The Technical Committee on Bitumen-Rubber, founded in May 1983 under the chairmanship of the Southern African Bitumen and Tar Association, has made steady progress towards developing an end-result (or performance) type specification for this product.

A prerequisite to such a specification is the formulation of relevant properties and appropriate test methods. This task was undertaken by a Sub-Committee on Specifications and Test Methods.

Although the scope of the main committee was broadened in February 1987 to embrace all modified bituminous binders, with a consequent change of name to Technical Committee on Modified Binders, it was desirable that test methods related to specifications for bitumen-rubber be addressed in the first instance.

It should be noted that the methods given in this manual cover special tests on modified binders and their constituents only. Standard methods described in SABS publications and TMH I are not included. The suffix “T” to the test numbers indicates that the methods are regarded as tentative. However, they are based on the best available knowledge and extensive research and development by various bodies represented on the main- and sub-committee.

This publication will therefore permit consistent application and uniformity of testing country-wide and thereby greatly facilitate the adoption of a national specification for bitumen-rubber and, ultimately, modified binders.

**Members of the Sub-Committee on Specifications and Test Methods:**

- Dr V P Servas NITRR, (Chairman)
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- Mr A O Bergh Mackintosh Bergh and Sturgess
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Abecol (Pty) Ltd
BP SA (Pty) Ltd
CSRA Highway Materials Sub-committee
Department Development Aid
Department of Transport
Much Asphalt (Pty) Ltd
Natal Roads Department
National Institute for Transport and Road Research, CSIR
Protea Asphalt (Pty) Ltd
SA Air Force
SA Association of Consulting Engineers
SA Bitumen and Tar Association
SA Bureau of Standards
Shell SA (Pty) Ltd
Tosas (Pty) Ltd
Transvaal Roads Department

Preface to revised edition

Experience gained in the application of this manual over the past four years has necessitated amendments to be made to the text. These amendments are largely of an editorial nature, excepting those reflecting changes in Method BR3T – Determination of the compression recovery of bitumen-rubber seals in which a water bath is now a requirement and time tolerances have been rationalised and in Method BR7T – Determination of the resilience of rubber crumb used in bitumen-rubber blends in respect of component materials and dimensions of the apparatus used.

The test methods in their amended form are currently under consideration by the Highways Materials Committee of the Committee of State Road Authorities for incorporation into TMH 1 – Standard methods of testing road construction materials.

Current members on the Sub-committee on Specifications and Test Methods are:
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List of manuals published by Sabita

Manual 1 : Construction of bitumen rubber seals
Manual 2 : Bituminous products for road construction
Manual 3 : Test methods for bitumen-rubber
Manual 4 : Specification for rubber in binders
Manual 5 : Manufacture and construction of hot-mix asphalt
Manual 6 : Interim specification bitumen-rubber
Manual 7 : Economic warrants for surfacing roads

Contents

Method BR1 T  Sampling, storing and preparation of samples of bitumen-rubber for testing  9
Method BR2 T  Ball penetration and resilience of bitumen-rubber blends  11
Method BR3 T  Determination of the compression recovery of bitumen-rubber blends  15
Method BR4 T  Flow test for bitumen-rubber blends  18
Method BR5 T  Determination of the dynamic viscosity of bitumen-rubber blends using a rotary viscometer  21
Method BR6 T  Determination of the grading and loose fibre content of rubber crumbs used in bitumen-rubber blends  24
Method BR7 T  Determination of the resilience of rubber crumbs used in bitumen-rubber blends  27
Method BR8 T  Determination of the bulk density of rubber rubber crumbs used in bitumen-rubber blends  30
Sampling, storing and preparation of samples of bitumen-rubber for testing

1 SCOPE

This method describes how a sample of bitumen-rubber is taken after blending and how it is stored and prepared prior to testing.

2 APPARATUS

2.1 Sample tins with tightly fitting lids and a capacity of approximately one litre.

2.2 An oven capable of maintaining a temperature of 140 ± 5 °C.

3 METHOD

3.1 Sampling

As the properties of bitumen-rubber may change during storage, test samples should be taken at the start of spraying or if asphalt is made, at the start of production and again as soon as possible after spraying or mixing has been terminated. If required, samples may also be taken during the process of spraying or mixing to control the variability of the product.

