

Sampling and examination of bituminous mixtures for roads and other paved areas —

**Part 104: Methods of test for the
determination of density and
compaction**

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/36 upon which the following bodies were represented:

- British Aggregate Construction Materials Industries
- British Civil Engineering Test Equipment Manufacturers' Association
- British Tar Industry Association
- County Surveyor's Society
- Department of the Environment (Property Services Agency)
- Department of Transport (Highways)
- Department of Transport (Transport and Road Research Laboratory)
- Institute of Asphalt Technology
- Institute of Petroleum
- Institution of Civil Engineers
- Institution of Highways and Transportation
- Mastic Asphalt Council and Employers' Federation
- Mastic Asphalt Producers' Association
- Refined Bitumen Association Ltd.
- Sand and Gravel Association Ltd.
- Society of Chemical Industry
- Coopted members

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Foreword

This Part of BS 598 has been prepared under the direction of Technical Committee B/510.

It has been assumed in the drafting of this British Standard that the execution of its provisions is entrusted to appropriately qualified and experienced people.

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 does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 12, 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 598 describes two methods for determining the density and compaction of bituminous mixtures for roads and other paved areas. The first method describes how to determine the percentage refusal density of core samples of 150 mm nominal diameter cut from compacted bituminous mixtures. This method is intended to apply only to coated macadam dense roadbases or basecourses that have cooled to ambient temperatures and have a minimum layer thickness complying with Table 1 of BS 4987-2:1973.

The second method describes how to measure the density of cores.

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

2 Definitions

For the purposes of this Part of BS 598 the definitions given in BS 6100 apply, together with the following.

2.1

initial dried bulk density

the mass per unit volume, including voids, of the specimen after being placed in an oven until the mass is stable

2.2

refusal density

the mass per unit volume, including voids, of the specimen compacted to refusal in accordance with the test method

2.3

percentage refusal density (PRD)

the ratio of the initial dried bulk density of the sample to the refusal density expressed as a percentage

2.4

bulk density (for use in the calibration of the vibrating hammer)

the mass of a material (including solid particles and any contained water) per unit volume including voids

2.5

repeatability (r)

the value below which the absolute difference between two single test results obtained with the same method on identical test material under the same conditions (same operator, same apparatus, same laboratory and a short interval of time) may be expected to lie with a specified probability; in the absence of other indications, the probability is 95 %

2.6

reproducibility (R)

the value below which the absolute difference between two single test results obtained with the same method on identical test material under different conditions (different operators, different apparatus, different laboratories and/or different time) may be expected to lie with a specified probability; in the absence of other indications, the probability is 95 %

2.7

single test result

the value obtained by applying the standard test method fully, once, to a single specimen; it may be the mean of two or more observations or the result of a calculation from a set of observations as specified by the standard test method

3 Determination of the percentage refusal density (PRD)

3.1 Principle

The initial dried bulk density of the core sample of bituminous mixture is measured by weighing the sample in air and water, the sample being coated in paraffin wax to prevent the ingress of water. After removal of the wax coating, the sample is then heated and compacted with a vibrating hammer “to refusal”. The final density of the sample is then measured by weighing the sample in air and water. The percentage refusal density is a measure of the relative state of compaction of the sample.

3.2 Materials

3.2.1 Paraffin wax of known density at a temperature of 20 °C. The wax shall be capable of covering the core with an uncracked impervious coating.

NOTE Paraffin wax with a congealing point between 49 °C and 50 °C, type BDH 29839, is satisfactory. A coating with optimum properties is obtained when the liquid wax is maintained at a temperature of 55 ± 3 °C.

3.2.2 Paper discs to prevent the ends of the core from sticking to the base plate (see 3.3.5) or the tamping foot (see 3.3.10).

3.2.3 *Silicone grease*, such as one conforming to Ministry of Defence Standard 59-10¹⁾, for use as a releasing agent.

