The CARES Guide to Product Certification

Part 5
2024

Standards, Codes and **Regulations**

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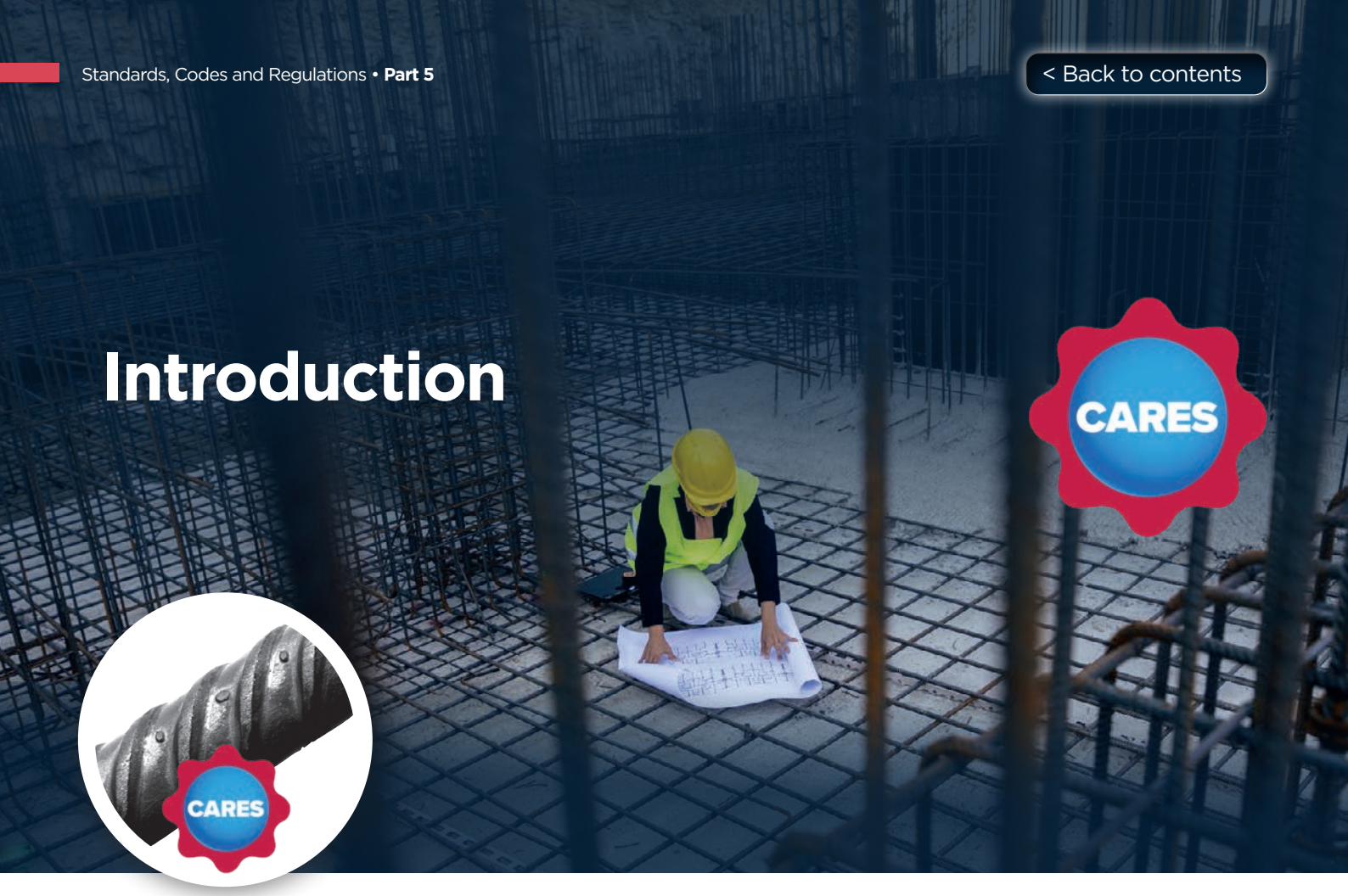
Introduction



The production of a European standard for reinforcing steels began in 1988 and continues to this day (February 2024). The key stumbling block to bringing this to fruition has been the inability to agree a common set of steel grades. The process was further interrupted by the requirement for the European standards committee to account for the requirements placed upon it by the Construction Products Regulation, which included the requirements for the application of the CE Marking and the associated certification.

