BS 8004:2015+A1:2020



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**Code of Practice for foundations** 



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# Foreword

## **Publishing information**

This British Standard is published by BSI Standards Limited, under licence from The British Standards Institution, and came into effect on 30 June 2015. It was prepared by Technical Committee B/526, Geotechnics. A list of organizations represented on this committee can be obtained on request to its secretary.

#### Supersession

BS 8004:2015+A1:2020 supersedes BS 8004:2015, which is withdrawn.

#### **Relationship with other publications**

BS 8004 gives non-contradictory, complementary information for use with <u>BS EN 1997</u> and its National Annexes.

#### Information about this document

This is a full revision of the standard, which introduces the following principal changes:

- the revised text is fully compatible with the current version of Eurocode 7 (BS EN 1997);
- guidance is given on designing foundations according to limit state principles using partial factors;
- guidance is given on the selection of design parameters for soils;
- guidance is given on the calculation of ultimate bearing resistance of shallow foundations;
- guidance is given on the design of pile foundations by calculation and by testing;
- the revised text reflects advances in foundation technology over the past 30 years.

Text introduced by or altered by Amendment No. 1 is indicated in the text by tags A1 and A1. Minor editorial corrections are not tagged.

#### Use of this document

As a code of practice, this British Standard takes the form of guidance and recommendations. It should not be quoted as if it were a specification and particular care should be taken to ensure that claims of compliance are not misleading.

Any user claiming compliance with this British Standard is expected to be able to justify any course of action that deviates from its recommendations.

#### **Presentational conventions**

The provisions of this standard are presented in roman (i.e. upright) type. Its recommendations are expressed in sentences in which the principal auxiliary verb is "should".

# Commentary, explanation and general informative material is presented in smaller italic type, and does not constitute a normative element.

The word "should" is used to express recommendations of this standard. The word "may" is used in the text to express permissibility, e.g. as an alternative to the primary recommendation of the Clause. The word "can" is used to express possibility, e.g. a consequence of an action or an event.

Notes and commentaries are provided throughout the text of this standard. Notes give references and additional information that are important but do not form part of the recommendations. Commentaries give background information.

#### **Contractual and legal considerations**

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a British Standard cannot confer immunity from legal obligations.

#### 1 Scope

This British Standard gives recommendations for the design and construction of foundations for the normal range of buildings and engineering structures. It provides non-contradictory, complementary information for use in conjunction with <u>BS EN 1997</u> and its UK National Annex.

<u>Clause 4</u> gives general recommendations for the design and construction of all types of foundations; <u>Clause 5</u> and <u>Clause 6</u> give specific recommendations for the design and construction of spread foundations and pile foundations (respectively).

<u>Annex A</u> gives specific recommendations for the design and construction of helical steel piles.

Annex B gives specific recommendations for the design and construction of underpinning.

<u>Annex C</u> gives information about specific geological formations encountered in the UK.

<u>Annex D</u> gives information about the UK Government's policy regarding archaeological finds.

NOTE 1 This standard does not cover the design and construction of earthworks, for which see BS 6031.

*NOTE 2* This standard does not cover the design and construction of earth retaining structures, for which see <u>BS 8002</u>.

NOTE 3 This standard does not cover the design and construction of maritime works, for which see BS 6349.

NOTE 4 For non-industrial structures of not more than four storeys, see BS 8103-1.

NOTE 5 This standard does not cover the design and construction of foundations for reciprocating machinery.

*NOTE 6* This standard does not cover the design and construction of offshore foundations, for which see BS EN ISO 19901-4.

#### 2 Normative references

The following documents, in whole or in part, are normatively referenced in 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.

<u>BS 65</u>, Specification for vitrified clay pipes, fittings and ducts, also flexible mechanical joints for use solely with surface water pipes and fittings

<u>BS 437</u>, Specification for cast iron drain pipes, fittings and their joints for socketed and socketless systems

BS 1852-1, Plastics piping systems for non-pressure underground drainage and sewerage – Polypropylene (PP) – Part 1: Specifications for pipes, fittings and the system

<u>BS 4449</u>, Steel for the reinforcement of concrete – Weldable reinforcing steel – Bar, coil and decoiled product – Specification

<u>BS 4660</u>, Thermoplastics ancillary fittings of nominal sizes 110 and 160 for below ground gravity drainage and sewerage

BS 4729, Clay and calcium silicate bricks of special shapes and sizes – Recommendations

BS 4962, Specification for plastics pipes and fittings for use as subsoil field drains

BS 5480, Specification for glass reinforced plastics (GRP) pipes, joints and fittings for use for water supply or sewerage

BS 5481, Specification for unplasticized PVC pipe and fittings for gravity sewers

BS 5837, Trees in relation to design, demolition and construction – Recommendations

