete shall be as specified in CC 482/WSR/007.

Requirements for precast structural concrete

Structure ID	Precast concrete element reference	In-situ concrete structural element connected to the precast concrete element reference (where applicable)	Description of structural element(s)	Drawing/ model reference(s)	Design documentation reference(s)	Precast concrete element within the scope of a designated precast concrete product standard	Reference standard for the manufacting of the precast concrete element within the scope of a designated precast concrete product standard (where applicable
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)

1. Enter a unique reference.

2. Enter a unique reference, to provide reference of the precast concrete element.

3. Enter a unique reference, to provide reference of any in-situ concrete structural element connected to the precast concrete element.

4. Enter text, to describe the precast concrete element and/or its part and any in-situ concrete structural element and/or its part connected to it.

5. Enter a unique reference, to provide reference of drawing(s) or model(s) for the precast concrete element and any in-situ concrete structural element connected to it, where any specified geometrical dimensions for the precast concrete element such as length, cross sectional dimensions, straightness, angular deviation, camber, sag and lateral bow are shown.

6. Enter a unique reference, to provide reference of the design documentation for the precast concrete element and any in-situ concrete structural element connected to it.

7. Enter a value, from options yes, no, to identify whether the precast concrete element to be used in the works is in the scope of a designated precast concrete product standard.

8. Enter a value, from options BS EN 12843 [Ref 65.N], BS EN 14844 [Ref 63.N], BS EN 15050 [Ref 64.N], BS EN 15258 [Ref 66.N], to identify which designated precast product standard the precast concrete element is to be manufactured to when the element falls within the scope of a designated standard.

Requirements for precast structural concrete (continued)

Structure ID	**Compliance with BS EN 13369 [Ref 20.N]for the manufacturing of the precast concrete element outside the scope of a designated precast concrete product standard required (where applicable)**	**Prestressing in the precast concrete element required**	**Composite precast/in-situ construction with in-situ concreting required**	**Surface preparation required for the precast concrete element subject to receive in-situ concrete on site in composite precast-in situ construction (where applicable)**	**Rebates on precast concrete bridge deck elements for receiving permanent soffit formwork required (where applicable)**
(a)	(i)	(j)	(k)	(l)	(m)

1. Enter a value, from options yes, no, to identify whether the precast concrete element outside the scope of a designated precast concrete product standard is to be manufactured in accordance with BS EN 13369 [Ref 20.N].

2. Enter a value, from options yes, no, to identify whether prestressing is required for the precast concrete element.

3. Enter a value, from options yes, no, to identify whether the precast concrete element is subject to receive in-situ concrete on site in composite precast-in-situ construction.

4. Enter a value, from options yes, no, to identify whether surface preparation is required for the precast concrete element subject to receive in-situ concrete on site in composite precast-in situ construction, due to a non-prepared surface between concrete cast at different times not satisfying the interface shear requirements of 6.2.5 of BS EN 1992-1-1 [Ref 35.N].

5. Enter a value, from options yes, no, to identify whether rebates for receiving permanent soffit formwork are required to be

incorporated in the manufacturing process for the precast concrete bridge deck element.

Product requirements for precast concrete elements falling within the scope of a designated precast concrete product standard

7.8 Precast concrete bridge deck elements shall be compliant with BS EN 15050 [Ref 64.N]and BS EN 13369 [Ref 20.N].

7.9 The precast concrete bridge deck elements shall meet the performance characteristics as stated in table 7.9.

Table 7.9 Characteristics and performance requirements for precast concrete bridge deck elements

Characteristic	Performance requirement
Compressive strength (of concrete)	As required in CC 482/WSR/006 for the concrete specified for the precast concrete bridge deck element
Ultimate tensile and tensile yield strength (of steel)	As required in CC 482/WSR/004 for any steel reinforcement and in CC 482/WSR/005 for any prestressing steel specified for the precast concrete bridge deck element
Mechanical strength (by calculation)	Compliance with a 'design specification' as per Method 3 in Table ZA.1 of BS EN 15050 [Ref 64.N]. This is met by the precast concrete bridge deck element being manufactured in compliance with this document and with the design documentation and drawing(s)/model(s) referenced in CC 482/WSR/007
Durability against corrosion	Met by the precast concrete bridge deck element being manufactured in compliance with "Steel reinforcement for structural concrete" in Section 4 of this document, "Prestressing of structural concrete" in Section 5 of this document, "Concreting of structural concrete" in Section 6 of this document and as required in CC 482/WSR/006 for the concrete specified for the precast concrete bridge deck element
Durability against freeze-thaw	Met by the precast concrete bridge deck element being manufactured in compliance with "Concreting of structural concrete" in Section 6 of this document and as required in CC 482/WSR/006 for the concrete specified for the precast concrete bridge deck element
Detailing	Met by the precast concrete bridge deck element being manufactured with: - Geometrical properties complying with the values in 4.3.1 of BS EN 13369 [Ref 20.N] and 4.3.1 of BS EN 15050 [Ref 64.N] - Dimensions measured at 28 ± 2 days after casting and checked for accuracy in accordance with 5.2 and Annex

	D of BS EN 13369 [Ref 20.N] and 5.2 and Annex J of BS EN 15050 [Ref 64.N], when compared with the dimensions from the design documentation and drawing(s)/model(s) referenced in CC 482/WSR/007 - Tolerances for positioning of steel reinforcement and cover to steel reinforcement complying with "Geometrical tolerances for structural concrete" in Section 8 of this document and with "Steel reinforcement for structural concrete" in Section 4 of this document - Surface finish in accordance with "Concreting of structural concrete" in Section 6 of this document

7.10 The requirements of "Designated standards" in Section 10 of GC 101 [Ref 44.N] shall apply to precast concrete bridge deck elements.

7.11 Precast concrete box culverts shall be compliant with BS EN 14844 [Ref 63.N] and BS EN 13369 [Ref 20.N].

7.12 The precast concrete box culverts shall meet the performance characteristics as stated in table 7.12.

Table 7.12 Characteristics and performance requirements for precast concrete box culverts

Characteristic	Performance requirement
Compressive strength (of concrete)	As required in CC 482/WSR/006 for the concrete specified for the precast concrete box culvert
Ultimate tensile and tensile yield strength (of steel)	As required in CC 482/WSR/004 for any steel reinforcement and in CC 482/WSR/005 for any prestressing steel specified for the precast concrete box culvert
Load bearing capacity (by tests) or mechanical resistance (by calculation)	Compliance with a 'design specification' as per Method 3 in Table ZA.1 of BS EN 14844 [Ref 63.N]. This is met by the precast concrete box culvert being manufactured in compliance with this document and with the design documentation and drawing(s)/model(s) referenced in CC 482/WSR/007
Detailing	Met by the precast concrete box culvert being manufactured with: - Geometrical properties complying with the values in 4.3.1 of BS EN 13369 [Ref 20.N] and 4.3.1 of BS EN 14844 [Ref 63.N] - Dimensions measured at 28 ± 2 days after casting and checked for accuracy in accordance with 5.2 and Annex D of BS EN 13369 [Ref 20.N]and 5.2 and Table 1 of BS EN 14844 [Ref 63.N], when compared with the dimensions from the design documentation and

	drawing(s)/model(s) referenced in CC 482/WSR/007 - Tolerances for positioning of steel reinforcement and cover to steel reinforcement complying with "Geometrical tolerances for structural concrete" in Section 8 of this document and with "Steel reinforcement for structural concrete" in Section 4 of this document - Surface finish in accordance with "Concreting of structural concrete" in Section 6 of this document
Durability against corrosion	Met by the precast concrete box culvert being manufactured in compliance with "Steel reinforcement for structural concrete" in Section 4 of this document, "Prestressing of structural concrete" in Section 5 of this document, "Concreting of structural concrete" in Section 6 of this document and as required in CC 482/WSR/006 for the concrete specified for the precast concrete box culvert
Durability against freeze-thaw (for exposed applications)	Met by the precast concrete box culvert being manufactured in compliance with "Concreting of structural concrete" in Section 6 of this document and as required in CC 482/WSR/006 for the concrete specified for the precast concrete box culvert
Drying shrinkage (in end use conditions and only for lightweight concrete)	Declared value

7.13 The requirements of "Designated standards" in Section 10 of GC 101 [Ref 44.N] shall apply to precast concrete box culverts.

7.14 Precast concrete retaining wall elements shall be compliant with BS EN 15258 [Ref 66.N] and BS EN 13369 [Ref 20.N].

7.15 The precast concrete retaining wall elements shall meet the performance characteristics as stated in table 7.15.

Table 7.15 Characteristics and perfomance requirements for precast concrete retaining wall elements

Characteristic	Performance requirement
Compressive strength (of concrete)	As required in CC 482/WSR/006 for the concrete specified for the precast concrete retaining wall element
Ultimate tensile and tensile yield strength (of steel)	As required in CC 482/WSR/004 for any steel reinforcement and in CC 482/WSR/005 for any prestressing steel specified for the precast concrete retaining wall element
Mechanical	Compliance with a 'design specification' as per Method 3

resistance	in Table ZA.1 of BS EN 15258 [Ref 66.N]. This is met by the precast concrete retaining wall element being manufactured in compliance with this document and with the design documentation and drawing(s)/model(s) referenced in CC 482/WSR/007
Detailing	Met by the precast concrete retaining wall element being manufactured with: - Geometrical properties complying with the values in 4.3.1 of BS EN 13369 [Ref 20.N] and 4.3.1 of BS EN 15258 [Ref 66.N] - Dimensions measured at 28 ± 2 days after casting and checked for accuracy in accordance with 5.2 and Annex D of BS EN 13369 [Ref 20.N] and 5.2 and Annex A of BS EN 15258 [Ref 66.N], when compared with the dimensions from the design documentation and drawing(s)/model(s) referenced in CC 482/WSR/007 - Tolerances for positioning of steel reinforcement and cover to steel reinforcement complying with "Geometrical tolerances for structural concrete in Section 8 of this document and with "Steel reinforcement for structural concrete" in Section 4 of this document - Surface finish complying with "Concreting of structural concrete" in Section 6 of this document
Durability	Met by the precast concrete retaining wall element being manufactured in compliance with "Steel reinforcement for structural concrete" in Section 4 of this document, "Prestressing of structural concrete" in Section 5 of this document, "Concreting of structural concrete" in Section 6 of this document and as required in CC 482/WSR/006 for the concrete specified for the precast concrete retaining wall element

7.16 The requirements of "Designated standards" in Section 10 of GC 101 [Ref 44.N] shall apply to precast concrete retaining wall elements.

7.17 Precast concrete masts and poles shall be compliant with BS EN 12843 [Ref 65.N]and BS EN 13369 [Ref 20.N].

7.18 The precast concrete masts and poles shall meet the performance characteristics as stated in table 7.18.

Table 7.18 Characteristics and performance requirements for precast concrete masts and poles

Characteristic	Performance requirement
Compressive strength (of concrete)	As required in CC 482/WSR/006 for the concrete specified for the precast concrete mast/pole

Ultimate tensile and tensile yield strength (of steel)	As required in CC 482/WSR/004 for any steel reinforcement and in CC 482/WSR/005 for any prestressing steel specified for the precast concrete mast/pole
Mechanical strength (by calculation)	Compliance with a 'design specification' as per Method 3 in Table ZA.1 of BS EN 12843 [Ref 65.N]. This is met by the precast concrete mast/pole being manufactured in compliance with this document and with the design documentation and drawing(s)/model(s) referenced in CC 482/WSR/007
Detailing	Met by the precast concrete mast/pole being manufactured with: - Geometrical properties complying with the values in 4.3.1 of BS EN 13369 [Ref 20.N] and 4.3.1 of BS EN 12843 [Ref 65.N] - Dimensions measured at 28 ± 2 days after casting and checked for accuracy in accordance with 5.2 and Annex D of BS EN 13369 [Ref 20.N] and 5.2 and Annex A of BS EN 12843 [Ref 65.N], when compared with the dimensions from the design documentation and drawing(s)/model(s) referenced in CC 482/WSR/007 - Tolerances for positioning of steel reinforcement and cover to steel reinforcement complying with "Geometrical tolerances for structural concrete in Section 8 of this document and with "Steel reinforcement for structural concrete" in Section 4 of this document - Surface finish complying with "Concreting of structural concrete" in Section 6 of this document
Durability against corrosion	Met by the precast concrete mast/pole being manufactured in compliance with "Steel reinforcement for structural concrete" in Section 4 of this document, "Prestressing of structural concrete" in Section 5 of this document, "Concreting of structural concrete" in Section 6 of this document and as required in CC 482/WSR/006 for the concrete specified for the precast concrete mast/pole
Durability against freeze-thaw (for exposed applications)	Met by the precast concrete mast/pole being manufactured in compliance with "Concreting of structural concrete" in Section 6 of this document and as required in CC 482/WSR/006 for the concrete specified for the precast concrete mast/pole

7.19 The requirements of "Designated standards" in Section 10 of GC 101 [Ref 44.N] shall apply to precast concrete masts and poles.

Product requirements for precast concrete elements that are outside the scope of a designated precast concrete product standard

7.20 Precast concrete elements that are outside the scope of a designated precast concrete product standard shall be manufactured in compliance with BS EN 13369 [Ref 20.N]as amended and complemented by this document, unless otherwise stated in CC 482/WSR/007.

7.21 Formwork for precast concrete elements that are outside the scope of a designated precast concrete product standard, shall comply with "Falsework and formwork for structural concrete" in Section 3 of this document.

7.22 Steel reinforcement for precast concrete elements that are outside the scope of a designated precast concrete product standard shall comply with "Steel reinforcement for structural concrete" in Section 4 of this document.

7.23 Prestressing for precast concrete elements that are outside the scope of a designated precast product standard shall comply with "Prestressing of structural concrete" in Section 5 of this document.

7.24 Concreting for precast concrete elements that are outside the scope of a designated precast concrete product standard shall comply with "Concreting of structural concrete" in Section 6 of this document.

