

BS 5930:2015



BSI Standards Publication

Code of practice for ground investigations

bsi.

...making excellence a habit.™

Publishing and copyright information

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

© The British Standards Institution 2015

Published by BSI Standards Limited 2015

ISBN 978 0 580 80062 7

ICS 91.200

The following BSI references relate to the work on this document:

Committee reference B/526/3

Draft for comment 14/30268442 DC

Publication history

First published 1957

Second edition 1981

Third edition October 1999

Fourth (present) edition July 2015

Amendments issued since publication

Date	Text affected
-------------	----------------------

Contents

Foreword	v
Introduction	1
1	Scope 2
2	Normative references 2
3	Terms and definitions 5
Section 1: Preliminary considerations 7	
4	Primary objectives 7
5	Safety on investigation sites 8
6	Personnel for ground investigations 10
7	Investigation strategy 13
8	Planning and control of investigations 14
9	Quality management 15
Section 2: Desk study and field reconnaissance 16	
10	General 16
11	Desk study 17
12	Field reconnaissance 19
13	Earlier uses and state of site 20
14	Aerial photographs and satellite imagery 22
Section 3: Planning ground investigations 26	
15	Types of ground investigation 26
16	Geological mapping 29
17	Scope of the ground investigation 30
18	Frequency of sampling and testing 37
19	General considerations in the selection of methods of ground investigation 40
20	The effect of ground conditions on the selection of methods of intrusive investigation 44
21	Ground chemically aggressive or prone to volume change 54
22	Ground investigations over water 56
Section 4: Exploratory holes 60	
23	Surveying of investigation points 60
24	Excavations and boreholes 60
25	Sampling the ground 70
26	Groundwater monitoring and sampling 90
Section 5: Geophysical field investigations 96	
27	General 96
28	The use of geophysical surveys as part of a ground investigation 96
29	Geophysical techniques 97
30	Application of geophysical techniques 102
31	Specification and planning of a geophysical survey 103
Section 6: Description of soils and rocks 106	
32	The description process 106
33	Description of soils 109
34	Field procedures for description of principal inorganic soil type 129
35	Classification of soils 132
36	Description and classification of rocks 133
Section 7: Field tests 151	
37	General 151
38	Probing 153
39	Static cone penetration testing 155
40	Flat dilatometer test 159
41	Standard penetration test 159
42	Vane test 161

43	Pressuremeter tests	162
44	Field density	165
45	In-situ stress measurements	166
46	Bearing tests	173
47	In-situ shear tests	181
48	Geohydraulic testing	184
49	Large-scale field trials	187
Section 8: Field instrumentation 191		
50	General	191
51	Planning a field monitoring programme	192
52	Groundwater measurements	192
53	Inclinometers	204
54	Extensometers	210
Section 9: Laboratory tests on samples 213		
55	General	213
56	Roles and responsibilities	213
57	Health and safety in laboratories	213
58	Sample storage and inspection facilities	215
59	Selection of testing programme	216
60	Visual examination and description of laboratory samples	217
61	Laboratory tests	218
Section 10: Reports and interpretation 238		
62	General	238
63	Reports	243
Section 11: Review during and after construction 256		
64	General	256
65	Purpose of review	256
66	Information required	257
67	Monitoring	257
68	Reporting	258
Annexes		
Annex A (informative) National safety legislation and guidance 259		
Annex B (informative) General information for a desk study 263		
Annex C (informative) Sources of information 267		
Annex D (informative) Detailed information for design and construction 276		
Annex E (informative) Notes on field reconnaissance 279		
Annex F (informative) Ground investigations and development in ground potentially containing voids 281		
Annex G (informative) Integrated investigations 293		
Annex H (informative) Photographic records 302		
Bibliography 304		
List of figures		
Figure 1 – Basic details of open-tube sampler 77		
Figure 2 – A typical thin-walled sampler 80		
Figure 3 – U100 sampler 81		
Figure 4 – Basic details of a piston sampler 83		
Figure 5 – Selection of descriptive procedure for different materials 107		
Figure 6 – General identification and description of soils 108		
Figure 7 – Angularity terms 118		
Figure 8 – Plasticity chart 122		
Figure 9 – Description and classification of weathered rock for engineering purposes 143		
Figure 10 – Application of fracture state terms for rock cores 149		
Figure 11 – Measurement of in-situ stress – CSIRO cell 169		
Figure 12 – Measurement of in-situ stress – Borre probe 170		

