

Recommendations for

Testing of aggregates —

**Part 1: Compactibility test for graded
aggregates**

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Foreword

These recommendations supplement BS 812 “*Methods for sampling and testing of mineral aggregates, sands and fillers*”, which at present includes neither a test that determines the bulk density of graded aggregates at high levels of compaction, nor a test for “optimum moisture content”. Tests for these properties are included in BS 1377 “*Methods of test for soil for civil engineering purposes*”, but these have been found to be unreliable when applied to the aggregates that are commonly used for road sub-bases and base materials.

The recommendations are based on work carried out at the Transport and Road Research Laboratory of the Department of the Environment and the Department of Transport, and the committee responsible felt that the publication of this document would encourage the wider use of a standardized approach to compactibility testing. Subject to minor changes that will be made if such wider use reveals a need to amend apparatus or procedure, it is intended that this standard will be superseded by an addition to BS 812 in due course.

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.

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Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 14, an inside back cover and 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 5835 makes recommendations for testing the compactibility of graded aggregates, particularly those used in roadbases and sub-bases.

2 References

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

3 Definitions

For the purposes of this Part of this British Standard, the definitions given in BS 892 and BS 2787 apply, with the following additions.

3.1

moisture content

the mass of water that can be removed from the aggregate by heating at 105 °C, expressed as a percentage of the mass of the dry aggregate

3.2

initial moisture content

the moisture content of the aggregate before compaction

3.3

residual moisture content, W_R

the moisture content of the aggregate after compaction

3.4

optimum moisture content

the moisture content at which the specified amount of compaction produces the peak value of (dry) bulk density (see Figure 4.)

NOTE The term "optimum moisture content" can be abbreviated to "OMC".

3.5

pessimimum moisture content

the moisture content at which the specified amount of compaction produces the lowest value of (dry) bulk density (see Figure 4)

3.6

saturation

the condition when all air in the voids within and between the particles in an aggregate at a given level of bulk density is displaced by water

3.7

(dry) bulk density, B

the ratio of the mass of a sample of (dry) aggregate to the volume of a standard container required to contain that sample

NOTE Peak (dry) bulk density is the highest mean value found in any *complete* set of compactibility tests.

3.8

proportion of volume occupied by solids, V_s the volumetric equivalent of (dry) bulk density

NOTE Peak proportion of volume occupied by solids is the highest mean value found in any *complete* set of compactibility tests.

3.9

particle density, P

the average mass per unit volume of a sample of individual particles of oven-dried aggregate as determined using the test methods described in clause 5 of BS 812-2:1975

NOTE This term is roughly synonymous with the term "specific gravity" used in BS 1377. The term "relative density" is now preferred.

3.10

water absorption value, W_A

the mass of water held in the voids within particles of aggregate. This, together with the free water around the particles, gives the total moisture content expressed as a percentage of the dry mass of the aggregate, as determined using the test methods described in clause 5 of BS 812-2:1975

4 General

Vibrating hammer compaction tests on graded aggregates give an indication of their packing properties. When such tests are carried out at moisture contents covering a sufficient range, they can give estimates of those levels of bulk density that are likely to be achieved in field conditions, and also of the effects of moisture content upon bulk density levels. It is usually, but not always, possible to identify optimum moisture contents.

The test described is suitable for aggregates having a nominal maximum size not exceeding 37.5 mm. Materials used as sub-bases may include particles as large as 50 mm. These should be removed during the sampling stage (see clause 5).

5 Sampling

The bulk sample for this test should be taken in accordance with clause 5 of BS 812-1:1975, and the method used should be reported. Particles larger than 37.5 mm should be removed and discarded.

The proportion by mass of discarded material should be recorded, and given in the report.

6 Preparation of test material

Representative portions of aggregate for testing should be prepared from the bulk sample so that the mass of oven-dry aggregate in each portion lies in the range of 2.4 kg to 2.6 kg. Care should be taken to minimize variations in grading between these replicate portions.

If a decision has been made to test only the dry material, then only five oven-dry portions will usually be required. These should be stored in sealed containers until required for testing.

For each level of initial moisture content above zero, a set of five portions should be taken. Water should be added to, and mixed with, each of the five portions in each set, to raise their individual moisture contents to within 0.1 % of the required initial moisture content. Each of the wetted portions should be stored in a sealed, water-tight container for at least 12 h before testing, to ensure thorough wetting.