7.25 Tolerances for geometrical dimensions of precast concrete elements that are outside the scope of a designated precast concrete product standard shall comply with the values in 4.3.1 of BS EN 13369 [Ref 20.N].

7.26 Tolerances for positioning of steel reinforcement and cover to steel reinforcement in precast concrete elements that are outside of the scope of a designated precast concrete product standard shall comply with "Geometrical tolerances for structural concrete" in Section 8 of this document and with "Steel reinforcement for structural concrete" in Section 4 of this document.

7.27 Surface finish for precast concrete elements that are outside of the scope of a designated precast concrete product standard shall comply with "Concreting of structural concrete" in Section 6 of this document.

7.28 Verification shall be undertaken for the geometrical dimensions of precast concrete elements that are outside the scope of a designated precast concrete product standard by measurement, in accordance with 5.2 and Annex D of BS EN 13369 [Ref 20.N], of the geometrical dimensions of the elements to confirm they meet the permitted deviations in 4.3.1 of BS EN 13369 [Ref 20.N] when compared with the dimensions from the design documentation and drawing(s)/model(s) referenced in CC 482/WSR/007.

7.29 The frequency of measurement of the geometrical dimensions of precast concrete elements that are outside the scope of a designated

precast concrete product standard shall be once on each element, at 28 ± 2 days after casting.

7.30 The requirements for "Verification" in Section 14 of GC 101 [Ref 44.N] shall apply to the measurement of the geometrical dimensions of precast concrete elements that are outside the scope of a designated precast concrete product standard.

7.31 The following Documentation shall be submitted for measurement of the geometrical dimensions of precast concrete elements that are outside the scope of a designated precast concrete product standard prior to the commencement of the installation of the precast concrete elements in the works: report summarising the measurement results.

7.32 The requirements for "Documentation" in Section 2 of GC 101 [Ref 44.N] shall apply to : report summarising the measurement results.

7.33 Precast concrete elements that are outside the scope of a designated precast concrete product standard shall be indelibly marked to show the element mark, the weight of the element, the production line on which they were manufactured, the date on which the concrete was cast and, if they are of symmetrical section, the face that is to be uppermost when the element is in its correct position in the work.

7.34 Markings for precast concrete elements that are outside the scope of a designated precast concrete product standard shall be so located that they are not exposed to view when the element is in its permanent position in the works.

Surface preparation for precast concrete elements

7.35 The surfaces of precast concrete elements which are to subsequently receive in-situ concrete shall be prepared to provide a 'rough surface' to 6.2.5 of BS EN 1992-1-1 [Ref 35.N]in accordance with "Concreting for structural concrete" in Section 6 of this document, unless otherwise stated in CC 482/WSR/007.

Product requirements for sealing of gaps, bedding/packing mortar and structural bonding between precast concrete elements

7.36 Products for sealing of gaps between precast structural concrete elements shall comply with "Sealing of gaps in bridges and structures" in Section 3 of CC 490 [Ref 9.N].

7.37 Mortar used as bedding/packing at load bearing joints of precast concrete elements shall comply with "Bedding Mortar" in Section 1 of CC 495 [Ref 55.N].

7.38 Products for structural bonding at joints between precast concrete elements shall be compliant with BS EN 1504-4 [Ref 72.N].

7.39 The products for structural bonding at joints between precast concrete units shall meet the performance characteristics as stated in table 7.39.

Table 7.39 Characteristics and performance requirements for products for structural bonding at joints between precast concrete units

Characteristic	Performance requirement
Bond/adhesion strength	As required in Table 3.2(14) of BS EN 1504-4 [Ref 72.N]for 'hardened concrete to hardened concrete'
Shear strength	As required in Table 3.2(3) of BS EN 1504-4 [Ref 72.N]
Compressive strength	≥ 50 MPa, tested to BS EN 12190 [Ref 69.N]
Shrinkage/expansion	As required in Table 3.2(9) of BS EN 1504-4 [Ref 72.N]
Workability	Declared value
Sensitivity to water/suitability for application and curing under special environmental conditions	As required in Table 3.2(13) of BS EN 1504-4 [Ref 72.N] for 'hardened concrete to hardened concrete' and tested in both 'dry' and 'wet' conditions at temperatures of 5°C, 23°C and 35°C
Modulus of elasticity in compression	As required in Table 3.2(6) of BS EN 1504-4 [Ref 72.N]
Coefficient of thermal expansion	As required in Table 3.2(8) of BS EN 1504-4 [Ref 72.N]
Glass transition temperature	≥ 45 MPa, tested to BS EN 12614 [Ref 68.N]
Durability	As required in Table 3.2(15) of BS EN 1504-4 [Ref 72.N]
Modulus of elasticity in flexure	As required in Table 3.2(1) of BS EN 1504-4 [Ref 72.N]
Open time	As required in Table 3.2(4) of BS EN 1504-4 [Ref 72.N], tested in both 'dry' and 'wet' conditions
Suitability for application to vertical surfaces and soffits	As required in Table 3.2(10) of BS EN 1504-4 [Ref 72.N]
Suitability for application to horizontal surfaces	As required in Table 3.2(11) of BS EN 1504-4 [Ref 72.N]
Suitability for injection	As required in Table 3.2(12) of BS EN 1504-4 [Ref 72.N]

7.40 The requirements of "Designated standards" in Section 10 of GC 101 [Ref 44.N] shall apply to products for structural bonding at joints between precast concrete elements.

7.41 The following Documentation shall be submitted for products for structural bonding at joints between precast concrete elements prior to the commencement of application of the bonding product to the precast concrete element: product data sheet containing the product properties for the performance characteristics in table 7.39.

7.42 The requirements for "Documentation" in Section 2 of GC 101 [Ref 44.N] shall apply to the product data sheet containing the product properties for the performance characteristics in table 7.39.

Installation requirements for precast structural concrete

7.43 The following Documentation shall be submitted for precast structural concrete prior to the commencement of the works incorporating precast concrete elements: erection specification for the precast concrete elements complying with Section 9 and Annex A of BS EN 13670 [Ref 38.N].

7.44 The requirements for "Documentation" in Section 2 of GC 101 [Ref 44.N] shall apply to the erection specification for the precast concrete elements complying with Section 9 and Annex A of BS EN 13670 [Ref 38.N].

7.45 Installation of precast concrete elements including their handling, storage, placing, adjustment, jointing and completion works shall be in accordance with the requirements of the erection specification.

Requirements for handling and storage of precast concrete elements

7.46 Verification shall be undertaken for precast concrete elements by visual inspection to identify any damage to the precast concrete elements, upon delivery to site when manufactured in a factory or after formwork removal when manufactured on site.

7.47 The frequency of the visual inspection shall be once, within 24 hours after delivery to site when manufactured in a factory or within 24 hours after formwork removal when manufactured on site.

7.48 The requirements for "Verification" in Section 14 of GC 101 [Ref 44.N] shall apply to visual inspection to identify any damage to the precast concrete elements, upon delivery to site when manufactured in a factory or after formwork removal when manufactured on site.

7.49 The following Documentation shall be submitted for the visual inspection of the precast concrete elements, upon delivery to site when manufactured in a factory or after formwork removal when manufactured on site, prior to the commencement of placing of the precast concrete elements into position in the works: notification of any damage to the precast concrete elements upon delivery to site when manufactured in factory or after formwork removal when manufactured on site.

7.50 Documentation for the visual inspection of the precast concrete elements, upon delivery to site when manufactured in a factory or after formwork removal when manufactured on site, shall be submitted within 24 hours of the visual inspection.

7.51 Following delivery to site when manufactured in a factory or after formwork removal when manufactured on site, and until placing into position in the works, the exposed surfaces of precast concrete elements, including any decorative features, finishes and arrises, shall be protected from damage in a way that does not mark or disfigure the surface.

7.52 Precast concrete elements shall be transported, handled, supported, restrained and lifted without damage or over-stress.

7.53 Precast concrete elements shall not be subject to impact during handling.

7.54 The constraints for handling and storage of precast concrete elements, including position of lifting points, position of supporting points and limits on stacking of the elements shall be as stated in CC 482/WSR/007.

7.55 When precast concrete elements are stored, they shall only be supported at the points as stated in CC 482/WSR/007.

7.56 Where precast concrete elements are stored by stacking several elements vertically, packing pieces shall be be provided between each element located vertically above each other to prevent additional bending stresses in the elements.

7.57 Packing pieces shall not cause damage or discolouration of the precast concrete elements.

7.58 Water and deleterious materials shall not accumulate in or on precast concrete elements, to prevent freezing of trapped water, rust staining and efflorescence.

7.59 Handling and storage of precast concrete elements shall be as specified in CC 482/WSR/007.

Handling and storage of precast concrete elements

Structure ID	Precast concrete element reference	In-situ concrete structural element connected to the precast concrete element reference (where applicable)	Description of structural element(s)	Handling and storage drawing/model reference(s)	Handling and storage documentation reference(s)	Precast concrete element handling constraints
(a)	(b)	(c)	(d)	(e)	(f)	(g)

1. Enter a unique reference.

2. Enter a unique reference, to provide reference of the precast concrete element.

3. Enter a unique reference, to provide reference of any in-situ concrete structural element connected to the precast concrete element.

4. Enter text, to describe the precast concrete element and/or its part and any in-situ concrete structural element and/or its part connected to it.

5. Enter a unique reference, to provide reference of drawing(s) or model(s) where handling and storage requirements, including handling and storage constraints, for the precast concrete element are shown.

6. Enter a unique reference, to provide reference of the documentation containing handling and storage requirements, including handling and storage constraints, for the precast concrete element.

7. Enter text, to describe any constraints for handling of the precast concrete element, such as minimum concrete age for handling, 'lifting scheme' with method of lifting and type of equipment, position of supporting points/lifting points/inserts and constraints on support/restraint/dynamic loading during transport, also with reference to the relevant drawing(s)/model(s) and documentation.

Handling and storage of precast concrete elements (continued)

Structure ID	Precast concrete element storage constraints
(a)	(h)

1. Enter text, to describe any constraints for storage of the precast concrete element, such as supporting points for storage, maximum height of a stack when stacking elements vertically and provisions to maintain stack stability, also with reference to the relevant drawing(s)/model(s) and documentation.

Requirements for placing and adjustment of precast concrete elements for structural concrete

7.60 Placing and adjustment of precast concrete elements shall be as specified in CC 482/WSR/007.

Placing and adjustment of precast concrete elements

Structure ID	Precast concrete element reference	In-situ concrete structural element connected to the precast concrete element reference (where applicable)	Description of structural element(s)	Placing and adjustment drawing/model reference(s)	Placing and adjustment documentation reference(s)	Method of assembly and sequencing restrictions
(a)	(b)	(c)	(d)	(e)	(f)	(g)

1. Enter a unique reference.

2. Enter a unique reference, to provide reference of the precast concrete element.

3. Enter a unique reference, to provide reference of any in-situ concrete structural element connected to the precast concrete element.

4. Enter text, to describe the precast concrete element and/or its part and any in-situ concrete structural element and/or its part connected to it.

5. Enter a unique reference, to provide reference of drawing(s) or model(s) where placing and adjustment requirements, including placing and adjustment constraints and sequencing restrictions, for the precast concrete element and any in-situ concrete structural element connected to it are shown.

6. Enter a unique reference, to provide reference of the documentation containing placing and adjustment requirements, including placing and adjustment constraints and sequencing restrictions, for the precast concrete element and any in-situ concrete structural element connected to it.

7. Enter text, to describe the method of assembly and sequencing restrictions for the placing and adjustment of the precast concrete element, also with reference to the the relevant drawing(s)/model(s) and documentation.

Placing and adjustment of precast concrete elements (continued)

Structure ID	**Method of placing and sequencing restrictions for in-situ concrete in composite precast/in-situ concrete construction (where applicable)**	**Tolerance for the difference in soffit level between adjacent precast concrete bridge beams in composite precast/in-situ concrete construction (where applicable)**	**Tolerance for the width of the gaps between adjacent precast concrete bridge beams laid side by side with a nominal gap between beams in composite precast/in-situ concrete construction (where applicable)**	**Tolerance for the total width of the bridge deck soffit in composite precast/in-situ concrete construction (where applicable)**	**Tolerance for the continuity of line of outside precast concrete beams in adjacent spans of multi-span bridges (where applicable)**
(a)	(h)	(i)	(j)	(k)	(l)

1. Enter text, to describe the sequencing and restrictions of placing of the in-situ concrete in composite construction made of

precast concrete elements and in-situ concrete, also with reference to the relevant drawing(s)/model(s) and documentation.

2. Enter a number in units of , to identify the allowable tolerance for the difference in soffit level between adjacent precast concrete bridge beams in composite precast/in-situ concrete construction before the in-situ concrete is placed.

3. Enter a number in units of , to identify the allowable tolerance for the width of the gaps between adjacent precast concrete bridge beams butted up against each other in composite precast/in-situ concrete construction before the in-situ concrete is placed.

4. Enter a number in units of , to identify the allowable tolerance for the total width of the bridge deck soffit in composite precast/in-situ concrete construction with adjacent precast concrete beams before the in-situ concrete is placed.

5. Enter a number in units of , to identify the allowable tolerance for the continuity of line of outside precast concrete beams in adjacent spans of multi-span bridges.

7.61 The allowable tolerance for the difference in soffit level between adjacent precast concrete bridge beams in composite precast/in-situ concrete construction, before the in-situ concrete is placed, shall be such that the difference in soffit level is within ± 5 mm of the difference in soffit level between adjacent beams shown in the drawing(s)/model(s) referenced in CC 482/WSR/007 for beams up to 5 m in length, and within ± 10 mm for longer beams, unless otherwise stated in CC 482/WSR/007.

7.62 Verification shall be undertaken for the tolerance in soffit level between adjacent precast concrete bridge beams in composite precast/in-situ concrete construction by soffit level survey of all precast concrete bridge beams.

7.63 The frequency of soffit level survey of the adjacent precast concrete bridge beams shall be once, following placing of the precast concrete bridge beams and prior to in-situ concreting.