- Figure 13 – Measurement of in-situ stress – Flat jack equipment – Typical layout 172
- Figure 14 – Types of bearing test equipment – Plate test equipment for 864 mm diameter 174
- Figure 15 – Types of bearing test equipment – Jacking in adit-type of loading equipment 175
- Figure 16 – Equipment layout for shear and sliding friction test on rock or soil samples 182
- Figure 17 – Typical response times for various piezometers 195
- Figure 18 – Examples of observation well and standpipe piezometer construction 196
- Figure 19 – Schematic of a Bishop-type twin-tube piezometer 198
- Figure 20 – Schematic of a Ridley-type flushable piezometer 199
- Figure 21 – Schematic of a pneumatic piezometer 200
- Figure 22 – Schematic of a vibrating wire piezometer 201
- Figure 23 – Schematic of an electric piezometer 202
- Figure 24 – Probe inclinometer system 205
- Figure 25 – Magnetic probe extensometer system 211
- Figure 26 – Rod extensometer system 212
- Figure F.1 – Principal types of void 282
- Figure G.1 – Layout at the time of the investigation 300
- Figure G.2 – Proposed layout and trial pit location plan 301

List of tables

- Table 1 – Desk study: Typical factual core 18
- Table 2 – Desk study: Typical interpretative elements 18
- Table 3 – Quality classes of soil samples and sampling categories 72
- Table 4 – Mass of soil sample required for various laboratory tests 75
- Table 5 – Geophysical methods in ground investigation 98
- Table 6 – Usefulness of engineering geophysical methods 100
- Table 6 – Usefulness of engineering geophysical methods (continued) 101
- Table 7 – Field identification and description of soils 110
- Table 8 – Terms for description of consistency 112
- Table 9 – Terms for classification of strength 113
- Table 10 – Terms for classification of relative density 114
- Table 11 – Assessment of field density 115
- Table 12 – Terms for very coarse soils 119
- Table 13 – Terms for mixtures of very coarse soils 120
- Table 14 – Terms for mixtures of very coarse and finer soils 120
- Table 15 – Terms for mixtures of finer and very coarse soils 120
- Table 16 – Terms for mixtures of coarse soils 121
- Table 17 – Terms for mixtures of coarse and fine soils 123
- Table 18 – Some example descriptions of anthropogenic soils 125
- Table 19 – Terms for description of odours 126
- Table 20 – Types of peats 127
- Table 21 – Description of condition of peats 127
- Table 22 – Terms for description of secondary organic matter in an inorganic soil 128
- Table 23 – Terms for description of plasticity 131
- Table 24 – Decision on fine soil type from results of hand tests 132
- Table 25 – Terms for description of rock strength 134
- Table 26 – Terms for description of thickness and spacing of structure 135
- Table 27 – Aid to identification of rocks for engineering purposes 137
- Table 27 – Aid to identification of rocks for engineering purposes (continued) 138

Table 28 – Stability of rock material	139
Table 29 – Types of discontinuity	144
Table 30 – Terminology and checklist for rock discontinuity description	145
Table 31 – Terms for classification of discontinuity state (see Figure 10)	147
Table 32 – Example rock descriptions	150
Table 33 – The applicability and usefulness of in-situ tests	152
Table 34 – Typical cement-bentonite grout mixes for piezometers	204
Table 35 – Typical cement-bentonite grout mixes for inclinometers and extensometers	206
Table 36 – Categories of test specified in BS 1377 with the BS EN ISO 17892 equivalent tests	219
Table 37 – Common laboratory tests for soils	220
Table 38 – Swelling and shrinkage tests	229
Table 39 – Specialist laboratory tests for soils	230
Table 40 – Rock testing	232
Table 41 – Tests for aggregate suitability	235
Table 42 – Geophysical laboratory tests	236
Table 43 – Summary of reporting requirements	239
Table C.1 – BGS maps	269
Table F.1 – Principal types of void	283
Table F.2 – Natural voids: potential hazards	286
Table F.3 – Anthropogenic voids: potential hazards	289
Table G.1 – Identification of principal potential hazards relating to contamination	299

Summary of pages

This document comprises a front cover, an inside front cover, pages i to vi, pages 1 to 318, 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 July 2015. It was prepared by Subcommittee B/526/3, *Site investigation and ground testing*, 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

This British Standard supersedes BS 5930:1999+A2:2010, which is withdrawn.

Information about this document

The first edition of this British Standard (published as CP2001:1957) covered basic guidance on effective ground investigation. This was replaced by full editions in 1981 and 1999, which covered the subject matter in greater detail and each of which was brought up to date at the time of publication. The 1999 edition was amended twice to incorporate changes necessary to maintain compliance with BS EN 1997-1 and BS EN 1997-2 and their related standards.

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

- The majority of changes arise from the further implementation into UK practice of BS EN 1997-1 and BS EN 1997-2 and the related test standards cited therein and the need to conform to these standards.
- The revision of material that is now out of date. There is new information on geophysical surveying and ground testing and updated guidance on ground investigations on contaminated ground, changes to accommodate the requirements of data capture in the field and the inclusion of this in reporting as well as other amendments throughout the code.

Product certification. Users of this British Standard are advised to consider the desirability of third-party certification with this British Standard. Appropriate conformity attestation arrangements are described in BS 22475-3. Users seeking assistance in identifying appropriate conformity assessment bodies or schemes may ask BSI to forward their enquiries to the relevant association.

