



BS 598 : Part 3 : 1985

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British Standard

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

Part 3. Methods for design and physical testing

Echantillonnage et contrôle des mélanges bitumineux pour chaussées et autres surfaces pavées
Partie 3. Méthodes de conception et d'essais physiques

Probenahme und Untersuchung von bituminösen Mischgut für Straßen und andere befestigte Verkehrsflächen
Teil 3. Ausführung und Verfahren zur mechanischen Prüfung

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Foreword

This British Standard has been prepared under the direction of the Road Engineering Standards Committee and now comprises three Parts:

- Part 1 Sampling
- Part 2 Methods for analytical testing
- Part 3 Methods for design and physical testing

A fourth Part covering field tests is under consideration.

This Part of BS 598 includes methods of test for the design method for wearing course mixtures which has been developed to cover the complete mixture and is given equal status with the traditional recipe method described in BS 594 : Part 1.

The requirements for the composition of all mixtures described in BS 594 : Part 1 are based on the testing of the components and of the mixture by methods specified in other British Standards. Where the methods are not available elsewhere, they are described in this Part of BS 598. Methods of test have been included to determine the condition of the binder on coated chippings and their rate of spread, the texture of finished surfaces and the density of cores drilled from asphalt surfacing. Also included for the first time is a method for assessing the compaction performance of a new roller by comparison with the performance of a conventional 8 t roller.

It has been assumed in the drafting of this Part of BS 598 that the execution of its provisions is entrusted to appropriately qualified and experienced people.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

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Methods

1 Scope

This Part of BS 598 describes design and physical methods of testing all types of coated bituminous mixtures and their constituent materials, except slurry seals, used for roads and other paved areas. The methods include the determination of stability index of pitch bitumen binders, a design method for the composition of wearing-course rolled asphalt, a test for the condition of the binder on coated chippings, the measurement of the temperature of rolled asphalt and the rate of spread of coated chippings, the determination of texture depth and the density of cores. Also given is a means for assessing the compaction performance of a roller.

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 892 apply together with the following.

NOTE. These definitions apply specifically to the design method.

2.1 stability. The maximum resistance to deformation in newtons of a moulded asphalt specimen when tested in accordance with clause 4 of this standard.

2.2 flow. The deformation of the moulded specimen in millimetres at the point of maximum resistance when tested in accordance with clause 4 of this standard.

2.3 mix density. The mass of asphalt mixture per unit volume of the compacted specimen.

2.4 design binder content. The binder content of an asphalt mixture determined in accordance with clause 4 of this standard.

3 Determination of stability index of pitch-bitumen binders

3.1 Principle

The relative stabilities of pitch-bitumen binders are examined under conditions that simulate those in a binder storage vessel. The test consists of two parts:

- (a) sedimentation;
- (b) measurement of the degree of separation resulting from the sedimentation.

The material under test is stored in a glass sedimentation tube kept in a thermostatically controlled oven at 160°C for 4 days. The tube is then sectioned and the relative density of the material in the bottom third is determined. The difference between this relative density and that of the original material gives a measure of the relative storage stability of mixtures.

3.2 Apparatus

3.2.1 Test tubes, of heat-resistant glass, 305 mm long and 12 mm to 13 mm in internal diameter.

3.2.2 Oven, electrically heated and capable of maintaining a temperature of $160 \pm 2^{\circ}\text{C}$, having interior dimensions not less than 330 mm from the top of the heating element to the top of the chamber and not less than 305 mm in width and depth.

3.2.3 Tube holder made of metal, of any convenient form that will hold the test tubes in a vertical position without touching one another and that will support the tubes so that the bottom of the glass is not in direct contact with the oven floor.

3.2.4 Density bottle of Hubbard pattern as described in appendix J of BS 76 : 1964, or a *concentration gradient density column* complying with BS 3715.

