**BS 8081:2015+A2:2018**
Incorporating Corrigenda Nos. 1 and 2

BSI Standards Publication

# Code of practice for grouted anchors

**Publishing and copyright information**

The BSI copyright notice displayed in this document indicates when the document was last issued.



Published by BSI Standards Limited 2018

ISBN 978 0 539 06019 5

ICS 91.200, 93.020

The following BSI references relate to the work on this document:
Committee reference B/526
Drafts for comment 15/30302283 DC; 17/30359711 DC; 18/30375081 DC

**Amendments/corrigenda issued since publication**

| Date | Text affected |
|---|---|
| 30 September 2017 | A1: see Foreword |
| 30 November 2017 | C1: 11.3 subclause heading corrected |
| 30 September 2018 | A2: see Foreword |
| 30 December 2019 | C2: 3.2 and Annex B symbols and equations corrected |

# Contents



 

**Summary of pages**
This document comprises a front cover, and inside front cover, pages i to iv, pages 1 to 116, an inside back cover and a back cover.

 

# Foreword

## Publishing information

This British Standard is published by BSI Standards Limited, under licence from The British Standards Institution, and came into effect on 31 August 2015. It was prepared under the authority of Technical Committee B/526, *Geotechnics*. A list of organizations represented on this committee can be obtained on request to its secretary.

## Supersession

BS 8081:2015+A2:2018 supersedes BS 8081:2015+A1:2017, which is withdrawn.

BS 8081:2015+A1:2017 superseded BS 8081:2015, which was withdrawn.

## Information about this document

Text introduced or altered by Amendment No. 1 is indicated in the text by the tags [A1] 〈A1〉. Minor editorial changes are not tagged. Amendment No. 1 introduces the following changes:

- Table 2 has been updated;
- a new Clause 11.3 has been inserted and the following subclauses renumbered; and
- Clause 11.3.5 has been deleted.

Text introduced or altered by Corrigendum No. 1 is indicated in the text by the tags [C1] 〈C1〉.

Text introduced or altered by Amendment No. 2 is indicated by the tags [A2] 〈A2〉. Minor editorial changes are not tagged. Amendment No. 2 introduced the following changes:

- Annex G and associated citations in the text have been deleted; and
- References to BS EN ISO 22477-5 have been introduced.

Text introduced or altered by Corrigendum No. 2 is indicated in the text by the tags [C2] 〈C2〉.

## Relationship with other publications

BS 8081 gives non-contradictory, complementary information for use with BS EN 1997-1:2004+A1:2013 and its UK National Annexes, BS EN 1537:2013 and BS EN ISO 22477-5.

## 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.*

Where words have alternative spellings, the preferred spelling of the Shorter Oxford English Dictionary is used (e.g. "organization" rather than "organisation").

The auxiliary verb “may” is used in the text to express permissibility, e.g. as an alternative to the primary recommendation of the Clause. The auxiliary verb “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

**1.1** This British Standard, as a code of practice, gives recommendations for the design, construction, stressing, testing, monitoring and maintenance of grouted anchors as defined in BS EN 1997-1:2004+A1:2013, BS EN 1537:2013 and BS EN ISO 22477-5.

**1.2** Further general recommendations for corrosion hazards and protective measures, construction techniques and quality controls, stressing procedures, and the testing of grouted anchor components and complete installations are provided. Information supporting the practical implementation of these recommendations are provided in annexes to this code of practice.

**1.3** Annex A provides examples of records that are developed during the execution and testing of grouted anchors.

**1.4** Annex B provides information on the design of a fixed anchor length with respect to the bond or shear resistance at:

a) the ground/grout interface;

b) the grout/encapsulation interface;

c) the grout/tendon interface.

**1.5** Annex C provides information on the pre-grouting and post-grouting of ground, where necessary.

**1.6** Annex D provides information on the use of appropriate Young's modulus for the steel used in the design of the anchor tendon.

**1.7** Annex E provides information on the types of corrosion that affect the steel elements of an anchor and the influence on the corrosion of the tendon of the ground and groundwater in which the anchor is installed.