7.64 The requirements for "Verification" in Section 14 of GC 101 [Ref 44.N] shall apply to soffit level survey of the adjacent precast concrete bridge beams in composite precast/in-situ construction.

7.65 The allowable tolerance for the width of gaps between adjacent precast concrete bridge beams laid side by side with a nominal gap between beams in composite precast/in-situ concrete construction, before the in-situ concrete is placed, shall be such that the width of each gap

does not exceed twice the nominal gap shown on the drawing(s)/model(s) referenced in CC 482/WSR/007, unless otherwise stated in CC 482/WSR/007.

7.66 Verification shall be undertaken for the tolerance in the width of gaps between adjacent precast concrete bridge beams laid side by side with a nominal gap between beams in composite precast/in-situ concrete construction by dimensional survey of the gaps between the installed adjacent precast concrete beams.

7.67 The frequency of dimensional survey of the gaps between adjacent precast concrete bridge beams butted up against each other in composite precast/in-situ construction shall be once, following placing of the precast concrete bridge beams and prior to in-situ concreting.

7.68 The requirements for "Verification" in Section 14 of GC 101 [Ref 44.N] shall apply to dimensional survey of the gaps between adjacent precast concrete bridge beams butted up against each other in composite precast/in-situ construction.

7.69 The allowable tolerance for the total width of the bridge deck soffit in composite precast/in-situ concrete construction with adjacent precast concrete beams, before the in-situ concrete is placed, shall be such that the total width of the bridge deck soffit is within ± 25 mm of the total width shown on the drawing(s)/model(s) referenced in CC 482/WSR/007, unless otherwise stated in CC 482/WSR/007.

7.70 Verification shall be undertaken for the tolerance in the total width of the bridge deck soffit in composite precast/in-situ concrete construction with adjacent precast concrete beams by dimensional survey of the width of the bridge deck soffit.

7.71 The frequency of dimensional survey for the width of the bridge deck soffit in composite precast/in-situ construction with adjacent precast concrete beams shall be once, following placing of the precast concrete beams and prior to in-situ concreting.

7.72 The requirements for "Verification" in Section 14 of GC 101 [Ref 44.N] shall apply to dimensional survey of the width of the bridge deck soffit in composite precast/in-situ construction with adjacent precast concrete beams.

7.73 Verification shall be undertaken for the tolerance for the continuity of line of outside precast concrete beams in adjacent spans of multi-span bridges by positional survey of the outside precast concrete beams to check the continuity of line is within the allowable tolerance specified in CC 482/WSR/007.

7.74 The frequency of positional survey of the outside precast concrete beams in adjacent spans of multi-span bridges shall be once, following placing of the precast concrete beams and prior to in-situ concreting.

7.75 The requirements for "Verification" in Section 14 of GC 101 [Ref 44.N] shall apply to positional survey of the outside precast concrete beams in adjacent spans of multi-span bridges.

7.76 The following Documentation for for the surveys of placing tolerances for precast concrete elements shall be submitted as continuous records: report summarising the placing tolerance survey results for the precast concrete elements.

7.77 The requirements of "Records" in Section 3 of GC 101 [Ref 44.N] shall apply to the report summarising the placing tolerance survey results for the precast concrete elements.

7.78 Where the placing tolerance survey results for the the precast concrete elements show any non-conformance with the permitted tolerances, positioning of the precast concrete elements shall be adjusted and the surveys repeated until compliance is achieved.

7.79 The alignment of the transverse holes in adjacent precast concrete bridge beams in composite precast/in-situ concrete construction shall be such that, by taking into account of the size of the holes, the size of the steel reinforcement and/or prestressing tendons and the presence of laps/couplers, the steel reinforcement and/or prestressing tendons can be inserted straight through the holes with no distortions,.

7.80 Verification shall be undertaken for rebates for receiving permanent soffit formwork in precast concrete bridge deck elements by visual inspection and dimensional survey to confirm the rebates provide an even seating for the permanent soffit formwork.

7.81 The frequency of visual inspection and dimensional survey to confirm the rebates provide an even seating for the permanent soffit formwork shall be once, at least 4 weeks prior to placing of the permanent soffit formwork onto the precast concrete bridge deck elements.

7.82 The requirements for "Verification" in Section 14 of GC 101 [Ref 44.N] shall apply to visual inspection and dimensional survey to confirm the rebates in precast concrete bridge deck elements provide an even seating for the permanent soffit formwork.

7.83 Where the rebates for receiving permanent soffit formwork are found to not provide an even seating by the visual inspection and dimensional survey, the rebates shall be levelled out prior to placing of the permanent soffit formwork onto the precast concrete bridge deck elements.

7.84 Verification shall be undertaken for precast concrete elements by visual inspection to identify any damage to the precast concrete elements placed into position in the works.

7.85 The frequency of the visual inspection shall be once, 24 hours after placing of the precast concrete elements into position in the works and prior to the installation of steel reinforcement/prestressing steel and in-situ concrete.

7.86 The requirements for "Verification" in Section 14 of GC 101 [Ref 44.N] shall apply to the visual inspection to identify any damage to the precast concrete elements placed into position in the works.

7.87 The following Documentation shall be submitted for the visual inspection of the precast concrete elements placed in position in the works prior to the commencement of jointing and completions works: notification of any damage to the precast concrete elements placed into position in the works.

7.88 Documentation for the visual inspection of the precast concrete elements placed into position in the works shall be submitted within 24 hours of the visual inspection.

7.89 In composite precast/in situ concrete construction, temporary restraints shall be provided to precast concrete bridge deck elements installed in position to provide stability and prevent movement before and during the placing of the in-situ concrete.

Requirements for jointing and completion works for precast structural concrete

7.90 Jointing and completion works for precast structural concrete shall be as specified in CC 482/WSR/007.

Jointing and completion works for precast structural concrete

Structure ID	Precast concrete element reference	In-situ concrete structural element connected to the precast concrete element reference (where applicable)	Description of structural element(s)	Sealing of gaps between precast concrete elements required	Minimum/ maximum joint width when sealing of gaps is required (where applicable)	Packing/ bedding mortar at load-bearing joints required
(a)	(b)	(c)	(d)	(e)	(f)	(g)

1. Enter a unique reference.

2. Enter a unique reference, to provide reference of the precast concrete element.

3. Enter a unique reference, to provide reference of any in-situ concrete structural element connected to the precast concrete element.

4. Enter text, to describe the precast concrete element and/or its part and any in-situ concrete structural element and/or its part connected to it.

5. Enter a value, from options yes,no, to identify whether sealing of gaps between precast concrete elements is required for the precast concrete element.

6. Enter a number range (e.g. "40-60") in units of , to identify the minimum/maximum range for the joint width when sealing of gaps between precast concrete elements is required for the precast concrete element.

7. Enter a value, from options yes,no, to identify whether packing/bedding mortar at load-bearing joints is required for the precast concrete element.

Jointing and completion works for precast structural concrete (continued

Structure ID	Minimum/ maximum joint width when packing/bedding mortar is required (where applicable)	Structural bonding at joints between precast concrete elements required	Minimum/ maximum joint width when structural bonding at joints is required (where applicable)	Jointing and completion works drawing/model reference(s)	Jointing and completion works documentation reference(s)	Joint and com on work cons nts
(a)	(h)	(i)	(j)	(k)	(l)	(m)

1. Enter a number range (e.g. "40-60") in units of , to identify the minimum/maximum range for the joint width when packing/bedding mortar at load-bearing joints is required for the precast concrete element.

2. Enter a value, from options yes,no, to identify whether structural bonding at joints between precast concrete elements is required for the precast concrete element.

3. Enter a number range (e.g. "40-60") in units of , to identify the minimum/maximum range for the joint width when structural bonding at joints between precast concrete elements is required for the precast concrete element.

4. Enter a unique reference, to provide reference of the drawing(s) or model(s) where jointing and completion works requirements, and any constraints on jointing and completion works, for the precast concrete element and any in-situ concrete structural element connected to it are shown.

5. Enter a unique reference, to provide reference of the documentation containing jointing and completion works requirements, and any constraints to jointing and completion works, for the precast concrete element and any in-situ concrete structural element connected to it.

6. Enter text, to describe the constraints for jointing and completion works for the precast concrete element, such as those for sealing of gaps, installation of bedding/packing mortar, structural bonding at joints, in-situ works and structural connections/inserts, also with reference to the relevant drawing(s)/model(s) and documentation.

7.91 Sealing of gaps between precast concrete elements shall comply with "Sealing of gaps in bridges and structures" in Section 3 of CC 490 [Ref 9.N].

7.92 Installation of mortar used as bedding/packing at load bearing joints of precast concrete elements shall comply with "Bedding Mortar" in Section 1 of CC 495 [Ref 55.N].

7.93 The surfaces of precast concrete elements to be structurally bonded together at the joint shall be prepared in accordance with the structural bonding product manufacturer's instructions.

7.94 Verification shall be undertaken for the surfaces of precast concrete elements to be structurally bonded together at the joint by visual inspection to identify, in accordance with the manufacturer's instructions, any surface irregularity that could be detrimental to the performance of the bonded joint.

7.95 The frequency of visual inspection to identify surface irregularities that could be detrimental to the performance of the bonded joint shall be once for every joint, prior to the installation of the structural bonding product onto the surfaces to be structurally bonded together.

7.96 The requirements for "Verification" in Section 14 of GC 101 [Ref 44.N] shall apply to visual inspection to identify surface irregularities at the surfaces of the precast concrete elements to be structurally bonded together.

7.97 Any identified surface irregularity that, in accordance with the manufacturer's instruction, could be detrimental to the performance of the bonded joint shall be removed prior to the installation of the structural bonding product.

7.98 Products for structural bonding at joints between precast concrete elements shall be mixed, cured and applied to the surface of the precast concrete elements to be structurally bonded together in accordance with the manufacturer's instructions.

7.99 Verification shall be undertaken for the installation of the structural bonding by compressive strength testing, in accordance with BS EN 12190 [Ref 69.N], of a sample of the hardened structural bonding product taken from the same batch used for the works and checking that the resulting compressive strength meets the performance requirement in table 7.39.

7.100 The frequency of compressive strength testing of the hardened structural bonding product shall be a minimum of three cubes per batch or per 50 kg, whatever is the lesser quantity, of structural bonding product, mixed and cured in accordance with the manufacturer's instructions at the same time, for the same duration and at the same

temperature of that installed in the works, tested at 7 days after the installation of the bonding product in the works.

7.101 The requirements for "Verification" in Section 14 of GC 101 [Ref 44.N] shall apply to compressive strength testing of the hardened structural bonding product.

7.102 Verification shall be undertaken for the installation of the structural bonding by shear strength testing, in accordance with BS EN 12615 [Ref 75.N], of 'hardened concrete to hardened concrete' test specimens containing a sample of the structural bonding product taken from the same batch used for the works and checking that the resulting shear strength meets the performance requirement in table 7.39.

7.103 The frequency of shear strength testing of the 'hardened concrete to hardened concrete' test specimens shall be a minimum of three specimens per batch or per 50 kg, whatever is the lesser quantity, of structural bonding product, mixed and cured in accordance with the manufacturer's instructions at the same time, for the same duration and at the same temperature of that installed in the works and with the concrete test specimens substrate matching the dry or wet condition of the precast concrete element surface in the works, tested at 7 days after the installation of the bonding product in the works.

7.104 The requirements for "Verification" in Section 14 of GC 101 [Ref 44.N] shall apply to shear strength testing of the 'hardened concrete to hardened concrete' test specimens containing a sample of the structural bonding product.

7.105 Verification shall be undertaken for the installation of the structural bonding by bond/adhesion strength testing, in accordance with BS EN 12636 [Ref 74.N] of 'hardened concrete to hardened concrete' test specimens containing a sample of the structural bonding product taken from the same batch used for the works and checking that the resulting bond/adhesion strength meets the performance requirements in table 7.39.

7.106 The frequency of bond/adhesion strength testing of the 'hardened concrete to hardened concrete' test specimens shall be a minimum of three specimens per batch or per 50 kg, whatever is the lesser quantity, of structural bonding product, mixed and cured in accordance with the manufacturer's instruction at the same time, for the same duration and at the same temperature of that installed in the works and with the concrete test specimens substrate matching the dry or wet condition of the precast concrete element surface in the works, tested at 7 days after the installation of the bonding product in the works.

7.107 The requirements for "Verification" in Section 14 of GC 101 [Ref 44.N] shall apply to bond/adhesion strength testing of the 'hardened

concrete to hardened concrete' test specimens containing a sample of the structural bonding product.

7.108 Verification for compressive, shear and bond/adhesion strength testing of the installation of structural bonding at joints between precast concrete elements shall be undertaken by an accredited testing laboratory in compliance with "Accredited laboratory" in Section 16 of GC 101 [Ref 44.N].

7.109 Any levelling devices, such as nuts and wedges, and any devices used to keep the precast concrete elements in position during all jointing and completion works shall only be released or removed:.

1. In accordance with the erection specification; and

2. When the mortar used as bedding/packing at load bearing joints and the structural bonding product at joints between precast concrete elements have reached the specified strength as confirmed by the verification testing

7.110 Verification shall be undertaken for the precast structural concrete works by visual inspection to identify any damage to the completed works incorporating precast structural concrete.

7.111 The frequency of the visual inspection shall be once, 24 hours after completion of the works incorporating precast structural concrete.

7.112 The requirements for "Verification" in Section 14 of GC 101 [Ref 44.N] shall apply to the visual inspection to identify any damage to the completed works incorporating precast structural concrete.

7.113 The following Documentation for the visual inspection of the completed works incorporating precast structural concrete shall be submitted as continuous records: notification of any damage to the completed works incorporating precast structural concrete.

7.114 The requirements of "Records" in Section 3 of GC 101 [Ref 44.N] shall apply to the notification of any damage to the completed works incorporating precast structural concrete.

8. Geometrical tolerances for structural concrete

General requirements for geometrical tolerances for structural concrete

8.1 Geometrical tolerances for structural concrete shall be compliant with Section 10 of BS EN 13670 [Ref 38.N]as amended and complemented by this document, unless otherwise stated in CC 482/WSR/008.