BS 5911 (all parts), Concrete pipes and ancillary concrete products

BS 5930, Code of practice for site investigation

<u>BS 5975</u>, Code of practice for temporary works procedures and the permissible stress design of falsework

<u>BS 6031</u>, Code of practice for earthworks

BS 6349 (all parts), Maritime works

BS 8006-1:2010, Code of practice for strengthened/reinforced soils and other fills

BS 8002, Code of practice for earth retaining structures

BS 8081, Code of practice for ground anchors

BS 8215, Code of practice for design and installation of damp-proof courses in masonry construction

<u>BS 8417</u>, Preservation of wood – Code of practice

<u>BS 8500-1:2015</u>, Concrete – Complementary British Standard to BS EN 206-1 – Part 1: Method of specifying and guidance for the specifier

<u>BS 8500-2</u>, Concrete – Complementary British Standard to BS EN 206-1 – Part 2: Specification for constituent materials and concrete<sup>1)</sup>

BS 10175, Code of practice on investigation of potentially contaminated sites

BS EN 206:2013, Concrete – Specification, performance, production and conformity

BS EN 295, Vitrified clay pipe systems for drains and sewers

BS EN 335:2013, Durability of wood and wood-based products – Use classes: definitions, application to solid wood and wood-based products

BS EN 350-2, Durability of wood and wood-based products – Natural durability of solid wood – Part 2: Guide to the natural durability of and treatability of selected wood species of importance in Europe

BS EN 351-1, Durability of wood and wood-based products – Preservative-treated solid wood – Part 1: Classification of preservative penetration and retention

BS EN 460, Durability of wood and wood-based products – Natural durability of solid wood – Guide to the durability requirements for wood to be used in hazard classes

BS EN 598, Ductile iron pipes, fittings, accessories and their joints for sewerage applications – Requirements and test methods

BS EN 771-1, Specification for masonry units – Part 1: Clay masonry units

BS EN 771-2, Specification for masonry units – Part 2: Calcium silicate masonry units

BS EN 771-3, Specification for masonry units – Part 3: Aggregate concrete masonry units

BS EN 771-4, Specification for masonry units - Part 4: Autoclaved aerated concrete masonry units

BS EN 771-5, Specification for masonry units - Part 5: Manufactured stone masonry units

BS EN 771-6, Specification for masonry units – Part 6: Natural stone masonry units

BS EN 1090 (all parts), Execution of steel structures and aluminium structures

BS EN 1401-1, Plastic piping systems for non-pressure underground drainage and sewerage – Unplasticized poly(vinyl chloride) (PVC-U) – Part 1: Specifications for pipes, fittings and the system

BS EN 1536, Execution of special geotechnical works – Bored piles<sup>2)</sup>

<sup>&</sup>lt;sup>1)</sup> Informative reference is made to BS 8500-2:2015.

<sup>&</sup>lt;sup>2)</sup> Informative reference is made to BS EN 1536:2010+A1:2015.

Polypropylene (PP) – Part 1: Specifications for pipes, fittings and the system BS EN 1916, Concrete pipes and fittings, unreinforced, steel fibre and reinforced BS EN 1990:2002+A1:2005, Eurocode: Basis of structural design BS EN 1991 (all parts), Eurocode 1: Actions on structures<sup>3)</sup> BS EN 1992 (all parts), Eurocode 2: Design of concrete structures<sup>4)</sup> BS EN 1993 (all parts), Eurocode 3: Design of steel structures<sup>5)</sup> BS EN 1995 (all parts), Eurocode 5: Design of timber structures<sup>6)</sup> BS EN 1996-1-1, Eurocode 6: Design of masonry structures – Part 1-1: General rules for reinforced and unreinforced masonry structures BS EN 1996-2, Eurocode 6: Design of masonry structures – Part 2: Design considerations, selection of materials and execution of masonry BS EN 1997-1:2004+A1:2013, Eurocode 7: Geotechnical design – Part 1: General rules BS EN 1997-2:2007, Eurocode 7: Geotechnical design – Part 2: Ground investigation and testing (incorporating corrigendum 2010) BS EN 10025, Hot rolled products of structural steels BS EN 10080, Steel for the reinforcement of concrete – Weldable reinforcing steel – General BS EN 10210, Hot finished structural hollow sections of non-alloy and fine grain steels BS EN 10219, Cold formed welded structural hollow sections of non-alloy and fine grain steels BS EN 10248, Hot rolled sheet piling of non alloy steels BS EN 10249, Cold formed sheet piling of non alloy steels BS EN 12666-1, Plastics piping systems for non-pressure underground drainage and sewerage – Polyethylene (PE) – Part 1: Specifications for pipes, fittings and the system BS EN 12699, Execution of special geotechnical work – Displacement piles<sup>7</sup>) BS EN 12715, Execution of special geotechnical works - Grouting

BS EN 1852-1, Plastics piping systems for non-pressure underground drainage and sewerage –