3.2.5 Silicone rubber sheet, flat and approximately 100 mm square.

3.3 Reagent

3.3.1 Commercial grade zinc chloride for use in the density column (method B).

3.4 Procedure

3.4.1 General. Carry out either method A or method B.

3.4.2 Method A. Proceed as follows.

- (a) Thoroughly mix the sample by stirring, warming if necessary, to ensure obtaining a representative specimen for test.
- (b) Bring the sample to a temperature of $125 \pm 5^{\circ}\text{C}$ and pour into the upright sedimentation tube which has previously been heated to 120°C , so that the final level of the material in the tube is 10 mm from the top of the tube to enable a loosely fitting cork to be inserted.
- (c) Fill two tubes with the material for one test and test them together.
- (d) Concurrent with the filling of the tubes, pour some of the specimen into sample containers (penetration tins) of metal.
- (e) Determine the relative density of this sample by the method given in appendix J of BS 76 : 1964, at a temperature of 25°C .
- (f) Support the filled tubes in a vertical position in the tube holder and transfer to the oven controlled at $160 \pm 2^{\circ}\text{C}$, and allow to stand undisturbed for a period of 96 h.
- (g) After 96 h remove the sample tubes from the oven and allow them to cool to room temperature. Scribe a line round the tube with a diamond or glass knife 100 mm from the bottom. Apply a bead of molten soda-glass to the scratch; this will cause the glass to

crack neatly. Separate the lower one-third of the tube with a thin sharp blade. Warm the contents of this part of the tube, remove completely from the tube and stir very thoroughly to obtain a representative sample.

(h) Determine the relative density of the specimen from each tube by the method given in appendix J of BS 76 : 1964, at a temperature of 25 °C.

3.4.3 Method B

NOTE. Relative density may be accurately and rapidly measured by means of a concentration-gradient density column as described in BS 3715. The method depends on the flotation of a particle of the material in a column of liquid, in which the density is graded over the required range.

Proceed as follows.

- (a) Carry out the procedures in 3.4.2(a) to (d) inclusive.
- (b) Prepare a density-gradient column in a glass tube so that the relative density is approximately 1.00 at the top and 1.10 at the bottom. Distilled water and an aqueous zinc chloride solution with a relative density of approximately 1.1 afford suitable media for the column which should be about 1.0 m in length.
- (c) Enclose the prepared density-gradient tube in a water jacket controlled at 25 ± 0.1 °C and keep the tube loosely covered when not in use to prevent evaporation.
- (d) Calibrate the column by floating in it a series of glass spheres (3 mm to 4 mm in diameter) of known densities spaced uniformly over the range of the column.
- (e) Prepare the specimen for testing by pouring a ribbon of the well-mixed molten binder on to a flat sheet of silicone rubber. On cooling, cut a small piece (1 mm³ to 2 mm³) from the ribbon. Wet the pellet in a dilute solution of a surfactant to remove air bubbles. Prepare a minimum of three specimens from one ribbon and test together.
- (f) Introduce three separate pellets from each sample into the top of the density-gradient column. Normally they attain the same level; 'wild' results caused by an included air bubble or by a gross separation of the sample are immediately apparent and should be rejected. Introduce further pellets from the same sample until three pellets come to rest at the same level. Calculate the relative density of the sample from a previously constructed graph.
- (g) Follow the procedures described in 3.4.2(f) and (g).
- (h) Determine the relative density of the specimen from each tube by repeating procedures (b) to (f) inclusive of this clause.

3.5 Expression of results

Derive the stability index from the difference between the relative density of the original specimen (D_1) and that of material from the bottom one-third of the sedimentation tube (D_2) from the following:

$$\text{Stability index} = 100(D_2 - D_1)$$

Report the stability index to one decimal place and report which method was used.

3.6 Precision

3.6.1 If results of duplicate tests of determination of relative density by either the density bottle method or the density-gradient column method differ by more than 0.001, then the test shall be repeated.

3.6.2 When results are submitted by each of two laboratories determining the stability index of a particular sample they shall not differ by more than ± 0.2 from the mean.

4 Design method for the composition of wearing-course rolled asphalt

4.1 Principle

Aggregate compositions suitable for wearing-course rolled asphalt that is to be specified by the design method are given in tables 3 and 4 of BS 594 : Part 1 : 1985. This clause describes the procedure to be followed in deciding a suitable binder content for a chosen aggregate composition. The appropriate binder content will differ, for any particular grading of aggregate, according to the nature and source of the aggregate, hence the need for a design procedure, particularly if an unfamiliar aggregate source is to be used.

It has to be emphasized that the design procedure is not simple and takes time. At least three consecutive working days are needed to carry out the procedure properly, and great care and attention to detail are essential if a reliable result is to be obtained. Precise conformity to all the requirements for apparatus and procedure will give a binder content that can be used with confidence in specification; other equipment and the use of short cuts and variation in procedure will almost certainly give misleading results.

The procedure in this clause will give a binder content, called the design binder content, which is a compromise between the conflicting needs of stability, durability and workability.