8.2 The provisions and geometrical tolerances in 10.2 to 10.8 and Annex G of BS EN 13670 [Ref 38.N], which were derived specifically for building structures and have been amended in this document, shall not apply to structural concrete for highway structures..

8.3 The box principle, as defined in 10.1 of BS EN 13670 [Ref 38.N], shall not apply to structural concrete for highway structures..

Geometrical tolerance requirements for geometrical dimensions of structural concrete

8.4 The permitted deviations for the length of cross-sectional dimensions of in-situ concrete beams, slabs and columns, as illustrated in Figure 4 of BS EN 13670 [Ref 38.N], shall be in accordance with table 8.4.

Table 8.4 Permitted deviations for the length of cross-sectional dimensions of in-situ concrete beams, slabs and columns

Length of cross-sectional dimension,	Permitted deviation,
	linearly interpolated between and
	linearly interpolated between and

8.5 Verification shall be undertaken for the geometrical dimensions of in-situ concrete beams, slabs and columns by measuring the length of their cross-sectional dimensions and checking that the tolerances for the cross-sectional dimensions meet the permitted deviations in table 8.4 when compared with the dimensions from the design documentation and drawing(s)/model(s) referenced in CC 482/WSR/001.

8.6 The frequency of the measurement of geometrical dimensions of in-situ concrete beams, slabs and columns shall be once for each structural element, on completion of their execution.

8.7 The requirements for "Verification" in Section 14 of GC 101 [Ref 44.N] shall apply to the measurement of geometrical dimensions of in-situ concrete beams, slabs and columns.

8.8 The following Documentation for the measurement of geometrical dimensions of in-situ concrete beams, slabs and columns shall be submitted as continuous records: report with record of measurements of the geometrical dimensions.

8.9 The requirements of "Records" in Section 3 of GC 101 [Ref 44.N] shall apply to the report with record of measurements of the geometrical dimensions of in-situ concrete beams, slabs and columns.

8.10 Tolerances for geometrical dimensions of precast concrete elements shall be in accordance with "Precast structural concrete" in Section 7 of this document.

Geometrical tolerance requirements for the location of steel reinforcement and prestressing tendons in structural concrete

8.11 The cover to steel reinforcement, for cast in-situ concrete elements, and to steel reinforcement and prestressing tendons, for precast concrete elements, shall be in accordance with Equation 8.11.

Equation 8.11 Geometric tolerance requirement for cover to steel reinforcement and prestressing tendons in structural concrete elements

where:

actual cover

nominal cover as illustrated in Figure 4 of BS EN 13670 [Ref 38.N]and Figure 1 of BS EN 13369 [Ref 20.N]and specified in CC 482/WSR/006

required minimum cover as illustrated in Figure 4 of BS EN 13670 [Ref 38.N]and Figure 1 of BS EN 13369 [Ref 20.N]

permitted plus-deviation from as illustrated in Figure 4 of BS EN 13670 [Ref 38.N]and Figure 1 of BS EN 13369 [Ref 20.N]

permitted minus-deviation from as illustrated in Figure 4 of BS EN 13670 [Ref 38.N]and Figure 1 of BS EN 13369 [Ref 20.N], taken as equal to the term

Equation 8.11 New Equation

Equation 8.11 New Equation

8.12 The permitted plus-deviation for the cover to steel reinforcement in cast in-situ structural concrete elements other than concrete foundations and concrete members in foundations shall be in accordance with table 8.12.

Table 8.12 Permitted plus-deviation for the cover to steel

reinforcement in cast in-situ structural concrete elements other than concrete foundations and concrete members in foundations

Height of cross section of structural concrete element,	Permitted plus-deviation from nominal cover,
	linearly interpolated between and
	linearly interpolated between and

8.13 The permitted plus-deviation for the cover to steel reinforcement in cast in-situ concrete foundations and cast in-situ concrete members in foundations shall be in accordance with table 8.13.

Table 8.13 Permitted plus-deviation for the cover to steel reinforcement in cast in-situ concrete foundations and concrete members in foundations

Height of cross section of concrete foundation or concrete members in foundations	Permitted plus-deviation from nominal cover,
	linearly interpolated between and
	linearly interpolated between and

8.14 The permitted plus-deviation for the cover to steel reinforcement and prestressing tendons in precast concrete elements shall be in accordance with Table 4 of BS EN 13369 [Ref 20.N].

8.15 The permitted minus-deviation for the cover to steel reinforcement and prestressing tendons in cast in-situ and precast concrete elements shall be:

1. 10 mm, for cast in-situ concrete elements cast against formwork with height of cross section more than 150 mm

2. 5 mm, for cast in-situ concrete elements cast against formwork with height of cross section equal or less than 150 mm

3. in accordance with Table 4 of BS EN 13369 [Ref 20.N], for precast concrete elements

4. in accordance with BS 8500-1 [Ref 23.N]for cast-in situ concrete elements in contact with prepared ground or directly in contact with soil

8.16 The permitted deviation for lap lengths of lap joints of steel reinforcement in structural concrete elements, as illustrated in Figure 4 of BS EN 13670 [Ref 38.N], shall be .

Geometrical tolerance requirements for the location of sheathing/ducts in prestressed structural concrete

8.17 The permitted deviation for the location of the centerline of sheathing/ducts for post-tensioned structural elements in plan or section, as illustrated in Figure 4 of BS EN 13670 [Ref 38.N], shall be ± 5 mm.

Geometrical tolerance requirements for the position of structural bearings for structural concrete

8.18 The installed distance of the position of the axes of structural bearings for structural concrete from an edge of the supporting element, , shall be in accordance with Equation 8.18.

Equation 8.18 Tolerance requirements for the installed distance of the position of the axes of structural bearings for structural concrete from an edge of the supporting element

wher
e:

installed distance of the position of the axes of structural bearings for structural concrete from an edge of the supporting element in .

intended distance of the position of the axes of structural bearings for structural concrete from an edge of the supporting element in as illustrated in Figure 8.18.

permitted deviation for the position of the axes of structural bearings for structural concrete in

Figure 8.18 Intended distance from the edges of the supporting element for the position of the axes of structural bearings

8.19 The permitted deviation, , for the position of the axes of structural bearings for structural concrete shall be in accordance with Equation 8.19.

Equation 8.19 Permitted deviation for the position of the axes of structural bearings for structural concrete

wher
e:

permitted deviation for the distance of the position of the axes of structural bearings for structural concrete from an edge of the supporting element in

the smallest value, in of or

the intended distance of the position of the axes of structural bearings for structural concrete from an edge of the supporting element in as illustrated in Figure 8.18

8.20 Verification shall be undertaken for the position of structural bearings for structural concrete by measuring the distance between the axes of the bearing and the edges of the structural element supporting the bearing, and checking that the tolerances for the position of the structural bearing meet the tolerance requirements in Equation 8.18.

8.21 The frequency of the measurement of the position of structural bearings for structural concrete shall be : once for every bearing on completion of the positioning of the bearings, and once for every bearing following positioning of the structural element the bearing supports.

8.22 The requirements for "Verification" in Section 14 of GC 101 [Ref 44.N] shall apply to the measurement of the position of structural bearings for structural concrete.

8.23 The following Documentation for the measurement of the position of structural bearings for structural concrete shall be submitted as continuous records: report with record of measurement of the position of structural bearings.

8.24 The requirements of "Records" in Section 3 of GC 101 [Ref 44.N] shall apply to the report with record of position of structural bearings.

Geometrical tolerance requirements for the inclination and curvature of structural concrete columns and walls

8.25 The permitted deviation for the inclination and curvature of structural concrete columns and walls, as illustrated in Figure 2 of BS EN 13670 [Ref 38.N], shall be the larger value of h/600 or 15 mm, where h is equal to the free height of the column or wall in mm.

8.26 Verification shall be undertaken for the inclination and curvature of structural concrete columns and walls by measuring the inclination and curvature of the column and the wall, and checking that the tolerances for the inclination and curvature meet the permitted deviations.

8.27 The frequency of the measurement of the inclination and curvature of structural concrete columns and walls shall be once for each structural concrete column and wall, on completion of their execution.

8.28 The requirements for "Verification" in Section 14 of GC 101 [Ref 44.N] shall apply to the measurement of the inclination and curvature of structural concrete columns and walls.

8.29 The following Documentation for the measurement of the inclination and curvature of structural concrete columns and walls shall be submitted as continuous records: report with record of measurements of the inclination and curvature of structural concrete columns and walls.

8.30 The requirements of "Records" in Section 3 of GC 101 [Ref 44.N] shall apply to the report with record of measurements of the inclination and curvature of structural concrete columns and walls.

Specific requirements for geometrical tolerances for structural concrete

8.31 Specific geometrical tolerances for structural concrete construction shall be as specified in CC 482/WSR/008.

Specific geometrical tolerances for structural concrete construction

Structure ID	**Structural element reference**	**Description of structural element**	**Drawing/ model reference(s)**	**Specific requirements for stricter or additional geometrical tolerances**
(a)	(b)	(c)	(d)	(e)

1. Enter a unique reference.

2. Enter a unique reference, to identify the structural element reference.

3. Enter text, to describe the structural element and/or its part subject to specific geometrical tolerances.

4. Enter a unique reference, to provide reference of drawing(s) or model(s) where the structural element and/or its part subject to specific geometrical tolerances is shown.

5. Enter text, to identify any requirements for specific geometrical tolerances, including stricter or additional tolerances for aesthetic, durability or fitting purposes, for the structural element and/or its part.

9. Surface protection systems for structural concrete

General requirements for surface protection systems for structural concrete

9.1 Surface protection systems for structural concrete shall be as specified in CC 482/WSR/009.

Surface protection systems for structural concrete

Structure ID	Structural element reference	Description of structural element	Drawing/ model reference(s)	Surface protection system type(s)	Extent of application of the surface protection system(s)	Special requirements, constraints and consents for use of surface protection systems (where applicable)
(a)	(b)	(c)	(d)	(e)	(f)	(g)

1. Enter a unique reference.

2. Enter a unique reference, to identify the structural element reference.

3. Enter text, to describe the structural element and/or its part subject to the application of the surface protection system(s).

4. Enter a unique reference, to provide reference of drawing(s) or model(s) where the structural element and/or its part subject to the application of the surface protection system(s) is shown and which include details of the surface protection system(s), the extent of the surface protection system(s) application, the application method(s) and details of any removal of existing coatings prior to the application of the proposed surface protection system(s).

5. Enter one or more values, from options hydrophobic impregnation, anti-graffiti coating, anti-carbonation coating, to identify the type(s) of surface protection system to be applied to the structural element and/or its part.

6. Enter text, to describe the extent of application, in terms of boundaries and surface area, of the surface protection

system(s) to be applied to the structural element and/or its part, also with reference to the relevant drawing(s)/model(s).

7. Enter text, to identify any special requirements and/or constraints to the application of the surface protection system(s) to the structural element and/or its part, including any requirement to obtain consent from relevant authorities.

Surface protection systems for structural concrete (continued)

Structure ID	Rigid or flexible/crack-bridging anti-carbonation coating (where applicable)	Anti-carbonation coating crack bridging class (where applicable)	Rigid or flexible/crack-bridging anti-graffiti coating (where applicable)	Sacrificial or non-sacrificial anti-graffiti coating (where applicable)
(a)	(h)	(i)	(j)	(k)

1. Enter a value, from options rigid system, flexible/crack-bridging system, to identify whether a rigid or flexible/crack-bridging anti-carbonation coating is required as surface protection system for the structural element and/or its part.

2. Enter one or more values, from options A1, A2, A3, A4, A5, B1, B2, B3.1, B3.2, B4.1, B4.2, to identify, when a flexible/crack-bridging anti-carbonation coating is specified, the required crack bridging class(es) to Tables 6 and 7 of BS EN 1504-2 [Ref 73.N] for the anti-carbonation coating required as surface protection system for the structural element and/or its part.

3. Enter a value, from options rigid system, flexible/crack-bridging system, to identify whether a rigid or flexible/crack-bridging anti-graffiti coating is required as surface protection system for the structural element and/or its part..

4. Enter a value, from options sacrificial, non-sacrificial, either, to identify whether a sacrificial or non-sacrificial anti-graffiti coating is required as surface protection system for the structural element and/or its part.

9.2 To mitigate against obscuring defects, hindering inspections and, in the case of anti-graffiti coatings, attracting vandals, surface protection systems for structural concrete shall be clear, colourless and not impart a gloss finish to the treated areas following application to the concrete surface.

9.3 Where surface protection systems are applied in combination, the systems shall be compatible and not impair the functionality of each other.

9.4 When concrete repairs are carried out prior to the application of surface protection systems, the subsequently applied surface protection systems shall be compatible with the repair materials used and any existing protection system.

Product requirements for surface protection systems for structural concrete

Hydrophobic impregnation for structural concrete

9.5 Hydrophobic impregnation products shall be compliant with BS EN 1504-2 [Ref 73.N].

9.6 The hydrophobic impregnation products shall meet the performance characteristics as stated in table 9.6.

Table 9.6 Characteristics and performance requirements for hydrophobic impregnation products

Characteristic	Performance requirement
Depth of penetration	Class II in accordance with Table 3(19) of BS EN 1504-2 [Ref 73.N]
Water absorption and resistance to alkali	As required in Table 3(23) of BS EN 1504-2 [Ref 73.N]
Drying rate coefficient for hydrophobic impregnation	Class I in accordance with Table 3(24) of BS EN 1504-2 [Ref 73.N]
Loss of mass after freeze-thaw salt stress	As required in Table 3(17) of BS EN 1504-2 [Ref 73.N]
Diffusion of chloride ions	Met, as a national UK requirement with reference to Table 3(25) of BS EN 1504-2 [Ref 73.N], by successful verification of the resistance to diffusion of chloride ions on concrete specimens using the ponding test methodology in accordance with "Surface protection systems for structural concrete" in Section 9 of this document and TRL PPR 362 [Ref 59.N]

9.7 The requirements of "Designated standards" in Section 10 of GC 101 [Ref 44.N] shall apply to hydrophobic impregnation products.