Test laboratory accreditation. Users of this British Standard are advised to consider the desirability of selecting test laboratories that are accredited to BS EN ISO/IEC 17025 by a national or international accreditation body.

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.

It has been assumed in the preparation of this British Standard that the execution of its provisions will be entrusted to appropriately qualified and experienced people, for whose use it has been produced.

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.

Introduction

The ground is naturally variable and often the nature of these variations is not known. A ground investigation is a process starting with initial documentation about the site and its environs followed by continuous exploration and interpretation, with the scope of the investigation requiring regular amendment in the light of the data being obtained.

This British Standard is set out to follow, in broad terms, the sequence of a ground investigation from initial considerations through the phased design and implementation of an investigation programme and its reporting, to the continuing investigation during and after construction.

Section 1 of this British Standard deals with those matters of a technical, legal or environmental character that need to be taken into account in selecting the site (or in determining whether a selected site is suitable) and in preparing the design of the works. The safety of all those involved in investigation, including the general public and the environment, is also introduced here to emphasize its fundamental importance in the execution of all aspects of the investigation; this coverage is referred to but not repeated throughout the standard.

Section 2 outlines the procedures that should be followed and the information that should be collected in desk studies and field reconnaissance.

Section 3 discusses general aspects of planning investigations, including the factors that influence the selection of methods of investigation.

Section 4 discusses methods of intrusive investigation, including overwater investigations (i.e. those carried out using land-based methods), sub-divided into excavations and boreholes, sampling, and groundwater observations.

Section 5 outlines the methods of geophysics that can be used for ground mapping, characterization and testing, from the ground surface, boreholes, crosshole and surface to borehole and overwater.

Section 6 deals with the terminology and systems recommended for use in describing and classifying soil and rock materials and soil and rock masses.

Section 7 describes the range of field tests that can be considered to measure appropriate geotechnical parameters.

Section 8 outlines the instrumentation that can be used to measure parameters or monitor field conditions.

Section 9 describes the range of laboratory tests on samples that can be used to measure a range of geotechnical parameters for material classification and use in design.

Section 10 provides details of the information that is to be included in field reports, the presentation and evaluation of factual information in the investigation report and in the interpretation of the data obtained from the investigation and the preparation of the design report.

Section 11 describes the requirements of investigation that continues into and beyond the construction phase, including the requirements for monitoring and maintenance of the structure.

Users of this British Standard, particularly those with limited experience, are advised to study the preliminary considerations in Section 1 and Section 2 before referring to the methods of ground investigation in Section 3 to Section 10. Development continues to take place, and this is likely to involve changes in some of the methods. For this reason it is important to ensure that the planning, supervision and interpretation of results of any investigation is carried out by suitably qualified and experienced specialists (see Clause 6).

It might be noted that there is an imbalance of treatment between tests; in some cases more comprehensive treatment has been given to tests less frequently used. This is because many of the common tests are described extensively elsewhere in national and international standards whereas there is a paucity of reference to other tests.

This British Standard has been drawn up mainly in relation to conditions existing in the United Kingdom, but reference is made to technical and professional practice in other countries where relevant.

In this British Standard the term ground investigation (previously called site investigation in the UK) is used in the wider sense of investigation of the site, which includes desk studies, field reconnaissance and field and laboratory work within the broad geographical, geological, hydrogeological and environmental contexts.

1 Scope

This British Standard gives recommendations for the investigation of sites for the purposes of assessing their suitability for the construction of civil engineering and building works and of acquiring knowledge of the characteristics of a site that could affect the design and construction of such work and the security of neighbouring land and property.

NOTE The use of soil and rock as construction materials is treated only briefly; further information is given in BS 6031.

This British Standard provides guidance on the application of BS EN 1997-1 and BS EN 1997-2 and the related test standards cited therein.

It does not provide guidance on investigations for contamination or naturally elevated concentrations of potentially hazardous substances (these are dealt with in BS 10175). Nor does it provide guidance on investigations for ground gas (these are dealt with in BS 8576). However, it does provide guidance on the integration of geotechnical investigations with investigations for contamination or ground gas and other types of investigations (e.g. archaeological).

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 1377-1:1990, *Methods of test for soils for civil engineering purposes – Part 1: General requirements and sample preparation*

BS 1377-2:1990, *Methods of test for soils for civil engineering purposes – Part 2: Classification tests*

BS 1377-3:1990, *Methods of test for soils for civil engineering purposes – Part 3: Chemical and electro-chemical tests*

BS 1377-4:1990, *Methods of test for soils for civil engineering purposes – Part 4: Compaction-related tests*

BS 1377-5:1990, *Methods of test for soils for civil engineering purposes – Part 5: Compressibility, permeability and durability tests*

BS 1377-6:1990, *Methods of test for soils for civil engineering purposes – Part 6: Consolidation and permeability tests in hydraulic cells and with pore pressure measurement*