BRITISH STANDARD

BS 1377-9: 1990

Incorporating Amendments Nos. 1 and 2

Methods of test for

Soils for civil engineering purposes —

Part 9: In-situ tests

ICS 93.020

BSI British Standards

Committees responsible for this British Standard

The preparation of this British Standard was entrusted by the Road Engineering Standards Policy committee (RDB/-) to Technical committee RDB/38, upon which the following bodies were represented:

Association of consulting Engineers
British Civil Engineering Test Equipment Manufacturers' Association
County Surveyors' Society
Department of the Environment (Property Services Agency)
Department of the Environment (Building Research Establishment)
Department of Transport
Department of Transport (Transport and Road Research Laboratory)
Co-opted members

This British Standard, having been prepared under the direction of the Road Engineering Standards Policy Committee, was published under the authority of the Board of the BSI and comes into effect on 31 August 1990

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Amendments issued since publication

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Contents

Foreword

This Part of BS 1377 has been prepared under the direction of the Road Engineering Standards Policy Committee. It is a revision of the in-situ test methods described in BS 1377:1975 which are superseded by amendment.

NOTE Amendment 2 to this standard removes text superseded by BS EN ISO 22476-2 and BS EN ISO 22476-3, and makes reference to the relevant standard for each affected subclause.

BS 1377:1975 which has now been withdrawn is replaced by the following Parts of BS 1377:1990:

— *Part 1: General requirements and sample preparation;*

— *Part 2: Classification tests;*

— *Part 3: Chemical and electro-chemical tests;*

— *Part 4: Compaction-related tests;*

— *Part 5: Compressibility, permeability and durability tests;*

— *Part 6: Consolidation and permeability tests in hydraulic cells and with pore pressure measurement;*

— *Part 7: Shear strength tests (total stress);*

— *Part 8: Shear strength tests (effective stress);*

— *Part 9: In-situ tests.*

Regarding the in-situ test methods in BS 1377:1975, all have been retained except Test 15(C), determination of the dry density of fine-, medium- and coarse-grained soils by the hand scoop method. Regarding Test 15(C), a new test for coarse-grained soils has been substituted, based on a water replacement method that provides a more reliable result. With Test 19, determination of the penetration resistance using the split-barrel sampler, the method has been revised to conform more closely to international practice.

In addition to the change in the method for determining the density of coarse-grained soils, referred to above, the opportunity has been taken to add other test methods as follows:

Determination of the in-situ bulk density and moisture content of fine-, medium- and coarse-grained soils by attenuation of gamma rays and moderation of neutrons respectively.

Determination of the penetration resistance using the fixed 60° cone and friction sleeve (the static cone penetration test CPT).

Determination of the dynamic probing resistance using the 90° cone (dynamic probing DP).

Determination of the vertical deformation and strength characteristics of soil by the plate loading test.

Determination of the settlement characteristics of soil for lightly loaded foundations by the shallow pad maintained load test.

Determination of the in-situ California Bearing Ratio (CBR).

Determination of the in-situ apparent resistivity of soil.

Determination of the in-situ redox potential of soil.

In each of the test methods the measurement of only one value of the overall result is required. It is recognized that it is necessary in many practical applications to make a number of tests in order to obtain a mean value and an indication of its reliability. Guidance on the number of measurements required and the treatment of the results obtained is regarded as being beyond the scope of this Part of the standard.

Consideration was given to the inclusion of a test method for pressure meters but it was decided that it would be restrictive at this stage to formulate a standard.

General information relevant to the tests and common specification requirements applicable to a number of tests are given in Part 1 of this standard. Reference should always be made to this Part for any particular in-situ test method. For general information on site investigation procedures, especially with regard to safety precautions, reference should be made to BS 5930:1981.

Typical forms are included for a number of the test methods to illustrate how the results may conveniently be recorded and calculated. The layout of such forms is a matter of individual preference. This information is given in Appendix A.