9.8 Following application and absorption into the concrete surface pores and capillaries, hydrophobic impregnation products shall not leave a film or residue that could change the concrete appearance.

Anti-graffiti coatings for structural concrete

9.9 Anti-graffiti coatings shall enable graffiti to be removed without damage to the concrete substrate.

9.10 Anti-graffiti coatings shall be compliant with BS EN 1504-2 [Ref 73.N].

9.11 The anti-graffiti coatings shall meet the performance characteristics as stated in table 9.11.

Table 9.11 Characteristics and performance requirements for anti-graffiti coatings

Characteristic	Performance requirement
Water vapour permeability	Class I in accordance with Table 5(7) of BS EN 1504-2 [Ref 73.N]
Capillary absorption and permeability to water	As required in Table 5(8) of BS EN 1504-2 [Ref 73.N]
Adhesion strength by pull off test	As required in Table 5(15) of BS EN 1504-2 [Ref 73.N] without trafficking for the anti-graffiti coating type specified in CC 482/WSR/009

9.12 The requirements of "Designated standards" in Section 10 of GC 101 [Ref 44.N] shall apply to anti-graffiti coatings.

Anti-carbonation coatings for structural concrete

9.13 Anti-carbonation coatings shall be compliant with BS EN 1504-2 [Ref 73.N].

9.14 The anti-carbonation coatings shall meet the performance characteristics as stated in table 9.14.

Table 9.14 Characteristics and performance requirements for anti-carbonation coatings

Characteristic	Performance requirement
Permeability to CO_2	As required in Table 5(6) of BS EN 1504-2 [Ref 73.N]
Water vapour permeability	Class I in accordance with Table 5(7) of BS EN 1504-2 [Ref 73.N]
Capillary absorption and permeability to water	As required in Table 5(8) of BS EN 1504-2 [Ref 73.N]
Crack bridging ability	As required in Table 5(13) of BS EN 1504-2 [Ref 73.N] for the crack bridging ability class specified in CC 482/WSR/009
Adhesion strength by pull off test	As required in Table 5(15) of BS EN 1504-2 [Ref 73.N]without trafficking for the anti-carbonation coating type specified in CC 482/WSR/009

Adhesion after thermal compatibility for outside application with de-icing salt influence	As required in Table 5(9) of BS EN 1504-2 [Ref 73.N]without trafficking for the anti-carbonation coating type specified in CC 482/WSR/009
Artificial weathering	As required in Table 5(20) of BS EN 1504-2 [Ref 73.N]

9.15 The requirements of "Designated standards" in Section 10 of GC 101 [Ref 44.N] shall apply to anti-carbonation coatings.

Product verification requirements for hydrophobic impregnation for structural concrete

Performance requirements of hydrophobic impregnation products for structural concrete against diffusion of chloride ions

9.16 Verification shall be undertaken for the performance of hydrophobic impregnation products for structural concrete against diffusion of chloride ions by testing, using the ponding test methodology described in this document, the resistance to diffusion of chloride ions on concrete specimens treated with hydrophobic impregnation products of the same formulation and manufacturing process as those proposed for use in the works, with tests carried out as part of this contract or using previous test data, and checking that all test results meet the acceptance criteria for the ponding test as specified in this document.

9.17 The frequency of testing of the resistance to diffusion of chloride ions with the ponding test for determining the performance of hydrophobic impregnation products for structural concrete against diffusion of chloride ions, shall be once, on a minimum of 4 concrete specimens per hydrophobic impregnation product.

9.18 The requirements for "Verification" in Section 14 of GC 101 [Ref 44.N] shall apply to the testing of the resistance to diffusion of chloride ions with the ponding test for determining the performance of hydrophobic impregnation products for structural concrete against diffusion of chloride ions.

9.19 The following Documentation shall be submitted for the performance of hydrophobic impregnation products for structural concrete against the diffusion of chloride ions prior to the commencement of application of hydrophobic impregnation products into the works: test report with results of the ponding test verifying the resistance to diffusion of chloride ions on concrete specimens for the hydrophobic impregnation products proposed for use in the works.

9.20 The requirements for "Documentation" in Section 2 of GC 101 [Ref 44.N] shall apply to the test report with results of the ponding test verifying the resistance to diffusion of chloride ions on concrete

specimens for the hydrophobic impregnation products proposed for use in the works.

Ponding test methodology for verifying the resistance to diffusion of chloride ions

9.21 A minimum of four concrete specimens of 450 mm in length, 450 mm in width and 100 mm in depth shall be cast in a laboratory using a Type C (0,45) reference concrete in accordance with BS EN 1766 [Ref 77.N].

9.22 The concrete specimens shall be cast upside down in the mould, with an insert in the base of the mould that forms a recess of 400 mm in length, 400 mm in width and 12 mm in depth for the purpose of treatment and subsequent ponding.

9.23 The layout of the concrete specimens for the ponding test shall be as illustrated in Figure 9.23

Figure 9.23 Layout of concrete specimens for the ponding test

l_3 (400)
d_2 (12)
l_1 (450)

9.24 The concrete specimens shall be cured in their moulds under damp hessian for 24 hours then demoulded, cured under hessian continuously kept damp for a further 6 days and subsequently air-cured in a laboratory at a temperature of 21 ± 2°C and a relative humidity of 60 ± 10%.

9.25 A minimum of two concrete specimens shall be left untreated as control specimens.

9.26 At no less than 28 days after casting, a minimum of two concrete specimens shall be treated with the hydrophobic impregnation product in accordance with the manufacturer's instructions.

9.27 There shall be no cross-contamination between the untreated specimens and the specimens to be treated with the hydrophobic impregnation product.

9.28 The application of the hydrophobic impregnation product to the concrete specimens to be treated shall be undertaken within a fume cupboard with the fan turned on.

9.29 The quantity of hydrophobic impregnation product to be applied to each treated concrete specimen shall be determined in accordance with the manufacturer's instructions in relation to the surface area being treated.

9.30 Verification shall be undertaken for the quantity of hydrophobic impregnation product applied to each treated concrete specimen by measuring the actual quantity of hydrophobic impregnation product applied to each treated concrete specimen, taking into account any residual amount of product taken up by the device used for the application, and comparing it against the quantity determined in accordance with the manufacturer's instructions.

9.31 The frequency of measurement of the quantity of hydrophobic impregnation product applied to each treated concrete specimen shall be once, following the application of the hydrophobic impregnation product to each treated concrete specimen.

9.32 The requirements for "Verification" in Section 14 of GC 101 [Ref 44.N] shall apply to the measurement of the quantity of hydrophobic impregnation product applied to each treated concrete specimen.

9.33 Where the measured quantity of hydrophobic impregnation product applied to the treated concrete specimens is less than the quantity determined in accordance with the manufacturer's instructions, an additional amount of hydrophobic impregnation product shall be applied to the treated concrete specimens to achieve the determined quantity.

9.34 After the application of the hydrophobic impregnation product, the treated concrete specimens shall be kept in the fume cupboard with the fan turned off for a minimum of 48 hours before being moved back to the laboratory.

9.35 All treated and untreated concrete specimens shall be stored and kept on a level surface in a laboratory maintained at a temperature between 10°C and 25°C.

9.36 Ponding of the specimens shall commence no earlier than 3 days after completion of the application of the hydrophobic impregnation to the treated specimens.

9.37 Each concrete specimen shall be ponded with a sodium chloride solution every two weeks for 15 cycles, to ensure the solution applied in the previous cycle has dried off before the new cycle.

9.38 For each ponding cycle, one litre of 5% sodium chloride solution by weight shall be poured into the recessed area of each test specimen.

9.39 At 14 days after 15 ponding cycles, any remaining sodium chloride solution shall be removed from the recessed area of each specimen.

9.40 After 15 ponding cycles and once the solution has dried off, a single 50 mm diameter core with a minimum depth of 60 mm, taken at a minimum of 100 mm from the edges of the specimen, shall be removed from the recessed area of each specimen.

9.41 Dust samples shall be obtained from each extracted core for chloride content analysis at depth intervals of 5 mm to a total depth of 15 mm from the ponded surface.

9.42 Dust samples taken from all untreated specimens at each depth increment shall be combined together to form a single sample for that given depth increment.

9.43 Dust samples taken from all treated specimens at each depth increment shall be combined together to form a single sample for that given depth increment.

9.44 The chloride ion concentration of each dust sample shall be determined in accordance with BS 1881-124 [Ref 106.N].

9.45 For each depth increment, the percentage reduction (PR) in chloride ion concentration in the treated specimens (Ct) compared with the chloride ion concentration in the untreated specimens (Cu) shall be calculated in accordance with Equation 9.45.

Equation 9.45 Percentage reduction of chloride ion concentration

Ponding test acceptance criteria

9.46 The percentage reduction in chloride ion concentration for the 0-5 mm depth increment shall be greater than 75%.

9.47 The percentage reduction in chloride ion concentration for the 5-10 mm and 10-15 mm depth increments shall be greater than 90%.

Requirements for pre-installation trials of surface protection systems for structural concrete

Trial panels for surface protection systems for structural concrete

9.48 Verification shall be undertaken for the suitability of the proposed surface protection system products, the methods of application and the quality of workmanship from the proposed operatives in the application of the products by executing trial panels for surface protection systems for structural concrete.

9.49 The frequency of trial panels for surface protection systems for structural concrete shall be once for each permutation of different concrete mixes, different surface finishes and different orientations of the structural element and/or its part that the trial panels are representing, no less than 56 days prior to the execution of the permanent works unless otherwise stated in CC 482/WSR/009.

SI.9.49 The frequency of trial panels for surface protection systems for structural concrete shall be [enter free text].

9.50 The requirements for "Verification" in Section 14 of GC 101 [Ref 44.N] shall apply to the trial panels for surface protection systems for structural concrete.

9.51 Trial panels for surface protection systems for new concrete structures shall be undertaken by casting and treating concrete specimens with the same concrete mix, surface finish and orientation of the structural element and/or its part in the permanent works that the trial panel is representing.

9.52 Trial panels for surface protection systems for existing concrete structures shall be undertaken by treating in-situ areas on the concrete surface of the existing structural element and/or its part that the trial panel is representing.

9.53 Trial panels for surface protection systems for structural concrete shall be a minimum of 1600 mm in length and 1600 mm in width, unless otherwise stated in CC 482/WSR/009.

9.54 Trial panels for surface protection systems for structural concrete shall be as specified in CC 482/WSR/009.

Trial panels for surface protection systems for structural concrete

Structure ID	Structural element reference	Description of structural element	Trial panel drawing/model reference(s)	Trial panel surface protection system type(s)	Trial panel length and width	Trial panel depth (where applicable)
(a)	(b)	(c)	(d)	(e)	(f)	(g)

1. Enter a unique reference.

2. Enter a unique reference, to identify the reference of the structural element that the trial panel is representing.

3. Enter text, to describe the structural element and/or its part subject to the application of the surface protection system(s) that the trial panel is representing.

4. Enter a unique reference, to provide reference of drawing(s) or model(s) for the trial panel where the panel layout, reference and dimensions are shown including, for surface protection systems for existing concrete structures, the layout and dimensions of the in-situ area of the concrete surface of the structural element and/or its part that the trial panel is representing.

5. Enter one or more values, from options hydrophobic impregnation, anti-graffiti coating, anti-carbonation coating, to identify the type(s) of surface protection system to be applied to the trial panel representing the structural element and/or its part.

6. Enter text, to identify the required dimensions of the trial panel in terms of length and width including, for surface protection systems for existing concrete structures, the dimensions of the in-situ area of the concrete surface of the structural element and/or its part that the trial panel is representing.

7. Enter a number in units of , to identify the required depth of the trial panel to be cast for surface protection systems for new concrete structures.

Trial panels for surface protection systems for structural concrete (continued)

Structure ID	Designed concrete mix reference for the trial panel (where applicable)	Trial panel surface protection system application orientation (where applicable)	Surface finish class of the trial panel (where applicable)	In-situ trial panel location (where applicable)	Fugitive dyes for trial panel for hydrophobic impregnation required (where applicable)
(a)	(h)	(i)	(j)	(k)	(l)

1. Enter a unique reference, to identify the reference of the designed concrete mix used for concreting of the trial panel to be cast for surface protection systems for new concrete structures.

2. Enter a value, from options vertical, horizontal (soffit), horizontal (top surface), to identify the required orientation for the application of the surface protection system to the trial panel to be cast for surface protection systems for new concrete structures.

3. Enter a value, from options F1, F2, F3, F4, F5, U1, U2, U3, U4, U5, to identify the required class of the surface finish for the trial panel to be cast for surface protection systems for new concrete structures in accordance with "Concreting of structural concrete" in Section 6 of this document.

4. Enter text, to describe the boundaries of the location in the structural element and/or its part where the trial panel for surface protection systems for existing concrete structures is to be undertaken.

5. Enter a value, from options yes, no, to identify whether fugitive dyes are required to be used in the trial panel as a control measure of the extent of the application when hydrophobic impregnation is specified as surface protection system to be applied to the trial panel representing the structural element and/or its part.

9.55 Surface protection system products shall be applied to the entire area of the trial panels in accordance with the manufacturer's instructions, using the same methods stated in the method statement for the installation of the product in the permanent works and in accordance with the requirements for installation of surface protection systems for structural concrete given in "Surface protection systems for structural concrete" in Section 9 of this document.

9.56 Where the use of fugitive dyes during the application of hydrophobic impregnation products on trial panels is specified in CC 482/WSR/009 as a control measure of the extent of the application, the dye shall consist of the same fugitive dye proposed for use in the permanent works.

9.57 The quantity of each surface protection system product to be applied on each trial panel shall be determined in accordance with the manufacturer's instructions in relation to the surface area being treated.

9.58 Verification shall be undertaken for the appearance of trial panels for surface protection systems, when no fugitive dyes are used, by visually inspecting the surface of the treated panel and checking that after the application of the surface protection system product there is no noticeable change, including any evident gloss finish, to the appearance and colour of the concrete surface.