**1.8** Annex F provides information on the types of corrosion protection available for use in the fabrication and installation of the anchor.

**1.9** Annex G 〚A2〛 (not used) 〚A2〛

**1.10** Annex H provides information on monitoring anchors in the long term, including appropriate acceptance criteria and remedial measures that can be applied in the event of non-compliance with the acceptance criteria.

**1.11** Annex I draws attention to the statutory regulations affecting the safety, welfare and health of persons in the execution of anchor construction.

**1.12** This code of practice is for the use of clients who commission the use of grouted anchors, ground engineering contractors, and geotechnical and structural designers.

〚A2〛 *Text deleted* 〚A2〛

 

## 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.

**Standards publications**

BS 3148:1980, *Methods of test for water for making concrete (including notes on the suitability of the water)*

BS 6319 (all parts), *Testing of resin and polymer/cement compositions for use in construction*

BS EN 206, *Concrete — Specification, performance, production and conformity*

BS EN 445:2007, *Grout for prestressing tendons — Test methods*

BS EN 446:2007, *Grout for prestressing tendons — Grouting procedures*

BS EN 447, *Grout for prestressing tendons — Basic requirements*

BS EN 837-1:1998, *Pressure gauges — Bourdon tube pressure gauges — Part 1: Dimensions, metrology, requirements and testing*

BS EN 934-2, *Admixtures for concrete, mortar and grout — Concrete admixtures — Part 2: Definitions, requirements, conformity, marking and labelling*

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*

BS EN 1537:2013, *Execution of special geotechnical works — Ground anchors*

BS EN 1992-1-1:2004+A1:2014, *Eurocode 2 – Design of concrete structures — Part 1-1: General rules and rules for buildings*

BS EN 1992-2:2005+A1:2014, *Eurocode 2 – Design of concrete structures — Concrete bridges — Part 2: Design and detailing rules*

BS EN 1993-1-1:2005, *Eurocode 3 – Design of steel structures — Part 1-1:General rules and rules for buildings*

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*

BS EN 12715:2000, *Execution of special geotechnical works — Grouting*

BS EN 13391:2004, *Mechanical tests for post-tensioning systems*

BS EN ISO 1461:2009, *(E), Hot dip galvanized coatings on fabricated iron and steel articles – Specifications and test methods*

BS EN ISO 12944-1:1998, *Paints and varnishes — Corrosion protection of steel structures by protective paint systems — Part 1: General introduction*

BS EN ISO 14713-1:2009, *Zinc coatings — Guidelines and recommendations for the protection against corrosion of iron and steel in structures — General principles of design and corrosion resistance*

BS EN ISO 22477-5, *Geotechnical investigation and testing — Testing of geotechnical structures — Part 5: Testing of grouted anchors*

A2 *Text deleted* A2

ETAG 013, *Post-tensioning kits for prestressing of structures*

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

**Other publications**

[N1] INTERNATIONAL SOCIETY FOR ROCK MECHANICS (ISRM). The Complete ISRM Suggested Methods For Rock Characterization, Testing And Monitoring: 1974-2006. Ulusay, R. and Hudson, J.A. (Eds.). Commission on Testing Methods, ISRM, 2007.

[N2] BARTON. N., LIEN, R. and LUNDE, J. Engineering Classification of Rock Masses for the Design of Tunnel Support. *Rock Mech.* 1974, 6 pp. 189–236

[N3] BARTON. N. and BANDIS, S. 1982. Effects of block size on the shear behaviour of jointed rock. Keynote Lecture, 23rd US Symposium on Rock Mechanics, Berkeley, California.

[N4] BARTON. N. 1999. General report concerning some 20th Century lessons and 21st Century challenges in applied rock mechanics, safety and control of the environment. Gen. Rept., Theme 1, Proc. 9th ISRM Cong., Paris, 3, 21p, Balkema, Rotterdam.

[N5] HOEK. E. and BRAY, J.W. 1977. Rock Slope Engineering. Institute of Mining and Metallurgy, London, 2nd ed., 1-402.

[N6] HOEK. E. and BROWN, E.T. 1981**.** Underground Excavation in Rock. Institute of Mining and Metallurgy, London.