It has been assumed in the drafting of this British Standard that the execution of its provisions is entrusted to appropriately experienced people, for whose guidance it has been prepared.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

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

Summary of pages

This document comprises a front cover, an inside front cover, pages i to iv, pages 1 to 62, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

1 Scope

This Part of BS 1377 describes in-situ methods of test on soils for civil engineering purposes, i.e. tests made directly on the soil in place as distinct from laboratory tests, described in Parts 2 to 8 of this standard, for which samples first need to be taken. The methods described in this Part of this standard have been arranged in groups either according to the purpose of the test or the mode of execution. These groups are as follows.

a) Five methods for the determination of the in-situ density.

b) Three methods for the determination of penetration resistances.

c) Four methods for the determination of the vertical deformation and strength characteristics.

d) Two methods for the determination of the in-situ corrosivity characteristics.

NOTE The titles of the publications referred to in this standard are listed on the inside back cover.

2 In-situ density tests

2.0 Introduction

This clause specifies five methods for determining the in-situ density of soil, four of which use the direct measurements of mass and volume, the choice of which depends upon the type of material, and one method uses gamma rays. The last named also includes the measurement of moisture content with nuclear gauges that combine both facilities.

2.1 Sand replacement method suitable for fine- and medium-grained soils (small pouring cylinder method)

2.1.1 *General.* This method covers the determination in-situ of the density of natural or compacted fine- and medium-grained soils for which a 115 mm diameter sand-pouring cylinder is used in conjunction with replacement sand (see note 1). The method is applicable to layers not exceeding 150 mm in thickness (see note 2).

NOTE 1 With granular materials having little or no cohesion particularly when they are wet, there is a danger of errors in the measurement of density by this method. These errors are caused by the slumping of the sides of the excavated density hole and always result in an over-estimation of the density.

NOTE 2 For layers between 150 mm and 250 mm in thickness the test described in **2.2** should be used.

The requirements of Part 1 of this standard, where appropriate, shall apply to the test methods described in this clause.

2.1.2 *Apparatus*

2.1.2.1 *A pouring cylinder,* similar in detail to that shown in Figure 1.

2.1.2.2 *Suitable tools for excavating holes in soil,* e.g. a bent spoon dibber and a scraper tool, similar to that shown in Figure 2, to make a level surface.

2.1.2.3 *Cylindrical, metal, calibrating container,* with an internal diameter of 100 ± 2 mm and an internal depth of 150 ± 3 mm of the type illustrated in Figure 3, fitted with a lip 50 mm wide and about 5 mm thick surrounding the open end.

2.1.2.4 *Balance,* readable to 1 g.

2.1.2.5 *Glass plate,* a convenient size being one at least 10 mm thick and about 500 mm square.

2.1.2.6 *Metal tray or container* to take excavated soil, a convenient size being one about 300 mm in diameter and about 40 mm deep.

2.1.2.7 *A cylindrical, steel core cutter* (for fine-grained cohesionless soils), 130 mm long and 100 ± 2 mm internal diameter, with a wall thickness of 3 mm bevelled at one end. One suitable type is illustrated in Figure 6. This cutter shall be kept lightly greased.

2.1.2.8 *Apparatus for moisture content determination* as specified in BS 1377-2:1990.

2.1.2.9 *A metal tray* about 300 mm square and about 40 mm deep with a 100 mm diameter hole in the centre.

2.1.3 *Material.* The replacement sand shall be a clean closely graded silica sand which provides a bulk density that is reasonably consistent. The grading of the sand shall be such that 100 % passes a 600 μm test sieve and 100 % is retained on the 63 μm test sieve. In addition it shall be free from flakey particles, silt, clay and organic matter. Before using, it shall have been oven dried and stored in a loosely covered container to allow its moisture content to reach equilibrium with atmospheric humidity.

NOTE Generally a storage period, after oven drying, of about 7 days is sufficient for the moisture content of the sand to reach equilibrium with the atmospheric humidity. The sand should be mixed thoroughly before use. If sand is salvaged from holes in compacted soils after carrying out this test, it should be sieved, dried and stored again before it is used in further sand replacement tests.

2.1.4 *Calibrations*

2.1.4.1 *Determination of the mass of sand in the cone of the pouring cylinder*

2.1.4.1.1 Fill the pouring cylinder so that the level of the sand in the cylinder is within about 15 mm of the top. Find its total initial mass, m_1, to the nearest 1 g and always use the same initial mass for every calibration. Maintain this constant throughout the tests for which the calibration is used. Allow a volume of sand equivalent to that of the excavated hole in the soil (or equal to that of the calibrating container) to run out.