9.59 The frequency of visual inspection of the appearance of the surface of trial panels for surface protection systems shall be once on each trial panel, no less than 14 days after the application of each surface protection system product.

9.60 The requirements for "Verification" in Section 14 of GC 101 [Ref 44.N] shall apply to the visual inspection of the surface of trial panels for surface protection systems.

9.61 Verification shall be undertaken for the quality of workmanship in the application of hydrophobic impregnation products to trial panels by visually inspecting the surface of the treated panel to confirm that the hydrophobic impregnation has achieved saturation of the surface or evenness of the applied products in accordance with the manufacturer's instructions and the method statement and that no areas of the concrete substrate have been omitted.

9.62 The frequency of visual inspection of the application of hydrophobic impregnation products to trial panels shall be once on each trial panel, after the application of the hydrophobic impregnation product.

9.63 The requirements for "Verification" in Section 14 of GC 101 [Ref 44.N] shall apply to the visual inspection of the application of hydrophobic impregnation products to trial panels.

9.64 Verification shall be undertaken for the suitability of fugitive dyes by visually inspecting the surface of the panel treated with the hydrophobic impregnation product containing the fugitive dye and checking that the fugitive dye becomes colourless within 28 days from the application of the hydrophobic impregnation product to the trial panel.

9.65 The frequency of visual inspection to the surface of trial panels treated with hydrophobic impregnation products containing fugitive dyes

shall be daily, until the fugitive dye becomes colourless or until 28 days after the application of the hydrophobic impregnation product containing the fugitive dye to the trial panel, whichever is the sooner.

9.66 The requirements for "Verification" in Section 14 of GC 101 [Ref 44.N] shall apply to the visual inspection of the suitability of fugitive dyes for use in hydrophobic impregnation products.

9.67 Verification shall be undertaken for the thickness of non-sacrificial anti-graffiti coatings applied on trial panels by measuring the dry-film thickness of the non-sacrificial anti-graffiti coating applied on the trial panel on a 250 mm by 250 mm grid in accordance with method 4B of BS EN ISO 2808 [Ref 58.N].

9.68 The frequency of measurement of the dry-film thickness of the non-sacrificial anti-graffiti coating applied on the trial panel prior to graffiti application shall be once on each trial panel, no less than 5 days after the application of the non-sacrificial anti-graffiti coating but prior to the application of graffiti.

9.69 The requirements for "Verification" in Section 14 of GC 101 [Ref 44.N] shall apply to the measurement of the dry-film thickness of the non-sacrificial anti-graffiti coating applied on the trial panel prior to graffiti application.

9.70 Verification shall be undertaken for the adhesion strength of anti-graffiti and anti-carbonation coatings after their application on trial panels by performing pull off bond strength testing on the trial panel in accordance with BS EN 1542 [Ref 76.N] and checking that the measured value of the adhesion strength of the applied coating is no lower than the required adhesion strength by pull-off test in table 9.11, for anti-graffiti coatings, and table 9.14, for anti-carbonation coatings.

9.71 The frequency of pull off bond strength testing to BS EN 1542 [Ref 76.N]of the anti-graffiti and/or anti-carbonation coating applied on the trial panel shall be once on each trial panel, no less than 5 days after the application of the anti-graffiti and/or anti-carbonation coating.

9.72 The requirements for "Verification" in Section 14 of GC 101 [Ref 44.N] shall apply to pull off bond strength testing to BS EN 1542 [Ref 76.N]of the anti-graffiti and/or anti-carbonation coating applied on the trial panel.

9.73 After no less than 5 days following the application of anti-graffiti coatings to the trial panels, spray paint graffiti shall be applied, and subsequently allowed to cure in accordance with the spray paint manufacturer's instruction, to the entire area of the trial panels treated with anti-graffiti coatings using the following combination of spray paints:.

1. Solvent-based spray paints to half of the treated area of the trial panel;

2. Water-based spray paints to the remaining half of the treated area of the trial panel

9.74 Removal of the cured graffiti applied on the trial panels shall be undertaken by cleaning the trial panel surface in accordance with the anti-graffiti coating manufacturer's instructions.

9.75 Verification shall be undertaken for the removal of graffiti from trial panels treated with anti-graffiti coatings by measuring the percentage area of graffiti remaining and by visually inspecting the concrete substrate for damage.

9.76 The frequency of measurement of the percentage area of graffiti remaining after the removal of graffiti from trial panels treated with anti-graffiti coatings and the visual inspection of the concrete substrate for damage shall be once on each trial panel, after the removal of the graffiti.

9.77 The requirements for "Verification" in Section 14 of GC 101 [Ref 44.N] shall apply to the measurement of the percentage area of graffiti remaining after the removal of graffiti from trial panels treated with anti-graffiti coatings and the visual inspection of the concrete substrate for damage.

9.78 Verification shall be undertaken for the thickness of non-sacrificial anti-graffiti coatings after graffiti removal from trial panels by measuring the dry-film thickness of the non-sacrificial anti-graffiti coating after graffiti removal from the trial panel on a 250 mm by 250 mm grid in accordance with method 4B of BS EN ISO 2808 [Ref 58.N] and checking that the remaining thickness of the non-sacrificial anti-graffiti coating is no less than the minimum thickness required for the coating in the manufacturer's instructions.

9.79 The frequency of measurement of the dry-film thickness of the non-sacrificial anti-graffiti coating after graffiti removal from the trial panel shall be once on each trial panel, after the removal of the graffiti from the trial panel.

9.80 The requirements for "Verification" in Section 14 of GC 101 [Ref 44.N] shall apply to the measurement of the dry-film thickness of the non-sacrificial anti-graffiti coating after graffiti removal from the trial panel.

9.81 Verification shall be undertaken for the adhesion strength of non-sacrificial anti-graffiti coatings after graffiti removal from trial panels by performing pull off bond strength testing on the trial panel after graffiti removal in accordance with BS EN 1542 [Ref 76.N]and checking that the measured value of the adhesion strength of the coating after graffiti

removal is not lower than the required adhesion strength by pull off test in table 9.11.

9.82 The frequency of pull off bond strength testing to BS EN 1542 [Ref 76.N]of the non-sacrificial anti-graffiti coating after graffiti removal from trial panels shall be once each trial panel, after the removal of the graffiti from the trial panel.

9.83 The requirements for "Verification" in Section 14 of GC 101 [Ref 44.N] shall apply to pull off bond strength testing to BS EN 1542 [Ref 76.N]of the non-sacrificial anti-graffiti coating after graffiti removal.

9.84 The following Documentation shall be submitted for trial panels for surface protection systems prior to the commencement of the application of the surface protection systems to the permanent works: report with findings from the trial panels for surface protection systems that include the following information:.

1. Quantity and data sheet of the surface protection system products applied to each trial panel, including details of any fugitive dye

2. Findings of the visual inspection of the trial panels for surface protection systems confirming no noticeable changes to the appearance and colour of the concrete surface

3. Findings of the visual inspection of any trial panels for hydrophobic impregnation confirming adequacy of the application

4. Findings of the visual inspection for any fugitive dyes in hydrophobic impregnation confirming timescale to become colourless

5. Dry-film thickness measurements for any non-sacrificial anti-graffiti coatings prior and after graffiti removal

6. Adhesion strength testing results for any anti-graffiti and anti-carbonation coatings after their application to the trial panels

7. Percentage area of graffiti remaining following removal of graffiti from any trial panels with anti-graffiti coatings

8. Description of any damage to the concrete substrate following removal of graffiti from any trial panels with anti-graffiti coatings

9. Adhesion strength testing results for any non-sacrificial anti-graffiti coatings following removal of graffiti from the trial panels with anti-graffiti coatings

9.85 Documentation with the report with findings from the trial panels for surface protection systems shall be submitted no less than 7 days prior to the commencement of the application of the surface protection systems to the permanent works.

Installation requirements for surface protection systems for structural concrete

General requirements for the installation of surface protection systems for structural concrete

9.86 Operatives proposed for the application of surface protection systems for the permanent works shall the same as the operatives who executed the trial panels for surface protection systems.

9.87 The following Documentation shall be submitted for surface protection systems for structural concrete prior to the commencement of the application of surface protection systems for structural concrete: product data sheets for the the surface protection systems and method statement for the installation of the surface protection systems.

9.88 The requirements for "Documentation" in Section 2 of GC 101 [Ref 44.N] shall apply to : product data sheets for the surface protection systems and method statement for the installation of the surface protection systems.

9.89 The method statement for the installation of the surface protection systems shall include:.

1. Details of materials, substrate preparation and application procedures for the proposed surface protection systems

2. Evidence of previous successful application of surface protection systems by the proposed operatives responsible for executing the works

3. Details of all processes for delivery, storage, handling, disposal and spillage of surface protection systems such that all safety and environmental requirements are met.

Supply, storage and disposal of surface protection systems for structural concrete

9.90 Surface protection system products shall be delivered to site in containers in accordance with the manufacturer's instructions, BS EN 1504-10 [Ref 71.N]and the method statement.

9.91 Marking and labelling to containers of any supplied surface protection system products shall be provided in accordance with BS EN 1504-8 [Ref 70.N].

9.92 Verification shall be undertaken for the surface protection system products for structural concrete delivered to site by inspecting the containers and any marking and labelling information provided for the products, and checking that the products delivered are within the manufacturer's stated expiration date and that the remaining storage life of the products is such that it will not expire before the planned completion of the installation of the surface protection systems in the works.

9.93 The frequency of inspection of the delivered products for the adequacy of their storage life shall be once, after delivery to site and prior to installation in the works.

9.94 The requirements for "Verification" in Section 14 of GC 101 [Ref 44.N] shall apply to the inspection of the delivered products for the adequacy of their storage life.

9.95 Surface protection system products shall be stored in accordance with the manufacturer's instructions, BS EN 1504-10 [Ref 71.N]and the method statement with the containers sealed until the products are required for use, to minimise the risk of the products deteriorating when exposed to atmosphere.

9.96 The contents of any opened container that are not used within the time limits of the open pot life of the surface protection system product in accordance with the manufacturer's instructions shall be disposed of.

9.97 Disposal of any unused surface protection system products shall comply with "Hazards and hazardous materials" in Section 4 of GC 109 [Ref 82.N].

9.98 Disposal of any contaminated materials, protective sheeting or masking that have come into contact with surface protection system products shall comply with "Hazards and hazardous materials" in Section 4 of GC 109 [Ref 82.N].

9.99 Spillages of surface protection system products shall be contained and cleaned up in accordance with the manufacturer's instructions and the method statement.

9.100 The following Documentation for spillages of surface protection system products shall be submitted as continuous records: notification of spillages of surface protection system products.

9.101 The requirements of "Records" in Section 3 of GC 101 [Ref 44.N] shall apply to the notification of spillages of surface protection system products.

9.102 Spillages of surface protection system product shall be notified to any authority from which consent for the use of the surface protection system has been sought in accordance with CC 482/WSR/009.

Substrate preparation prior to application of surface protection systems for structural concrete

9.103 The concrete substrate shall be cleaned and prepared in accordance with the manufacturer’s instructions, BS EN 1504-10 [Ref 71.N]and the method statement.

9.104 Prior to the application of the surface protection system products, the concrete substrate shall be free from air gaps, cracks, delamination and spalls which might impair the application of the product and its coverage of the substrate.

9.105 Any concrete repairs to defects to the concrete substrate prior to the application of the surface protection system products shall comply with "Concrete repairs - general requirements" in Section 4 of CC 484 [Ref 22.N].

9.106 Prior to the application of the surface protection system products, the concrete substrate shall be free from dust, dirt, oil, laitance and curing agents which might affect the adhesion of the product to the substrate.

9.107 When the concrete substrate has been cleaned from contaminants it shall be protected from further contamination prior to the application of the surface protection system products.

9.108 Prior to the application of hydrophobic impregnation products, artificial drying of the concrete surface that has become wet following adverse weather shall not be permitted due to the risk of increased moisture at the surface by capillary action from within the concrete when the drying equipment is removed.

Refractive index testing of hydrophobic impregnation products for structural concrete prior to installation

9.109 Verification shall be undertaken for liquid hydrophobic impregnation products by measuring, using a portable refractometer, the temperature and the refractive index of hydrophobic impregnation product samples and checking, after correction of the refractive index measurements to the reference temperature stated in the manufacturer's product information, that the corrected refractive index is within 0.003 units of the refractive index stated in the manufacturer's product information.

9.110 The frequency of refractive index testing of liquid hydrophobic impregnation products shall be once for each working day of application of hydrophobic impregnation product, on 3 samples taken from each container of hydrophobic impregnation product and 3 samples taken from the spraying nozzle prior to the application of the hydrophobic impregnation product into the works.

9.111 The requirements for "Verification" in Section 14 of GC 101 [Ref 44.N] shall apply to the refractive index testing of liquid hydrophobic impregnation products.

9.112 The portable refractometer used for the refractive index testing shall have the capability for automatic temperature compensation.

9.113 The following Documentation for liquid hydrophobic impregnation products shall be submitted as continuous records: test report for refractive index testing of liquid hydrophobic impregnation products.

9.114 The requirements of "Records" in Section 3 of GC 101 [Ref 44.N] shall apply to the test report for refractive index testing of liquid transparent hydrophobic impregnation products.

Application of surface protection systems for structural concrete

9.115 The application of surface protection systems for structural concrete shall be undertaken in accordance with the manufacturer's instructions, BS EN 1504-10 [Ref 71.N]and the method statement.

9.116 The quantity of each surface protection system product for application on each structural element and/or its part shall be determined in accordance with the manufacturer's instructions in relation to the surface area being treated.

9.117 The application of surface protection systems shall not result in areas of omission of the surface protection system products on the concrete substrate.