Concrete design code, Eurocode 2, was published in 2004 and provides the design specification for European product standards. At the time of writing the 2nd generation Eurocode 2 (EN1992-1-1:2023) had just been published, and the UK National Annex was was not available. BSI have indicated that EC2 : 2004 will remain the applicable standard until it is withdrawn in March 2028. Therefore the detail of this Guide is concerned with the 2004 version, with only the principal changes in the 2023 version noted.

This Guide describes the current position in the UK regarding the concrete design code and the reinforcing product standards.

Design

Eurocode 2, the design code for structural concrete, was introduced into the UK in 2005 and superseded BS 8110 (BS 5400, Part 4 and BS 8007) and associated standards. The Eurocode adopts the principal of Nationally determined parameters, which allow national bodies to vary certain parameters, the decision on these parameters is included in a National Annex for the specific Eurocode.

The Eurocodes have been produced by CEN (Comité Européen de Normalisation), which BSI is a member of. This membership was not affected by Brexit. Under CEN rules, all National codes that conflict with the Eurocodes needed to be withdrawn by 2010. In the UK the Eurocodes are published by BSI who also publish the accompanying National Annex.

Whilst standard development work continues on hEN 10080, for carbon steel reinforcement and EN 10370 for stainless steel reinforcement, until such time as harmonised version of these standards exist the relevant standards in the UK for carbon steel will remain as BS 4449, BS 4483, BS 8666, for carbon steel and BS 6744 for stainless steel. This is stated in the National Annex to Eurocode.

Eurocode 2: Concrete

Eurocode '2' and 'EC2' are both abbreviations for BS EN 1992, Eurocode 2: Design of concrete structures.

Eurocode 2 has four parts:

- BS EN 1992-1-1:2004 - Design of concrete structures. General rules and rules for buildings
- BS EN 1992-1-2:2004 - Design of concrete structures. General rules. Structural fire design
- BS EN 1992-2:2005 - Design of concrete structures. Concrete bridges. Design and detailing rules
- BS EN 1992-3:2006 - Design of concrete structures. Liquid retaining and containing structures

When referring to Eurocode 2, most people mean BS EN 1992-1-1 General rules and rules for buildings.
Eurocode 2 Part 1-1 gives a general basis for the design of structures in plain, reinforced and prestressed concrete, while Part 1-2 deals with the design of concrete structures for the accidental situation of fire exposure. Part 2 gives a general basis for the design and detailing of bridges in reinforced and prestressed concrete. Finally, Part 3 covers additional rules for the design of concrete structures for the containment of liquids or granular solids and other liquid retaining structures.

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Note: It should be noted that hEN 10080, Steel for the reinforcement of concrete - Weldable reinforcing steel- General" is not expected to be published before 2025.

All Eurocodes follow a common editorial style and use the word "shall" for clauses that must be strictly followed, "should" for highly recommended actions where alternative approaches are only possible if technically justifiable, and "may" clause which effectively give a permission but other methods of satisfying the clause are possible.

Eurocode 2 is intended to be used in conjunction with:

- EN 1990: Eurocode - Basis of structural design;
- EN 1991: Eurocode 1 - Actions on structures;
- hENs, ETAGs and ETAs: Construction products relevant for concrete structures;
- ENV 13670: Execution of concrete structures;
- EN 1997: Eurocode 7 - Geotechnical design;
- EN 1998: Eurocode 8 - Design of structures for earthquake resistance, when concrete structures are built in seismic regions.

In the revised Eurocode parts 2 and 3 will be incorporated into Part 1-1.

Structure of EC2:2004

All Eurocodes follow a common editorial style and use the word "shall" for clauses that must be strictly followed, "should" for highly recommended actions where alternative approaches are only possible if technically justifiable, and "may" clause which effectively give a permission but other methods of satisfying the clause are possible. In the current Eurocode 2 these principles are broadly followed, however they will be explicitly stated in the revised Eurocodes.

Each Eurocode gives values with notes indicating where national choice may have to be made. These are recorded in the National Annex for each Member State as Nationally Determined Parameters (NDPs).

Each Eurocode may have a number of Annexes which can be Normative or Informative. The Normative Annexes must be considered to be part of the code for which there is no alternative. EC2 Part 1-1 contains a Normative Annex C, Properties of reinforcement suitable for use with this Eurocode (see Table 1).

Table 1. Properties of Reinforcement.