BS EN 12716, Execution of special geotechnical works – Jet grouting

BS EN 12794, Precast concrete products - Foundation piles

BS EN 13670, Execution of concrete structures

BS EN 14199:2015, Execution of special geotechnical works – Micropiles

BS EN 14227 (all parts), Hydraulically bound mixtures – Specifications

BS EN 14679:2005, Execution of special geotechnical works – Deep mixing

BS EN 14731:2005, Execution of special geotechnical works – Ground treatment by deep vibration

BS EN 15237:2007, Execution of special geotechnical works – Vertical drainage

 <sup>&</sup>lt;sup>3)</sup> Specific references are made to the following part: BS EN 1991-2:2003, Eurocode 1: Actions on structures – Part 2: Traffic loads on bridges.
 <sup>4)</sup> Specific references are made to the following part: BS EN 1992-1-1:2004+A1:2014, Eurocode 2: Design of concrete structures – Part 1-1: General rules and rules for buildings.

<sup>&</sup>lt;sup>5)</sup> Specific references are made to the following parts:

<sup>•</sup> BS EN 1993-1-1:2005, Eurocode 3: Design of steel structures – Part 1-1: General rules and rules for buildings;

<sup>•</sup> BS EN 1993-5, Eurocode 3: Design of steel structures – Part 5: Piling.

<sup>&</sup>lt;sup>6)</sup> Specific references are made to the following part: BS EN 1995-1-1:2004, *Eurocode 5: Design of timber structures – Part 1-1: General – Common rules and rules for buildings.* 

<sup>&</sup>lt;sup>7)</sup> Informative reference is made to BS EN 12699:2001.

BS EN 16228, Drilling and foundation equipment – Safety

BS EN ISO 13793, Thermal performance of buildings – Thermal design of foundations to avoid frost heave

BS EN ISO 14688-1, Geotechnical investigation and testing – Identification and classification of soil – Part 1: Identification and description

BS EN ISO 14688-2, Geotechnical investigation and testing – Identification and classification of soil – Part 2: Principles for a classification<sup>8)</sup>

BS EN ISO 14689-1, Geotechnical investigation and testing – Identification and classification of rock – Part 1: Identification and classification

prEN ISO 22476-13, Geotechnical investigation and testing – Field testing – Part 13: Plate loading test<sup>9)</sup>

prEN ISO 22477 (all parts), Geotechnical investigation and testing – Testing of geotechnical structures

<u>BS ISO 5667-11</u>, BS 6068-6.11: Water quality – Sampling – Part 11: Guidance on sampling of groundwaters

NA to BS EN 1991-2, UK National Annex to Eurocode 1 – Actions on structures – Part 2: Traffic loads on bridges

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<sup>10</sup>

NA to BS EN 1993-1-1, UK National Annex to Eurocode 3: Design of steel structures – Part 1-1: General rules and rules for buildings

NA to BS EN 1993-1-1, UK National Annex to Eurocode 3: Design of steel structures – Part 1-1: General rules and rules for buildings

NA to BS EN 1993-5, UK National Annex to Eurocode 3: Design of steel structures - Part 5: Piling

NA+A1:2014 to BS EN 1997-1:2004+A1:2013, UK National Annex to Eurocode 7 – Geotechnical design – Part 1: General rules

NA+A1:2014 to BS EN 1997-1:2004+A1:2013, UK National Annex to Eurocode 7 – Geotechnical design – Part 1: General rules

PAS 8811, Code of practice for temporary works - Client procedures

PAS 8812, Guide to the application of European Standards in temporary works design

PD 6694-1, Recommendations for the design of structures subject to traffic loading to BS EN 1997-1:2004

PD 6697, Recommendations for the design of masonry structures to BS EN 1996-1-1 and BS EN 1996-2

ASTM D7949-14, Standard test methods for thermal integrity profiling of concrete deep foundations<sup>11</sup>

#### **Other publications**

[N1] BURLAND. J.B., BROMS, B.B., and de MELLO, V.F.B. *Behaviour of foundations and structures,* State-of-the-Art Report, Session 2, Proc. 9th International Conference on Soil Mechanics and Foundation Engineering, 1977, Tokyo, Vol. 2, pp 495–546.

[N2] LORD. J.A., CLAYTON, C.R.I., and MORTIMORE, R.N. *Engineering in chalk (CIRIA Report C574)*. London: CIRIA, 2002. ISBN 0-86017-574-X.

<sup>&</sup>lt;sup>8)</sup> Informative reference is made to BS EN ISO 14688-2:2004+A1:2003.

<sup>9)</sup> In preparation.

<sup>&</sup>lt;sup>10)</sup> Informative reference is made to NA to BS EN 1992-1-1:2004.

<sup>&</sup>lt;sup>11)</sup> Available from ASTM International, <u>www.astm.org</u> (last viewed 25/6/15).