The method involves the determination of a binder content of the complete mix using Marshall test equipment. Specimens for test are made with the aggregate required for use in the plant mix and with a range of binder contents using the grade of binder proposed for the actual job. Marshall stability, flow and densities are determined by defined procedures which also permit the calculation of other properties.

Appendix B of BS 594 : Part 1 : 1985 gives advice on the application of test data obtained from the design procedure for deciding the best composition of wearing-course asphalt for a given site. Suggestions are also given in the same appendix on the verification procedure to be adopted.

4.2 Apparatus

NOTE. All dimensions are nominal unless tolerances are given.

4.2.1 *Balance*, of not less than 2 kg capacity, accurate to 0.1 g.

NOTE. A second balance, accurate to 5 g, is convenient for proportioning aggregates, filler and binder.

4.2.2 Oven, meeting the requirements of BS 2648 with fan-assisted air circulation, fitted with thermostatic control to maintain temperature in the range 80 °C to 200 °C.

NOTE. Two ovens may be found to be convenient. Aggregates, moulds and steel blocks may be heated in one oven and binder in a smaller oven with a time switch controller.

4.2.3 Mechanical mixing unit of not more than 8 L capacity, capable of combining 1500 g of aggregate, filler and binder speedily and thoroughly without loss.

NOTE. A mechanical mixer with detachable mixing bowl and accurately controlled heating element capable of maintaining the bowl at the required temperature is suitable for this purpose. A wire whisk of adequate strength will normally be found most suitable and the design illustrated has been found to be satisfactory for planetary mixers.

4.2.4 Whisk, of a suitable design such as that shown in figure 1.

NOTE 1. Alternative designs of the whisk head to that shown in figure 1 are suitable providing the wire scrapes the bowl sides.

NOTE 2. Since the wire blades wear out quickly, an economical method of obtaining a whisk is to purchase a boss and bayonet fitting as shown and to produce and fit the wires separately.

4.2.5 Steel mould cylinders, with a 101.6 ± 0.1 mm internal diameter, complete with mould bases and extension collars as detailed in figure 2, sufficient in number to enable the work to continue as required.

4.2.6 Steel compaction hammer, of total mass 7850 ± 50 g including a sliding weight of 4535 ± 25 g with a free fall of 457 ± 5 mm that acts upon the foot assembly as illustrated in figure 3. The apparatus shown in figure 2 is suitable for hand compaction. The foot assembly shall comprise a spring housing and a helical compression spring of hardened and tempered steel with a load rate of 10 N/mm to 18 N/mm and designed to exert a preload of 80 N to 150 N when confined within the foot assembly leaving a minimum movement of 20 mm. The foot of the hammer shall be machined flat and smooth and be securely fixed to the foot assembly.

4.2.7 Automatic compactor, the mass, free fall and design of the complete hammer foot assembly being as specified in 4.2.6 and the operating mechanism shall not be supported by the laminated hardwood block of the compaction pedestal. The free fall height shall be measured when the machine is in operation and be capable of being maintained within the specified tolerances throughout the compaction procedure. The automatic mechanism shall be capable of applying 50 blows at the rate of 60 ± 5 blows per minute.

NOTE. The use of an automatic compactor is recommended particularly in cases of dispute.

4.2.8 Steel block, of 100 mm diameter by not less than 50 mm high. This is used for the initial heating of the compaction hammer.

NOTE. The use of more than one block may be advantageous.

4.2.9 Compaction pedestal, as shown in figure 4 and consisting of the following.

(a) *Vibrated concrete base* of minimum density 2200 kg/m^3 and minimum dimensions 450 mm x 450 mm x 200 mm with a shoulder to receive a laminated hardwood block.

(b) *Laminated hardwood block* 200 ± 4 mm x 200 ± 4 mm in cross section and 450 ± 4 mm in height, made from straight-grained, seasoned timber (such as sapele) free from shakes, splits and knots with a density of 560 kg/m^3 to 720 kg/m^3 at a moisture content of 8 % to 10 %. The block shall be built up of between six and ten approximately equal laminations of quarter sawn board bonded with waterproof resin glue. The ends shall be smooth and normal to the vertical axis and the block shall be treated with a water-resistant impregnant and varnished to minimize changes of moisture content.