[N7] HOEK. E. and BROWN, E.T. Practical estimates for rock mass strength. Int. J. Rock Mech. Min.g Sci. &. Geomech. Abstr. 1997, **34** (8) pp. 1165–1186

[N8] WYLLIE. D. C. and MAH, C. W. 2004. Rock slope engineering: civil and mining. London, Spon Press.

[N9] HOEK, E. and MARINOS, P. 2007. A brief history of the development of the Hoek-Brown failure criterion. Soils and Rocks, No. 2, November 2007.

[N10] BRUCE. D.A. 1976. The Design and Performance of Prestressed Rock Anchors with Particular Reference to Load Transfer Mechanisms. Ph. D Thesis 1, Dept. of Engng, University of Aberdeen, Scotland.

[N11] BARLEY. A.D. 1978. A study and investigation of under reamed anchors, and associated load transfer mechanisms. MSc thesis Dept. of Engineering, University of Aberdeen, Scotland.

[N12] BRITISH DRILLING ASSOCIATION (BDA). BDA Health & Safety Manual for Land Drilling: A Code of Safe Drilling Practice. 2002.

[N13] CONCRETE SOCIETY, 1980. Safety Precautions for Prestressing Operations (post-tensioning) – Notes for Guidance. The Concrete Society, Terminal House, Grosvenor Gardens, London (ref. no. 53.031).

[N14] MOTHERSILLE. D.K.V, JACKMAN, S., & FERRIER, J. 2007. Performance and condition assessment of 30 year old anchorages, River Clyde Glasgow. Proceedings of International Conference on Ground anchorages and anchored structures in service, ICE, London, 33-42.

[N15] LITTLEJOHN. G.S. and MOTHERSILLE, D.K.V. Maintenance and monitoring of anchorages: guidelines. *Geotech. Eng.* 2008 April, 161 pp. 93–106

## 3 Terms, definitions, symbols and abbreviations

For the purposes of this British Standard, the terms, definitions, symbols and abbreviations given in BS EN 1997-1:2004+A1:2013 and the following apply.

 

## 3.1 Terms and definitions

### 3.1.1 anchor

#### 3.1.1.1 anchor head

element of a ground anchor that transmits the tensile load from the tendon to the bearing plate or the structure

[SOURCE: BS EN 1537:2013]

#### 3.1.1.2 bond-type grouted anchor

grouted anchor, the load of which is transferred via a steel tendon bonded to grout, with or without an encapsulation, and from there via the borehole grout into the ground

#### 3.1.1.3 compression-type anchor

grouted anchor, the load of which is transferred via a decoupled steel tendon down to the bottom of the borehole, and from there via a compression element and the borehole grout into the ground

*NOTE The transfer device may take a number of forms of which the most common is either a plate washer at the distal end, or a concentric tube restrained similarly at the distal end. This is sometimes referred to as a compression tube anchor.*

#### 3.1.1.4 detensionable anchor head

anchor head that has all the properties of the **restressable anchor head** (see 3.1.1.5) and, in addition, permits the tendon to be detensioned in a controlled way at any time during the working life of the anchor

#### 3.1.1.5 restressable anchor head

anchor head that permits the tendon load, throughout the working life of the anchor, to be measured by check lifting and enables small losses of up to 10% of the service state load to be recovered by shimming or thread-turning

[SOURCE: BS EN 1537:2013, modified]

#### 3.1.1.6 stressing head

component of the anchor head attached to the tendon

*NOTE For example, a nut and washer for bar tendons or steel plate with tapered holes and wedges for strand tendons.*

### 3.1.2 bearing plate

element located under the stressing head that distributes the tendon force into the supported structure

*NOTE* *See* 〈A1〉 *11.5.3* 〈A1〉

### 3.1.3 bond

#### 3.1.3.1 adhesion bond

initial bond before slip that arises mainly from the physical interlocking

*NOTE 1 Molecular attraction can also contribute to the bond.*

*NOTE 2 The adhesion bond reduces to zero when slip comparable with the size of the micro-indentations on the steel occurs.*