9.118 The application of surface protection system products shall be undertaken:.

1. Prior to the manufacturer's stated expiration date for the products; and

2. Within the time limits of the open pot life of the product in accordance with the manufacturer's instructions, after any containers containing the products have been opened

9.119 The application of surface protection system products shall not be undertaken earlier than:.

1. 7 days after placing of fresh concrete for the structural element and/or its part subject to the application of surface protection systems

2. 3 days after completion of any concrete repairs to the structural element and/or its part subject to the application of surface protection systems

9.120 Unless otherwise stated in the manufacturer’s instructions, the application of surface protection system products shall not be undertaken when:.

1. The temperature of the concrete surface is lower than 5°C or greater than 25°C; and

2. The shade temperature is below 5°C or less than 3°C above the dew point as determined in relation to ambient humidity in accordance with BS EN 1504-10 [Ref 71.N].

9.121 Hydrophobic impregnation products shall not be applied until the concrete surface has been dry for 24 hours following precipitation, splash or spray.

9.122 Unless otherwise stated in the manufacturer's instructions, the application of spray-applied hydrophobic impregnation products shall not be undertaken when the wind speed is in excess of 8 km/h, unless the working area is fully encapsulated.

9.123 Concrete surfaces to be treated with hydrophobic impregnation shall be protected from precipitation, splash and spray in accordance with the manufacturer's instructions during the application of the hydrophobic impregnation.

9.124 Verification shall be undertaken for the ambient conditions prior to the application of surface protection systems for structural concrete by measuring shade temperature, temperature of concrete surface, ambient humidity, wind velocity and dew point in accordance with BS EN 1504-10 [Ref 71.N]and checking that the application of the surface protection systems is not undertaken if the ambient conditions are not within the limits permitted in "Surface protection systems for structural concrete" in Section 9 of this document.

9.125 The frequency of measurement of the ambient conditions prior to the application of surface protection systems for structural concrete shall be once, prior to each working shift for the application of surface protection systems.

9.126 The requirements for "Verification" in Section 14 of GC 101 [Ref 44.N] shall apply to the measurement of the ambient conditions prior to the application of surface protection systems.

9.127 The following Documentation for measurement of the ambient conditions prior to the application of surface protection systems for structural concrete shall be submitted as continuous records: written records of the measurement of the ambient conditions prior to the application of surface protection systems for structural concrete.

9.128 The requirements of "Records" in Section 3 of GC 101 [Ref 44.N] shall apply to the written records of the measurement of the ambient conditions prior to the application of surface protection systems for structural concrete.

9.129 Prior to the application of hydrophobic impregnation products, protective measures shall be implemented to prevent contamination of watercourses and sensitive areas, harm to humans, animals and vegetation and to prevent damage to bearings, painted steel surfaces, bituminous materials, joint sealants and vehicles due to slippery road or rail surfaces caused by contamination with hydrophobic impregnation products.

9.130 The application of hydrophobic impregnation products to the face of the structural element and/or its part shall be undertaken in a single continuous operation to ensure that the hydrophobic impregnation application covers the entire face of the structural element, unless otherwise stated in CC 482/WSR/009.

9.131 Control measures on the extent of application of hydrophobic impregnation products when the application to the face of the structural element and/or its part is undertaken as a non-continuous operation shall be in accordance with CC 482/WSR/009.

9.132 Where fugitive dyes are specified in CC 482/WSR/009 as a control measure of the extent of the application of hydrophobic impregnation, they shall be compatible with the hydrophobic impregnation product they are used together with.

9.133 Fugitive dyes used during the application of hydrophobic impregnation products shall become colourless within 28 days from the application of the hydrophobic impregnation product to the concrete surface of the structural element and/or its part.

9.134 Site specific protective and control measures for the application of hydrophobic impregnation shall be as specified in CC 482/WSR/009.

Site specific protective and control measures for the application of hydrophobic impregnation

Structure ID	Structural element reference	Description of structural element	Drawing/ model reference(s)	Site specific protective measures requirements for the application of hydrophobic impregnation	Non-continuous operation for the application of hydrophobic impregnation to the face of the element permitted	Requirements for control measures on the extent of application for non-continuous hydrophobic impregnation to the face of the element (where applicable)
(a)	(b)	(c)	(d)	(e)	(f)	(g)

1. Enter a unique reference.

2. Enter a unique reference, to identify the structural element reference.

3. Enter text, to describe the structural element and/or its part subject to the application of hydrophobic impregnation.

4. Enter a unique reference, to provide reference of drawing(s) or model(s) where the structural element and/or its part subject to the application of hydrophobic impregnation and any neighbouring affected features are shown, which include details of any protective and control measures for the application of hydrophobic impregnation.

5. Enter text, to identify the requirements for protective measures to be implemented, such as complete encapsulation, protective sheeting and traffic management, for the application of hydrophobic impregnation to the structural element and/or its part subject to hydrophobic impregnation and any neighbouring affected features.

6. Enter a value, from options yes, no, to identity whether the application of the hydrophobic impregnation product to a face of the structural element and/or its part is permitted to be undertaken in a non-continuous operation, where this is required to suit site specific constraints.

7. Enter text, to identify the control measures required to demonstrate the adequacy of the extent of the application of hydrophobic impregnation to the face of the structural element and/or its part when this is undertaken as a non-continuous operation, such as the use of temporary markers, fugitive dyes or specification of a minimum overlap length onto the previous working shift's application of the hydrophobic impregnation.

9.135 Verification shall be undertaken for the application of hydrophobic impregnation products, when liquid hydrophobic impregnation products are used, by measuring the actual quantity of liquid hydrophobic impregnation product applied to the structural element and/or its part and comparing it against the quantity determined in accordance with the manufacturer's instructions.

9.136 The frequency of measurement of the quantity of liquid hydrophobic impregnation product applied to the structural element and/or its part shall be once after the application of hydrophobic impregnation to each structural element and/or its part, but no less than once for each working shift.

9.137 The requirements for "Verification" in Section 14 of GC 101 [Ref 44.N] shall apply to the measurement of the quantity of liquid hydrophobic impregnation product applied to each structural element and/or its part.

9.138 Verification shall be undertaken for the application of hydrophobic impregnation products, when gel or cream hydrophobic impregnation products are used, by measuring the wet-film thickness of the gel or cream hydrophobic impregnation product applied to the structural element and/or its part using a gauge in accordance with method 1A, 1B or 1C of BS EN ISO 2808 [Ref 58.N], calculating the resulting quantity of product applied and comparing it against the quantity determined in accordance with the manufacturer's instructions.

9.139 The frequency of measurement of the wet-film thickness of gel or cream hydrophobic impregnation product applied to the structural element and/or its part shall be once, with gauge readings taken at three different locations within each element, after the application of hydrophobic impregnation to each structural element and/or its part, but no less than once per each working shift.

9.140 The requirements for "Verification" in Section 14 of GC 101 [Ref 44.N] shall apply to the measurement of the wet-film thickness of gel or cream hydrophobic impregnation product applied to each structural element and/or its part.

9.141 The following Documentation for the application of liquid or gel/cream hydrophobic impregnation products shall be submitted as

continuous records: record of the actual measured quantity of liquid hydrophobic impregnation product applied against the quantity determined in accordance with the manufacturer's instructions; record of the wet-film thickness and resulting actual measured quantity of gel or cream hydrophobic impregnation product applied against the quantity determined in accordance with the manufacturer's instructions.

9.142 The requirements of "Records" in Section 3 of GC 101 [Ref 44.N] shall apply to the records of measured and determined quantities of hydrophobic impregnation products.

9.143 Verification shall be undertaken for the application of hydrophobic impregnation to the face of the structural element and/or its part, when hydrophobic impregnation is specified in CC 482/WSR/009 and the application is undertaken as a non-continuous operation, by visually inspecting the face of the structural element and/or its part and checking that there are no areas left untreated.

9.144 The frequency of inspection of the face of the structural element and/or its part when the application of the hydrophobic impregnation is undertaken as a non-continuous operation shall be once after the application of the hydrophobic impregnation to each face of the structural element and/or its part, but no less than once per each working shift.

9.145 The requirements for "Verification" in Section 14 of GC 101 [Ref 44.N] shall apply to the inspection of the face of the structural element and/or its part when the application of the hydrophobic impregnation is undertaken as a non-continuous operation.

9.146 The following Documentation for the application of hydrophobic impregnation to the face of a structural element and/or its part when the application is undertaken as a non-continuous operation shall be submitted as continuous records: inspection record for the application of hydrophobic impregnation to the face of the structural element and/or its part.

9.147 The requirements of "Records" in Section 3 of GC 101 [Ref 44.N] shall apply to the inspection record for the application of hydrophobic impregnation to the face of the structural element and/or its part.

9.148 When areas of a structural element and/or its part subject to hydrophobic impregnation are found to have been left untreated following inspection of the face of the structural element and/or its part, hydrophobic impregnation shall be applied to those areas in accordance with the manufacturer's instructions, BS EN 1504-10 [Ref 71.N]and the method statement.

9.149 Verification shall be undertaken for the application of anti-graffiti and/or anti-carbonation coatings, when anti-graffiti and/or anti-

carbonation coatings are specified in CC 482/WSR/009, by measuring the wet-film thickness of the anti-graffiti and/or anti-carbonation coating applied to the structural element and/or its part using a gauge in accordance with method 1A, 1B or 1C of BS EN ISO 2808 [Ref 58.N]and checking that the measured coating thickness is no less than the minimum thickness required for the coating in the manufacturer's instructions.

9.150 The frequency of measurement of the wet-film thickness of the anti-graffiti and/or anti-carbonation coating applied to the structural element and/or its part shall be once, with gauge readings taken at three different locations within each element, after the application of the anti-graffiti and/or anti-carbonation coating to each structural element and/or its part, but no less than once per each working shift.

9.151 The requirements for "Verification" in Section 14 of GC 101 [Ref 44.N] shall apply to the measurement of the wet-film thickness of the anti-graffiti and/or anti-carbonation coating applied to the structural element and/or its part.

9.152 The following Documentation for the application of anti-graffiti and/or anti-carbonation coatings shall be submitted as continuous records: record of the wet-film thickness measurements for the anti-graffiti and/or anti-carbonation coating applied to the structural element and/or its part.

9.153 The requirements of "Records" in Section 3 of GC 101 [Ref 44.N] shall apply to the record of the wet-film thickness measurements for the anti-graffiti and/or anti-carbonation coatings applied to the structural element and/or its part.

9.154 Concrete surfaces treated with hydrophobic impregnation shall be protected from precipitation, splash and spray in accordance with the manufacturer's instructions for the greater duration of six hours after completion of the application of the hydrophobic impregnation or any duration stated in the manufacturer's instructions.

9.155 Concrete surfaces treated with anti-graffiti and anti-carbonation coatings shall be protected to prevent early and irreparable defacement in accordance with the manufacturer’s instructions for the greater duration of 5 days after application of the final coat or any duration stated in the manufacturer's instruction.

9.156 The following Documentation for all surface protection systems applied to structural concrete shall be submitted as continuous records: report with records of application of the surface protection systems to structural concrete.

9.157 The requirements of "Records" in Section 3 of GC 101 [Ref 44.N] shall apply to the report with records of application of the surface protection systems to structural concrete.

9.158 The report with records of application of the surface protection systems to structural concrete shall be in accordance with CG 302 [Ref 7.N] and incorporate the following information:.

1. The extents of application of the surface protection systems
2. Date of application
3. Technical literature, including health and safety data sheets, related to the products used
4. Whether rigid or flexible/crack bridging coatings are used
5. Crack bridging class for any crack-bridging anti-carbonation coating used
6. Where used, the type of anti-graffiti coating, either sacrificial or non-sacrificial
7. Application method for each product used
8. Inspection, measurement and test findings
9. Amount of materials used
10. Number of applications undertaken for each product on each structural element
11. Coverage rate for each application
12. Weather conditions during application
13. Maintenance requirements
14. Removal requirements

10. 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.	**Document**
Ref 1.N	BSI. BS EN 934-4, 'Admixtures for concrete, mortar and grout. Admixtures for grout for prestressing tendons. Definitions, requirements, conformity, marking and labelling (Designated Standard - CPR)'
Ref 2.N	BSI. BS EN 934-1, 'Admixtures for concrete, mortar and grout. Common requirements'
Ref 3.N	BSI. BS EN 934-2, 'Admixtures for concrete, mortar and grout. Concrete admixtures. Definitions, requirements, conformity, marking and labelling (Designated Standard - CPR)'
Ref 4.N	BSI. BS EN 12620, 'Aggregates for concrete (Designated Standard - CPR)' , 2002+A1:2008
Ref 5.N	BSI. PD 6682-1, 'Aggregates. Aggregates for concrete. Guidance on the use of BS EN 12620'
Ref 6.N	BSI. PD 6682-4, 'Aggregates. Lightweight aggregates for concrete, mortar and grout. Guidance on the use of BS EN 13055-1'
Ref 7.N	National Highways. CG 302, 'As-built, operational and maintenance records for highway structures'
Ref 8.N	National Highways. CD 357, 'Bridge expansion joints'
Ref 9.N	National Highways. CC 490 'Bridge expansion joints and sealing of gaps [Series 2300]'
Ref 10.N	The International Federation for Structural Concrete (FIB). FIB Bulletin 33, 'Bulletin 33: Durability of post-tensioning tendons'
Ref 11.N	The International Federation for Structural Concrete (FIB). FIB Bulletin 75, 'Bulletin 75: Polymer-duct systems for internal bonded post-tensioning'
Ref 12.N	The International Federation for Structural Concrete (FIB). FIB Bulletin 97, 'Bulletin 97: External Tendons for Bridges'
Ref 13.N	National Highways. CD 370, 'Cathodic protection for use in reinforced concrete structures.'