(c) *Mild steel plate* 300 ± 5 mm x 300 ± 5 mm x 25 ± 1 mm fitted with a positive location to receive the hardwood block and with a mould assembly holder to secure the mould assembly centrally on the pedestal during compaction and a guide to ensure that the hammer is maintained in a truly vertical position throughout compaction. The mild steel plate with assembly holder and guide shall be secured to the base with four tie rods each tensioned to the equivalent of a torque of $10 \pm 1 \text{ N}\cdot\text{m}$ on an M10 thread.

NOTE. The compaction pedestal plays an important part in the compaction of specimens and it is essential that it conforms with the detailed description.

4.2.10 Extractor, of suitable design to eject the specimens from the moulds without distortion or shock to the specimens.

4.2.11 Water bath, fitted with thermostatic control to maintain the temperature at 60 ± 0.5 °C, with a tray or trays and deep enough to allow at least 25 mm depth of water above and below the specimens. It shall be made so that the specimens can be placed flat face down and not in contact with one another. The bath shall be fitted with one or more pumps, impellers or stirring devices to ensure a continuous circulation of water around the specimens.

NOTE. It is recommended that the water bath be large enough to hold a minimum of 15 specimens.

4.2.12 Steel or cast iron testing head, as shown in figure 5, having segments machined to an inner radius of 50.8 ± 0.05 mm and internal surface hardness of not less than Vickers Hardness Value (HV) 160.

4.2.13 Compression test machine, having a minimum capacity of 22 kN and capable of applying a constant rate of strain to the specimens of 50 ± 3 mm per minute under all loading conditions. The load measurement device shall be calibrated to grade B of BS 1610.