3.2.4 *Talcum powder* of pharmaceutical quality.

3.2.5 *Inert void-filling material*.

3.3 Apparatus

NOTE Apparatus should be calibrated and traceable as recommended in appendix A.

3.3.1 *A ventilated drying cabinet thermostatically controlled* maintain a temperature of between 25 °C and 45 °C.

3.3.2 *A balance* capable of weighing up to 10 kg to an accuracy of ± 1 g, with an attachment to facilitate the weighing of cores in water.

3.3.3 *A bath* suitable for holding molten paraffin wax.

3.3.4 *A water bath* maintained at a temperature of 20 ± 5 °C for immersing the sample while suspended from the balance.

3.3.5 *A split core mould and base plate* (Figure 1).

NOTE The design of the apparatus required in 3.3.5 is subject to crown copyright. The Secretary of State for Transport has agreed with BSI to make available, through the Transport and Road Research Laboratory, licences to market and manufacture this apparatus on non-exclusive and non-discriminatory terms in the form of royalty payments of 7 % 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.

3.3.6 *One spare base plate* (only one spare base plate is needed for a complete set of moulds).

3.3.7 *A heating oven with fan-assisted circulation* and of sufficient capacity and power to raise the temperature of the cores and moulds from ambient to the temperatures specified in Table 1.

3.3.8 *An electric vibrating hammer*, complying with appendix B.

3.3.9 *A 50 mm or 75 mm wide paint-stripping knife and a pallet knife*.

3.3.10 *A 102 ± 2 mm diameter tamping foot and 146 ± 2 mm diameter tamping foot* for use with the electric vibrating hammer (see 3.3.8).

3.3.11 *A 300 mm metric steel rule*, complying with BS 4372.

3.3.12 *A pair of external calipers*, complying with BS 3123.

3.3.13 *A stopclock or watch*

3.3.14 *A thermometer*, capable of measuring temperatures in the range 35 °C to 160 °C with an accuracy of 1 °C.

3.3.15 *A diamond-impregnated saw*, capable of slicing cores.

3.3.16 *A refrigerator or deep freeze*

3.3.17 *A paint brush* for applying wax.

3.4 Preparation of test specimen

3.4.1 Cut a core of 150 mm to 153 mm diameter in accordance with BS 598-100.

NOTE If the core is more than 150 mm deep and/or consists of more than a single layer it will be necessary to saw or split the core to produce valid test specimens.

3.4.2 Measure the diameter of the core to the nearest 1 mm in two directions using the external calipers and steel rule.

3.4.3 If any layer in the core is greater than 150 mm in depth saw the core so that the layer becomes two specimens of similar depth.

NOTE The sawing of multi-layer cores into separate layers should also be considered at this stage as it is often more efficient than splitting.

3.4.4 Place the core or sawn portions of the core, with axis vertical and flattest face down, in the drying cabinet at a temperature below 45 °C.

NOTE Low-temperature drying of cores is essential to ensure that the core does not become distorted. Typically a period of 16 h is necessary at 40 °C, but with voided cores a lower temperature may be necessary.

3.4.5 If the core consists of more than one layer of material, remove from the drying cabinet when warmed (after about 4 h) and separate the layers immediately by placing the core on a flat surface and working the paint-stripping knife or pallet knife around the circumference of the core at the interface between layers. If the bond between layers is such that this method fails then allow the core to cool, saw at the interface and return the layer or layers required for test to the cabinet, as described in 3.4.4.

3.4.6 Dry the core to constant mass. The core shall be considered to be at constant mass when the difference between successive weighings at 2-hourly intervals does not exceed 0.05 %.

NOTE For convenience, it is recommended that the successive weighings to determine constant mass should be carried out whilst the core is warm.

¹⁾ MOD Standard 59-10 "Insulating and filling compounds (insulating compound, electric/silicone grease type" published by Directorate of Standardization, Ministry of Defence, London.