Ref 14.N	BSI. BS EN 197-1, 'Cement. Composition, specifications and conformity criteria for common cements. (Designated Standard - CPR)'
Ref 15.N	BSI. BS EN 14216, 'Cement. Composition, specifications and conformity criteria for very low heat special cements'
Ref 16.N	BSI. BS EN 197-5, 'Cement. Portland-composite cement CEM II/C-M and Composite cement CEM VI'
Ref 17.N	British Standards Institution. BS EN 10045-1, 'Charpy impact test on metallic materials. Test method (V- and U-notches)' , 1990
Ref 18.N	BSI. BS 5975, 'Code of practice for temporary works procedures and the permissible stress design of falsework.'
Ref 19.N	BSI. BS 8539, 'Code of practice for the selection and installation of post-installed anchors in concrete and masonry'
Ref 20.N	BSI. BS EN 13369, 'Common rules for precast concrete products'
Ref 21.N	BSI. BS EN 206, 'Concrete - specification, performance, production and conformity'
Ref 22.N	National Highways. CC 484, 'Concrete Repairs'
Ref 23.N	BSI. BS 8500-1, 'Concrete. Complementary British Standard to BS EN 206. Method of specifying and guidance for the specifier.'
Ref 24.N	BSI. BS 8500-2, 'Concrete. Complementary British Standard to BS EN 206. Specification for constituent materials and concrete.'
Ref 25.N	BSI. BS EN ISO/IEC 17021-1, 'Conformity assessment. Requirements for bodies providing audit and certification of management systems. Requirements [Designated Standard - NLF]'
Ref 26.N	National Highways. CD 366, 'Design criteria for collision protection beams'
Ref 27.N	National Highways. CD 353, 'Design criteria for footbridges'
Ref 28.N	EOTA. TR 082, 'Design of bonded fasteners in concrete under fire conditions'
Ref 29.N	National Highways. CD 356, 'Design of highway structures for hydraulic action'
Ref 30.N	National Highways. CD 354, 'Design of minor structures'

Ref 31.N	National Highways. CD 372, 'Design of post-installed anchors and reinforcing bar connections in concrete'
Ref 32.N	National Highways. CD 359, 'Design requirements for permanent soffit formwork'
Ref 33.N	National Highways. CD 363, 'Design rules for aerodynamic effects on bridges'
Ref 34.N	BSI. BS EN 1992-4, 'Eurocode 2: Design of concrete structures. Design of fastenings for use in concrete'
Ref 35.N	BSI. BS EN 1992-1-1, 'Eurocode 2: Design of concrete structures. General rules and rules for buildings'
Ref 36.N	BSI. BS EN 1992-1-2, 'Eurocode 2: Design of concrete structures.General rules - Structural fire design '
Ref 37.N	BSI. BS EN 1993-1-4, 'Eurocode 3: Design of steel structures. General rules — Supplementary rules for stainless steels.'
Ref 38.N	BSI. BS EN 13670, 'Execution of concrete structures'
Ref 39.N	BSI. BS EN 12812, 'Falsework. Performance requirements and general design.'
Ref 40.N	BSI. BS EN 14889-2, 'Fibres for concrete. Polymer fibres. Definitions, specifications and conformity [Designated standard - CPR] '
Ref 41.N	BSI. BS EN 14889-1, 'Fibres for concrete. Steel fibres. Definitions, specifications and conformity [Designated standard - CPR] '
Ref 42.N	BSI. BS EN 450-1, 'Fly ash for concrete - Definitions, specifications and conformity criteria (Designated Standard - CPR)'
Ref 43.N	CD 364, 'Formation of Continuity Joints in Bridge Decks'
Ref 44.N	National Highways. GC 101, 'General requirements for the Specification for Highway Works'
Ref 45.N	BSI. BS EN 15167-1, 'Ground granulated blast furnace slag for use in concrete, mortar and grout. Definitions, specifications and conformity criteria (Designated Standard - CPR)'
Ref 46.N	BSI. BS EN 446, 'Grout for prestressing tendons. Grouting procedure'

Ref 47.N	BSI. BS EN 445, 'Grout for prestressing tendons. Test methods'
Ref 48.N	BSI. BS EN 447, 'Grouting for prestressing tendons. Basic requirements'
Ref 49.N	Construction Fixings Association. CFA (Construction fixings), 'Guidance Note: Procedure for site testing construction fixings'
Ref 50.N	BSI. BS 5896, 'High tensile steel wire and strand for the prestressing of concrete. Specification'
Ref 51.N	National Highways. CD 373, 'Impregnation of reinforced and prestressed concrete highway structures using hydrophobic impregnants'
Ref 52.N	BSI. BS EN 13055-1, 'Lightweight aggregates. Lightweight aggregates for concrete, mortar and grout (Designated Standard - CPR)' , 2002
Ref 53.N	BSI. BS EN 196-9, 'Methods of testing cement. Heat of hydration. Semi-adiabatic method'
Ref 54.N	BSI. BS EN 196-8, 'Methods of testing cement. Heat of hydration. Solution method'
Ref 55.N	National Highways. CC 495 'Miscellaneous'
Ref 56.N	BSI. BS EN 1008, 'Mixing water for concrete. Specification for sampling, testing and assessing the suitability of water, including water recovered from processes in the concrete industry, as mixing water for concrete.'
Ref 57.N	National Highways. CS 464, 'Non-destructive testing of highways structures'
Ref 58.N	BSI. BS EN ISO 2808, 'Paints and varnishes. Determination of film thickness'
Ref 59.N	Transport Research Laboratory. A J J Calder, M McKenzie. TRL PPR 362, 'Performance of impregnants'
Ref 60.N	BSI. BS EN 12878, 'Pigments for the colouring of building materials based on cement and/or lime. Specifications and methods of test (Designated Standard - CPR)' , 2005
Ref 61.N	National Highways. CD 365, 'Portal and cantilever signs/signals gantries'
Ref 62.N	EOTA. EAD 160004-00-0301, 'Post-tensioning kits for prestressing of structures [EAD & UKAD]'
Ref 63.N	BSI. BS EN 14844, 'Precast concrete products. Box culverts

	(Designated Standard - CPR)'
Ref 64.N	BSI. BS EN 15050, 'Precast concrete products. Bridge elements. (Designated Standard - CPR)'
Ref 65.N	BSI. BS EN 12843, 'Precast concrete products. Masts and poles (Designated Standard - CPR)'
Ref 66.N	BSI. BS EN 15258, 'Precast concrete products. Retaining wall elements (Designated Standard - CPR)'
Ref 67.N	BSI. BS EN ISO 8501-1, 'Preparation of steel substrates before application of paints and related products. Visual assessment of surface cleanliness. Rust grades and preparation grades of uncoated steel substrates and of steel substrates after removal of previous coatings'
Ref 68.N	BSI. BS EN 12614, 'Products and systems for the protection and repair of concrete structures - Test methods - Determination of glass transition temperatures of polymers'
Ref 69.N	BSI. BS EN 12190, 'Products and systems for the protection and repair of concrete structures - Test methods - Determination of compressive strength of repair mortar'
Ref 70.N	BSI. BS EN 1504-8, 'Products and systems for the protection and repair of concrete structures. Definitions, requirements, quality control and AVCP. Quality control and Assessment and verification of the constancy of performance (AVCP)'
Ref 71.N	BSI. BS EN 1504-10, 'Products and systems for the protection and repair of concrete structures. Definitions, requirements, quality control and evaluation of conformity. Site application of products and systems and quality control of the works'
Ref 72.N	BSI. BS EN 1504-4, 'Products and systems for the protection and repair of concrete structures. Definitions, requirements, quality control and evaluation of conformity. Structural bonding (Designated Standard - CPR)'
Ref 73.N	BSI. BS EN 1504-2, 'Products and systems for the protection and repair of concrete structures. Definitions, requirements, quality control and evaluation of conformity. Surface protection systems for concrete (Designated Standard - CPR)'
Ref 74.N	BSI. BS EN 12636, 'Products and systems for the protection and repair of concrete structures. Test methods. Determination of adhesion concrete to concrete'
Ref 75.N	BSI. BS EN 12615, 'Products and systems for the protection and repair of concrete structures. Test methods.

	Determination of slant shear strength'
Ref 76.N	BSI. BS EN 1542, 'Products and systems for the protection and repair of concrete structures. Test methods. Measurement of bond strength by pull-off'
Ref 77.N	BSI. BS EN 1766, 'Products and systems for the protection and repair of concrete structures. Test methods. Reference concretes for testing'
Ref 78.N	National Highways. CC 486 'Protection of steelwork against corrosion [Series 1900]'
Ref 79.N	National Highways. CD 377, 'Requirements for road restraint systems'
Ref 80.N	BSI. BS 8666, 'Scheduling, dimensioning, bending and cutting of steel, reinforcement for concrete. Specification'
Ref 81.N	BSI. BS EN 13263-1, 'Silica fume for concrete. Definitions, requirements and conformity criteria'
Ref 82.N	National Highways. GC 109 'Site Preparation and Clearance [Series 200]'
Ref 83.N	BSI. BS 7973-2, 'Spacers and chairs for steel reinforcement and their specification - Fixing and application of spacers and chairs and tying of Reinforcement'
Ref 84.N	BSI. BS 7973-1, 'Spacers and chairs for steel reinforcement and their specification - Product performance requirements'
Ref 85.N	EOTA. EAD 160027-00-0301, 'Special filling products for post-tensioning kits [EAD & UKAD]'
Ref 86.N	BSI. BS 8443, 'Specification for establishing the suitability of special purpose concrete admixtures'
Ref 87.N	BSI. BS 4486, 'Specification for hot rolled and hot rolled and processed high tensile alloy steel bars for the prestressing of concrete'
Ref 88.N	BSI. BS 7979, 'Specification for limestone fines for use with Portland cement '
Ref 89.N	BSI. BS 8615-2, 'Specification for pozzolanic materials for use with Portland cement. High reactivity natural calcined pozzolana'
Ref 90.N	BSI. BS 8615-1, 'Specification for pozzolanic materials for use with Portland cement. Natural pozzolana and natural calcined pozzolana'
Ref 91.N	BSI. BS 6744, 'Stainless steel bars for the reinforcement of

	and use in concrete, – Requirements and test methods'
Ref 92.N	BSI. BS EN 10088-1, 'Stainless steels. List of stainless steels'
Ref 93.N	BSI. BS EN 10088-5, 'Stainless steels. Technical delivery conditions for bars, rods, wire, sections and bright products of corrosion resisting steels for construction purposes (Designated Standard - CPR)'
Ref 94.N	American Society for Testing and Materials. ASTM A853, 'Standard Specification for Steel Wire, Carbon, for General Use'
Ref 95.N	BSI. BS 4483, 'Steel fabric for the reinforcement of concrete. Specification'
Ref 96.N	BSI. BS EN ISO 15630-3, 'Steel for the reinforcement and prestressing of concrete. Test methods. Prestressing steel'
Ref 97.N	BSI. BS 4449, 'Steel for the reinforcement of concrete. Weldable reinforcing steel. Bar, coil and decoiled product. Specification'
Ref 98.N	BSI. BS EN 10080, 'Steel for the reinforcement of concrete. Weldable reinforcing steel. General'
Ref 99.N	BSI. BS 4482, 'Steel wire for the reinforcement of concrete products. Specification'
Ref 100.N	BSI. BS ISO 10144, 'Steels for the reinforcement and prestressing of concrete. Certification scheme for steel bars and wires'
Ref 101.N	BSI. BS 8597, 'Steels for the reinforcement of concrete. Reinforcement couplers. Requirements and test methods'
Ref 102.N	National Highways. CD 371, 'Strengthening highway structures using fibre-reinforced polymers and externally bonded steel plates'
Ref 103.N	National Highways. CD 369, 'Surface protection for concrete highway structures'
Ref 104.N	BSI. BS EN 10002-1, 'Tensile testing of metallic materials. Method of test at ambient temperature'
Ref 105.N	BSI. BS EN 12504-1, 'Testing concrete in structures. Cored specimens. Taking, examining and testing in compression.'
Ref 106.N	BSI. BS 1881-124, 'Testing Concrete: Methods for Analysis of Hardened Concrete '
Ref 107.N	BSI. BS EN 12350-7, 'Testing fresh concrete. Air content.

	Pressure methods'
Ref 108.N	BSI. BS EN 12350-4, 'Testing fresh concrete. Degree of compactability'
Ref 109.N	BSI. BS EN 12350-5, 'Testing fresh concrete. Flow table test'
Ref 110.N	BSI. BS EN 12350-8 , 'Testing fresh concrete. Self-compacting concrete - Slump-flow test'
Ref 111.N	BSI. BS EN 12350-12, 'Testing fresh concrete. Self-compacting concrete. J-ring test'
Ref 112.N	BSI. BS EN 12350-10, 'Testing fresh concrete. Self-compacting concrete. L box test'
Ref 113.N	BSI. BS EN 12350-11, 'Testing fresh concrete. Self-compacting concrete. Sieve segregation test'
Ref 114.N	BSI. BS EN 12350-9, 'Testing fresh concrete. Self-compacting concrete. V-funnel test'
Ref 115.N	BSI. BS EN 12350-2, 'Testing fresh concrete. Slump test '
Ref 116.N	BSI. BS EN 12390-3, 'Testing hardened concrete. Compressive strength of test specimens'
Ref 117.N	BSI. BS EN 12390-13, 'Testing hardened concrete. Determination of secant modulus of elasticity in compression'
Ref 118.N	BSI. BS EN 12390-2, 'Testing hardened concrete. Making and curing specimens for strength tests'
Ref 119.N	National Highways. CD 351, 'The design and appearance of highway structures'
Ref 120.N	National Highways. CD 350, 'The design of highway structures'
Ref 121.N	National Highways. CD 374, 'The use of recycled aggregates in structural concrete'
Ref 122.N	National Highways. CD 367, 'Treatment of existing structures on highways widening schemes'
Ref 123.N	BSI. NA to BS EN 1992-1-1, 'UK National Annex to Eurocode 2: Design of concrete structures Part 1-1: General rules and rules for buildings'
Ref 124.N	National Highways. CD 360, 'Use of compressive membrane action in bridge decks'
Ref 125.N	National Highways. CD 358, 'Waterproofing and surfacing of

	concrete bridge decks'
Ref 126.N	National Highways. CC 488, 'Waterproofing for concrete structures'
Ref 127.N	Waste and Resources Action Programme. WRAP Quality Protocol, 'WRAP Quality Protocol: Aggregates from inert waste. End of waste criteria for the production and use of aggregates from inert waste'