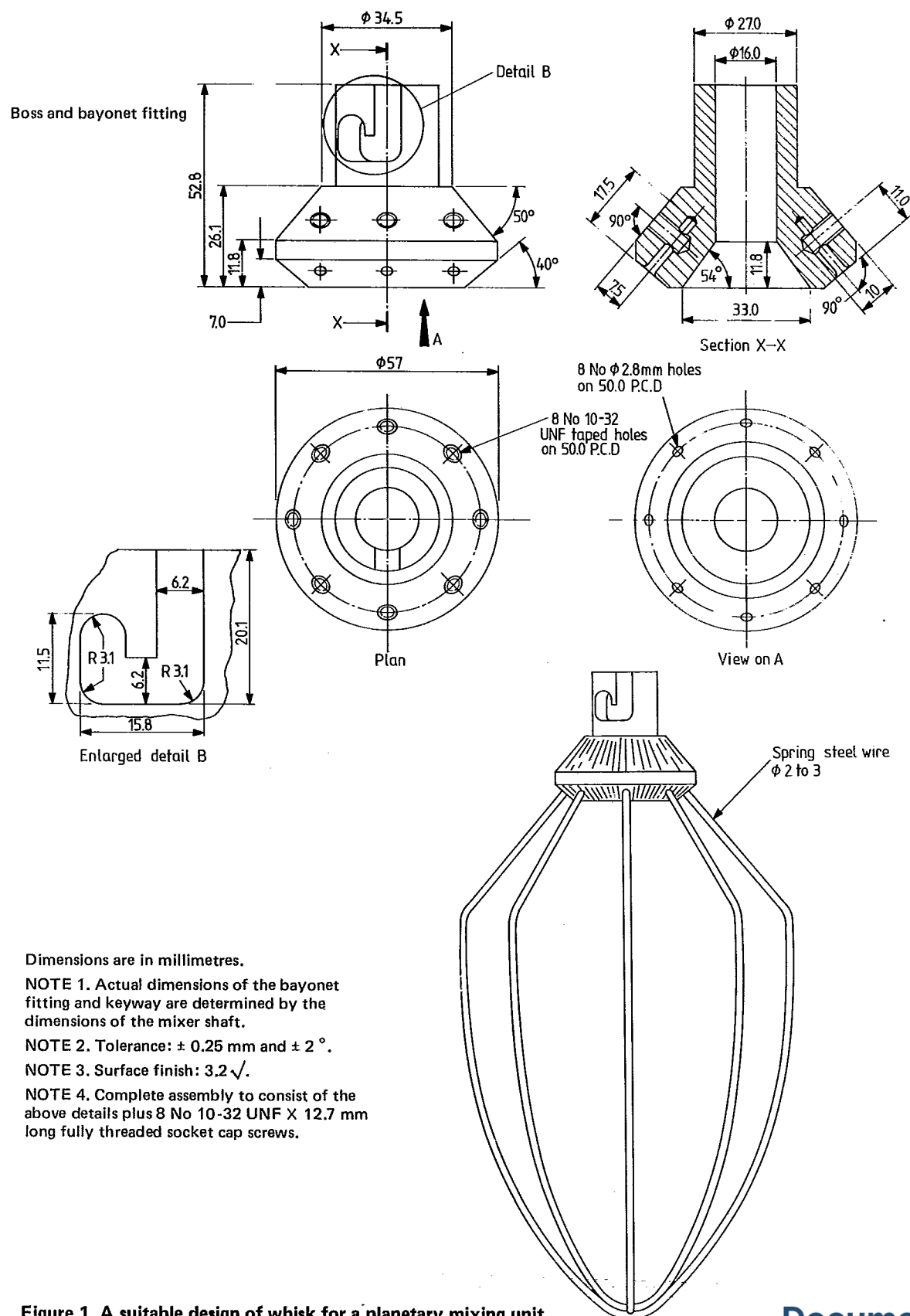
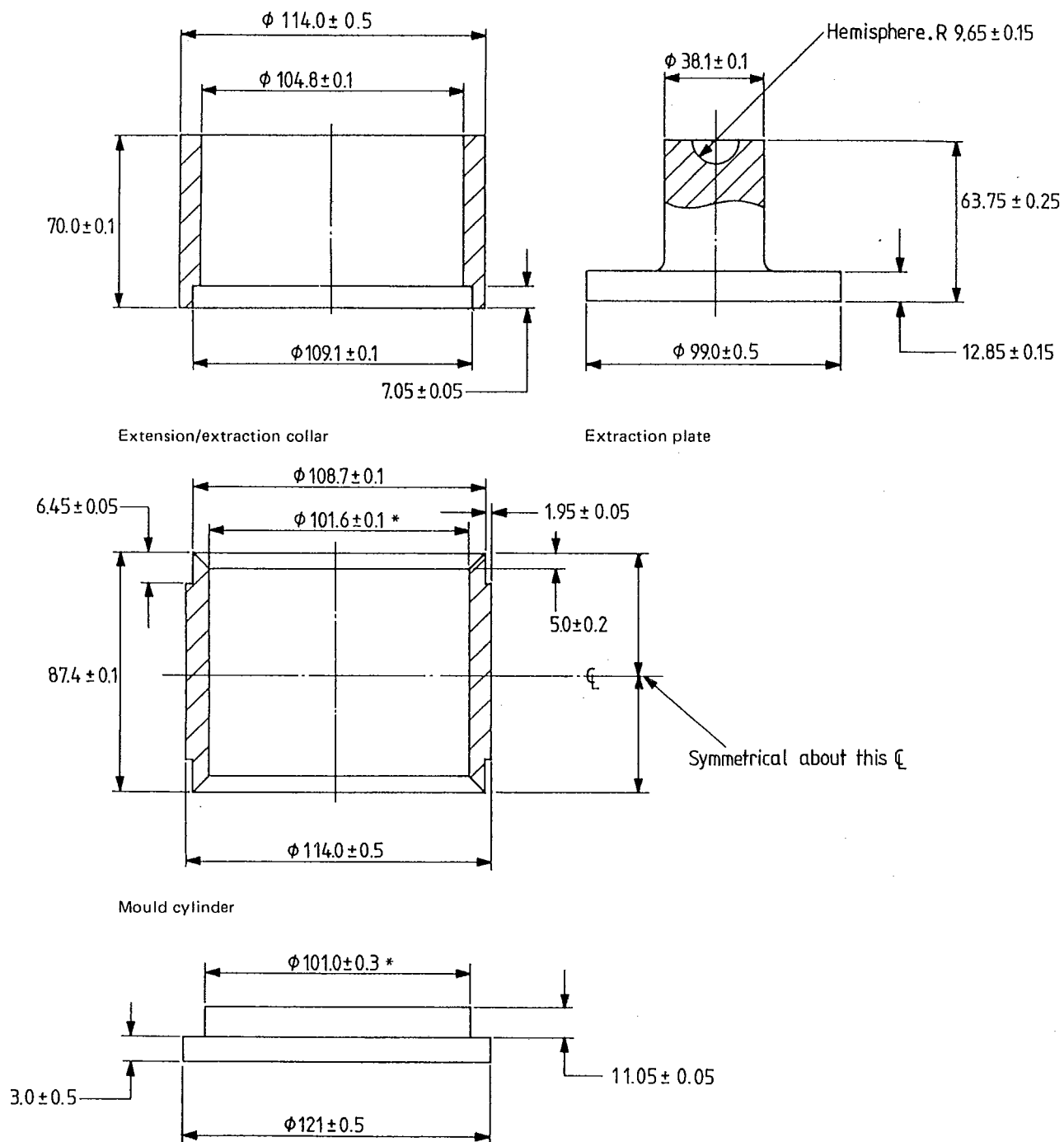