Product form	Bars and de-coiled rods			Wire Fabrics		
Class	A	B	C	A	B	C
Characteristic yield strength f_{yk} or $f_{0,2k}$ (MPa)	400 to 600					
Minimum value of k = $(f_t/f_y)_k$	≥1.05	≥1.08	≥1.15 ≥1.35	≥1.05	≥1.08	≥1.15 ≥1.35
Characteristic strain at maximum force, ε_{uk} (%)	≥2.5	≥5.0	≥7.5	≥2.5	≥5.0	≥7.5

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Implications of the revision to EC 2:2004

- EC2 permits a range of yield strengths from 400 to 600 MPa, although this range is not currently utilised in the UK where a yield strength of 500 MPa, is used. In the revised Eurocode the range will increase to allow yield strengths up to 700 MPa, it is likely that whilst still recommending 500 MPa for typical design the UK National Annex (NA) will allow design to higher strengths where availability exists. The partial safety factor for reinforcement in EC2 is set at present, in the UK National Annex, to 1.15, however PD 6687-1 gives some guidance on when lower values may be used.

- Class C reinforcement with, greater specified ductility (characteristic strain at maximum force, ε_{uk}) and tensile strength, f_t, is also available in the UK. Whilst design to the current version of Eurocode 2 offers only very limited benefits for using this type of reinforcement over the more typical ductility grade B reinforcement, the new Eurocode 2 will provide additional advantages. Similarly, there will be further disbenefits in using grade A reinforcement.

- EC2 allows both a bilinear stress strain relationship with no limit on reinforcement strain or an increase in the design strength with a limit on strain as shown in Figure 2.

- A distinction is made between hot rolled and cold worked steel as shown in Figure 3. The Tabulated data method of EC2, Part 1-2, "General rules – Structural Fire Design", requires the hogging tension reinforcement over intermediated supports in continuous solid slabs to be $\geq 0.005A_c$ for cold worked steel. Unfortunately, the processing route is not a specification item to BS 4449 so unless specific information on the reinforcement is available design should adopt the more conservative rules.

- If Class A reinforcement is used then restrictions are placed on the redistribution of moments permitted for continuous beams and slabs. The use of Class A reinforcement is not recommended for plastic analysis.

- For ductility Class C reinforcement the maximum actual yield stress, $f_{y,max}$, should not exceed $1.35f_{yk}$. This equates to 675 **MPa** for a Grade 500 reinforcing steel.

- The use of plain mild steel is not included in the current version of Eurocode 2 but compatible rules for its use are given in PD 6687-1. The revised version of Eurocode 2 includes an annex on appraisal of structures, and this includes plain bars.

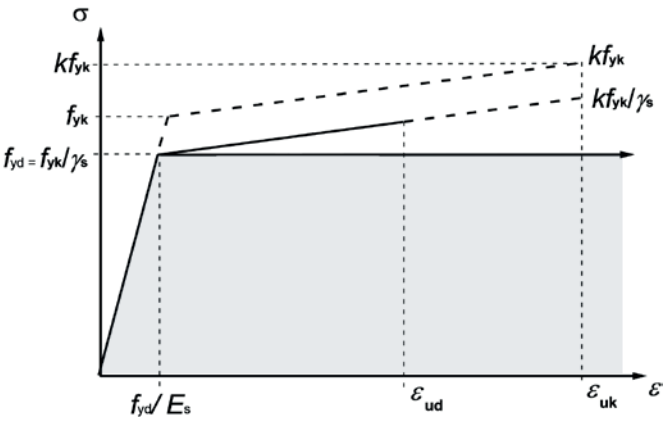
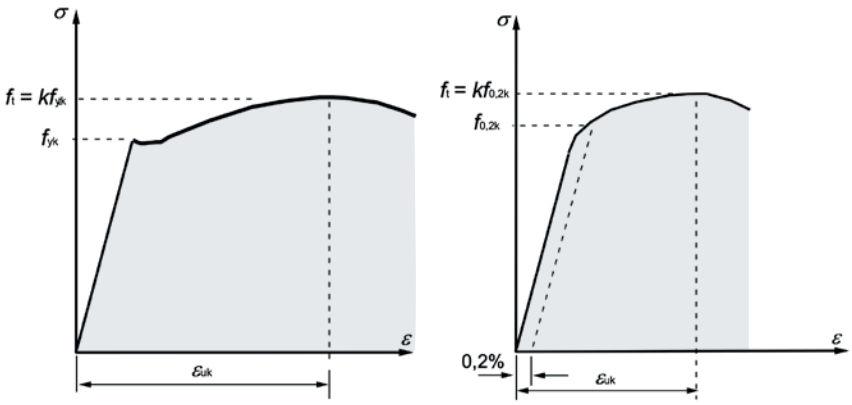