If compaction tests are to be carried out to define the relation between moisture content and (dry) bulk density over the whole range of moisture contents from zero to beyond optimum moisture content (see Figure 4), at least 25 portions should be prepared.

NOTE If the primary purpose is to measure optimum moisture content, it is usually best to select three levels of initial moisture content (e.g. 4 %, 6 % and 8 %) to span the likely value of optimum moisture content. Tests on the 15 portions required by this procedure may be sufficient, but it may be necessary to carry out further tests at other moisture contents.

A guide to the usefulness of tests at any particular moisture content may be gained by plotting the results as they are obtained (see clause 9 and Figure 3, Figure 4 and Figure 5). Moreover, if residual moisture contents are significantly lower than initial moisture contents, there is an implication that saturation moisture content has been reached, and thus it would be pointless to make up portions at even higher initial moisture contents.

7 Apparatus

NOTE The design of the apparatus required in 7.1, 7.2, 7.3, and 7.4 is subject to crown copyright. The Secretary of State for Transport has agreed with BSI to make available, through his Transport and Road Research Laboratory, licences to market and manufacture this apparatus on non-discriminatory terms in the form of royalty payments of 5 % of the net selling price of the apparatus. Applicants for licences should apply to the Director, Transport and Road Research Laboratory, Department of Transport, Old Wokingham Road, Crowthorne, RG11 6AU.

The following apparatus is required.

7.1 A standard compaction mould, comprising a body, a base, filter assembly and an anvil. Details of the standard mould are shown in Figure 1. The cross-sectional area of the mould, given to the nearest 10 square millimetres, should be stamped on the side of the body.

NOTE The anvil is fitted with a pair of rubber O-rings, which will suffer wear. In time this will allow fines to be forced past the O-rings during compaction. Replacement O-rings should therefore be kept and fitted when necessary.

7.2 An electric vibrating hammer, having a power consumption of 900 W and operating at a frequency of about 33 Hz, and equipped with a special shank (see Figure 1 and Figure 2).

NOTE It is important that the vibrating hammer should be properly maintained in accordance with the manufacturer's instructions and that its working parts are not worn. To ensure good working order, overhauls should be carried out not less frequently than every 50 h of operation, or every six months, whichever is the shorter.

7.3 A loading frame to support the hammer and mould and to provide a steady downward force of 450 ± 10 N. The design for the frame is shown in Figure 2.

NOTE Because vibrating hammers of the type used in this test can emit noise levels of up to 100 dB(A), the compaction rig may be housed in a noise-reducing cabinet. A suitable design for a cabinet is also shown in Figure 2. Other, cheaper noise-reduction devices may be satisfactory, but at least some precautions should be taken.

7.4 A depth gauge, clearly readable, to measure the distance between the top of the mould and the upper surface of the anvil to an accuracy of 0.1 mm or better.

NOTE It may be necessary to modify a standard depth gauge to fit into the hole in the anvil.

7.5 A balance, with a capacity of at least 4 kg, readable and accurate to 1 g.

7.6 A stop-watch or stop-clock or an automatic timer to control the vibrating hammer.

7.7 A supply of filter papers, 150 mm in diameter. "Whatman grade 113" has been found to be suitable.

7.8 A supply of non-corrodible, watertight storage containers, having a capacity of about two litres and with lids that can be sealed.

7.9 Apparatus for the determination of particle density and water absorption, in accordance with clause 5 of BS 812-2:1975.

7.10 Apparatus for the determination of moisture content, in accordance with clause 7 of BS 812-2:1975.

7.11 Apparatus for the determination of particle size distribution, in accordance with clause 7 of BS 812-1:1975. Washing and decantation will usually be appropriate (see 7.1.6 of BS 812-1:1975). (Alternatively apparatus for test 7a of BS 1377:1975 may be employed.)

8 Test procedure

NOTE A flow diagram showing the essential steps in the test is given in Figure 6.

8.1 Compaction test. Before each compaction test, check the compaction mould to ensure that it is thoroughly clean and dry. Assemble the mould body, base, filter plates and fibre filter taking care to ensure that the parts fit together properly. Tighten the hand screws to full tightness.