Figure 1. A suitable design of whisk for a planetary mixing unit



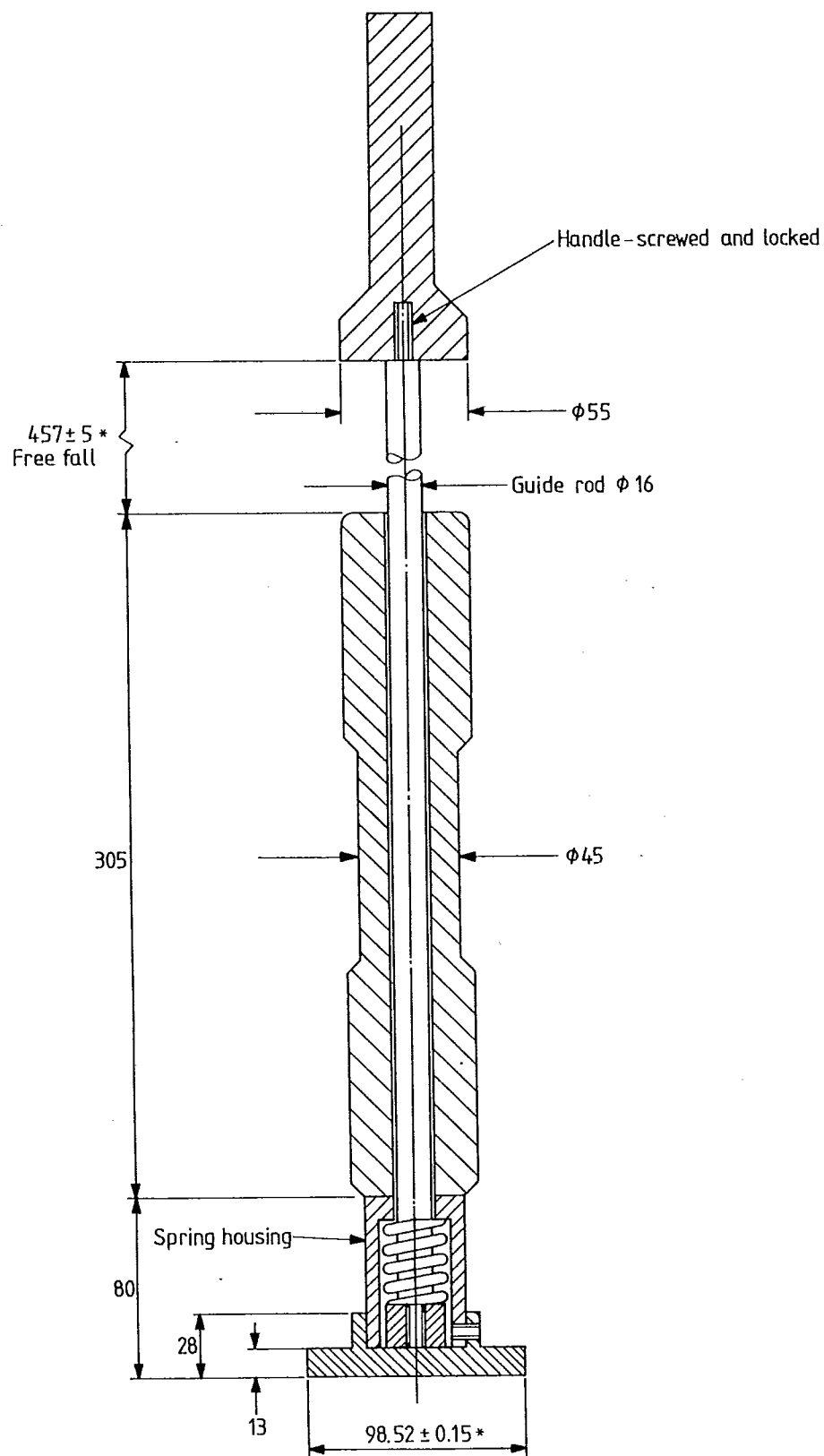
Mould base

Dimensions are in millimetres.