Figure 2
Idealised and design stress-strain diagrams for reinforcing steel (for tension and compression)



a) Hot rolled steel **b) Cold worked steel**

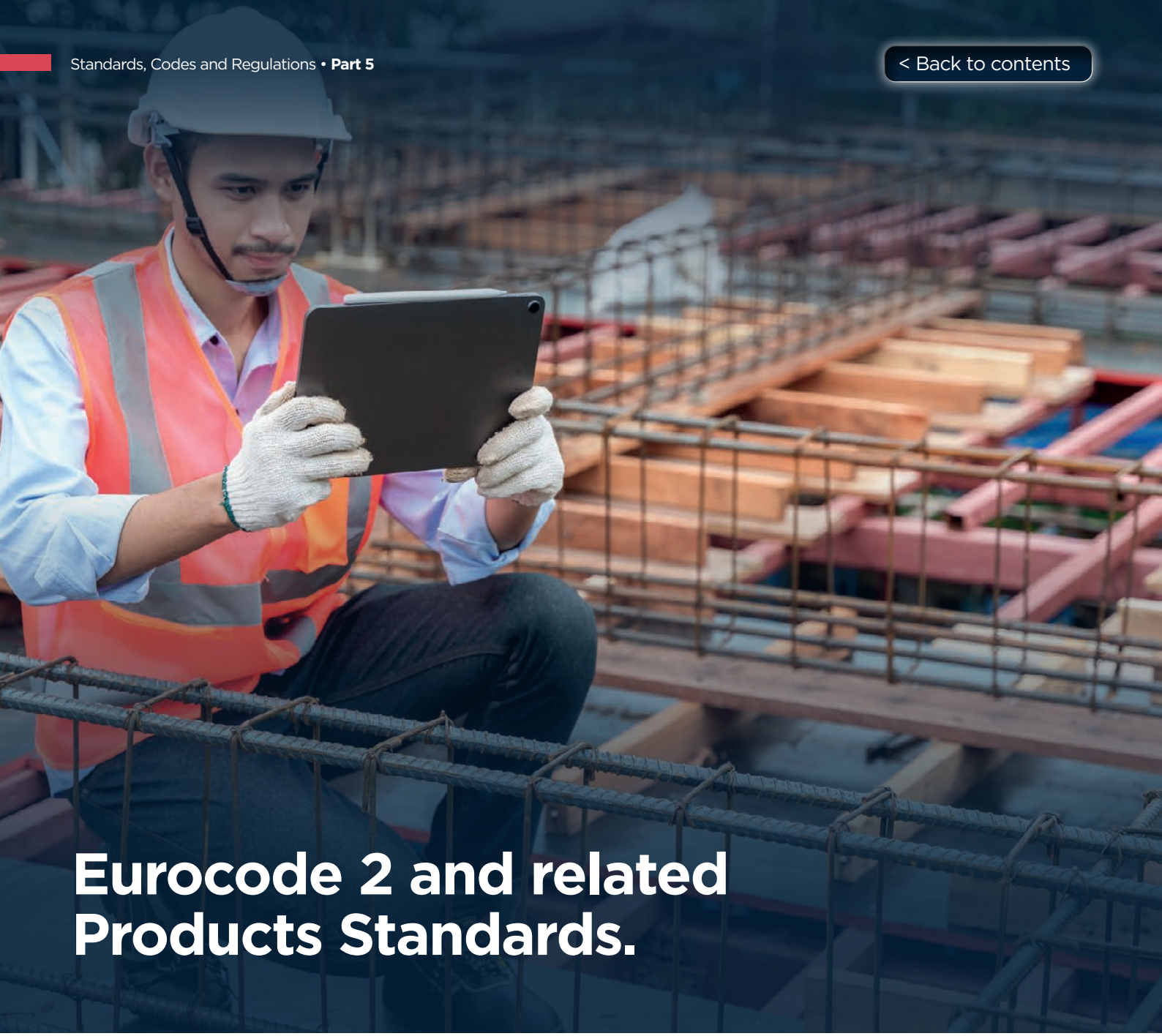
Figure 3
Stress-strain diagrams of typical reinforcing steel (absolute values are shown for tensile stress and strain)

Guidance

There is now extensive guidance on the application of Eurocode 2 including[16]:

- Manual for the design of reinforced concrete building structures to Eurocode 2 – IStructE.
- Standard method of detailing structural concrete - A manual for best practice 4th Edition – IStructE.
- Precast Eurocode 2 Design Manual – British Precast Concrete Federation.
- Concise Eurocode 2 – Concrete Centre
- Worked Examples – Concrete Centre
- How to Design leaflets – Concrete Centre
- Designers Handbook to Eurocode 2 by R S Narayanan and A W Beeby – Thomas Telford

It will be a significant task to update this guidance to the new Eurocode 2 and this is one reason why there will be a significant overlap period between the publication of the new code and the withdrawal of the existing code.



Eurocode 2 and related Products Standards.

The British standards for reinforcing steel supporting the use of EC 2 are:

- BS 4449 – Weldable reinforcing steel – Bar, coil and decoiled product
- BS 4482 – Steel wire for the reinforcement of concrete products.
- BS 4483 – Steel fabric for the reinforcement of concrete.
- BS 8666 – Scheduling, dimensioning, bending and cutting of steel reinforcement for concrete.

These are consistent with EC2, Annex C, and the UK National Annex.

The changes in materials requirements required by the revised Eurocode 2 are likely to be minor however, the above standards are currently be reviewed partly in anticipation of these changes.

Your guide to specifying Learn how to procure CARES certified steel products

specification guide

To specify CARES certification that meets government and private sector quality assurance and responsible sourcing requirements use the text from the guide in your project specifications.

References

1) BRITISH STANDARDS INSTITUTION. BS 4449:2005+A3:2016 Steel for the reinforcement of concrete – Weldable reinforcing steel – Bar, coil and decoiled product - Specification.

2) BRITISH STANDARDS INSTITUTION. BS 4482:2005 Steel wire for the reinforcement of concrete products - Specification.

3) BRITISH STANDARDS INSTITUTION. BS 4483:2005 Steel fabric for the reinforcement of concrete - Specification.

4) BRITISH STANDARDS INSTITUTION. BS 8110:Part 1:1997 Structural use of concrete. Code of practice for design and construction.

5) BRITISH STANDARDS INSTITUTION. BS 5400:Part 4:1990 Steel, concrete and composite bridges. Code of practice for design of concrete bridges.

6) BRITISH STANDARDS INSTITUTION. BS EN 1992-1-1:2004 - Design of concrete structures. General rules and rules for buildings

BRITISH STANDARDS INSTITUTION. BS EN 1992-1-2:2004 - Design of concrete structures. General rules. Structural fire design

BRITISH STANDARDS INSTITUTION. BS EN 1992-2:2005 - Design of concrete structures. Concrete bridges. Design and detailing rules

BRITISH STANDARDS INSTITUTION. BS EN 1992-3:2006 - Design of concrete structures. Liquid retaining and containing structures

7) PrEN10080 Steel for the reinforcement of concrete - weldable reinforcing steel - General.

8) BRITISH STANDARDS INSTITUTION. BS 8666:2020 Specification for scheduling, dimensioning, bending and cutting of steel reinforcement for concrete.

9) BRITISH STANDARDS INSTITUTION. BS 6744:2023 Stainless steel bars for the reinforcement of and use in concrete-Requirements and test methods.

10) BRITISH STANDARDS INSTITUTION. BS 8007: 1987, Code of practice for design of concrete structures for retaining aqueous liquids.

11) BRITISH STANDARDS INSTITUTION. BS 8500-1: 2023, Concrete. Complementary British Standard to BS EN 206-1. Method of specifying and guidance for the specifier.

12) BRITISH STANDARDS INSTITUTION. EN 206-1: 2013, Concrete. Specification, performance, production, and conformity.

13) BRITISH STANDARDS INSTITUTION. BS PD 6687-1 - Background paper to the National Annexes to BS EN 1992-1, BS EN 1992-3 and BS EN 1992-4

14) BRITISH STANDARDS INSTITUTION. BS NA EN 1992-2: UK National Annex to Eurocode 2. Design of concrete structures. Concrete bridges. Design and detailing rules

15) BRITISH STANDARDS INSTITUTION. PD 6688-1-4:2015 Background information to the National Annex to BS EN 1991-1-4 and additional guidance

16) BS EN 1992-1-1:2023 - Eurocode 2. Design of concrete structures. General rules and rules for buildings, bridges and civil engineering structures

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