*Essential dimensions.

NOTE. This design has been found satisfactory. Alternative designs are acceptable providing the essential dimensions are complied with and the mould does not distort during compaction.

Figure 2. A suitable design of compaction equipment



Dimensions are in millimetres.
 *Essential dimensions.

Figure 3. Hand compaction hammer

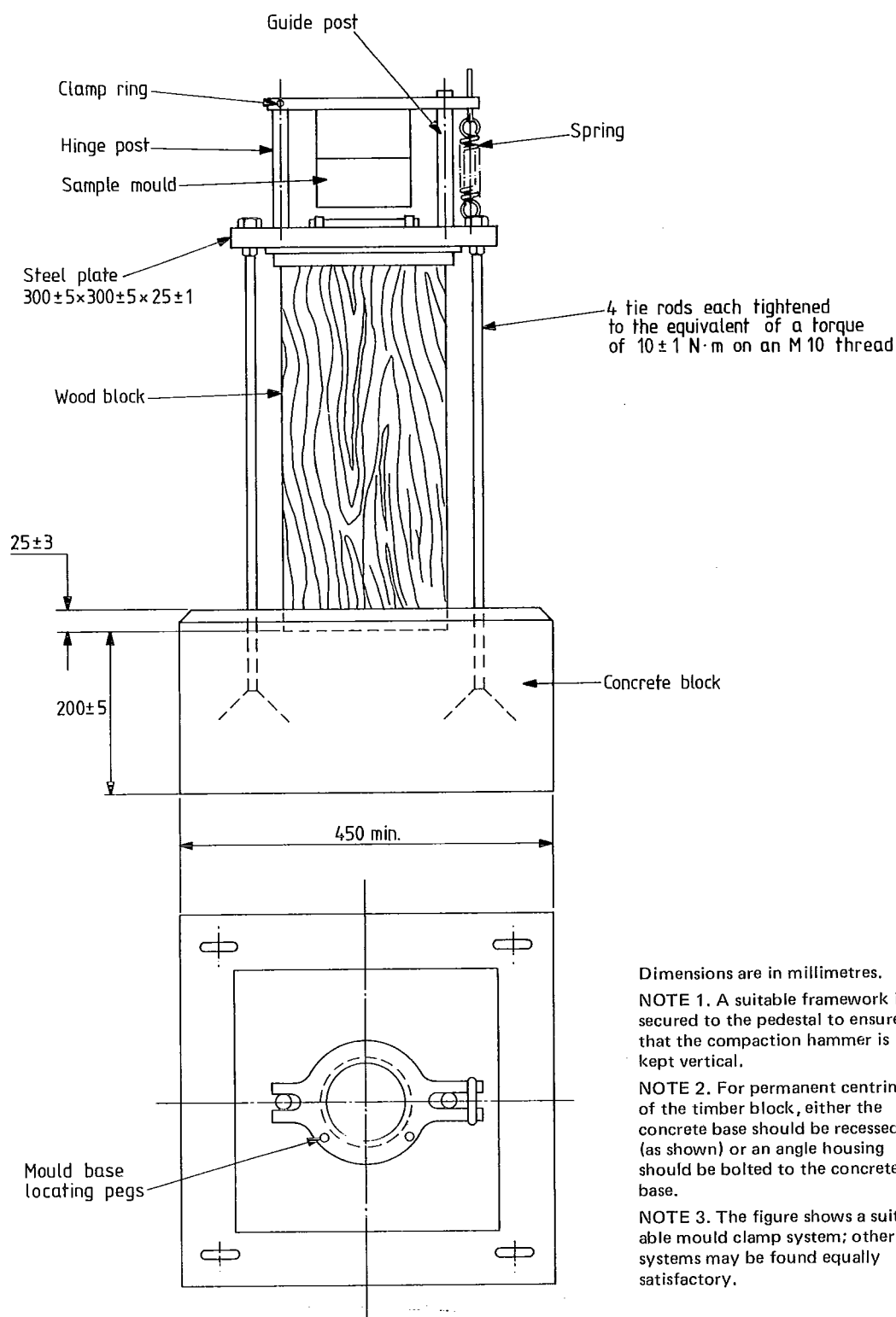


Figure 4. Compaction pedestal