The tanker or distributor should be provided with a sampling valve. Unless the distributor is fitted with a sampling valve in the circulation line, draw at least 10 litre of binder from the valve to clean it. Then draw at least two samples of one litre each in clean sample tins and seal them immediately (see 5.1).

When the samples have cooled down sufficiently, mark them clearly and indelibly as described in 4.

3.2 Storing of samples

Store the samples in a cool place (below 30 °C) until they are tested. Keep the containers sealed (see 5.2).
3.3 Preparation for testing

Open the sample container and place it in an oven at 140 ± 5 °C. As soon as the bitumen-rubber is soft enough to flow freely, remove it from the oven, stir it thoroughly and fill the test moulds as prescribed in the relevant test methods. As bitumen-rubber may not be re-heated, it is essential that enough test specimens are prepared (to allow for accidents, anomalous results etc).

The sample may not be kept at the preparation temperature for longer than one hour.

The heating and sample preparation time must not exceed three hours. Samples that have been heated once may not be used again.

4 MARKING AND REPORTING

Test sample containers should be indelibly marked with the following information:

- Job reference number
- Date when sampled
- Time when sampled
- Road location reference eg km, lane
- Name of product
- Temperature of product when sampled
- Viscosity (Method BR7 T) at the above temperature
- Time elapsed between mixing and sampling

The above information may also be contained in a sample submission letter or form. In that case the job reference number, date of sampling and sample reference number should be sufficient to identify the sample.

5 NOTES

5.1 The tins should be clean and dry, especially when they have been cleaned with a solvent prior to use. Asbestos gloves or other means of protecting the hands should be worn when the samples are drawn.

5.2 In some field storage facilities it may not be possible to keep the samples at a temperature of less than 30 °C during the summer months. In such cases the samples should be tested as soon as possible or removed to a cooler environment for extended storage.

METHOD BR2 T

Ball penetration and resilience of bitumen-rubber blends

1 SCOPE

The penetration of a standard ball into non-aged and oven-aged bitumen-rubber is determined together with the rebound recovery after the ball penetration tool has been pushed a further 10 mm into the material.

2 APPARATUS

2.1 A standard bitumen penetrometer with a plunger assembly which can be tared to weigh 75 ± 0,01 g when the ball penetration tool is attached (see 5.1).

2.2 A ball penetration tool with a ball of 17 ± 0,1 mm in diameter attached to a shaft which fits into the penetrometer. The tool should weigh 27,5 ± 0,1 g (see Fig BR2/1).

2.3 Glass beakers with diameters of approximately 70 mm and at least 70 mm deep or flat bottom metal tins with the same dimensions (see 5.2).

2.4 A forced draft drying oven capable of maintaining a temperature of 60 ± 1 °C.

2.5 A water bath, thermostatically controlled, capable of maintaining a temperature of 25 ± 0,2 °C.

2.6 A penetration transfer dish of glass or heavy plastic with a diameter of at least 130 mm and at least 120 mm high.

2.7 A glass thermometer, 0 - 50 °C accurate to 0,2 °C.
3 METHOD

3.1 Preparation of test specimen
Take samples of the bitumen-rubber and prepare them as described in method BR1 T. Fill the test container in 2.3 to a height of approximately 60 mm with the bitumen-rubber (see 5.2). Prepare two specimens from each sample. If only the non-aged or oven-aged test is to be done, one specimen will be sufficient.

3.2 Ageing of samples
Leave the samples to stand under laboratory atmospheric conditions (24 ± 4 °C) for 24 ± 2 hours. Allow one of the two samples to age by placing it uncovered in a force draft oven at 60 ± 1 °C for 24 ± 1 hours. After ageing, place both samples in a water bath at 25 ± 0.2 °C for at least two hours before testing.

3.3 Testing
Coat the penetration ball, fitted to the penetrometer, very lightly with silicone grease. Place the container with sample in the transfer dish filled with water from the waterbath to cover the surface of the sample to a depth of at least 20 mm (see 5.2). Place the ball in contact with the surface of the material to be tested, not less than 10 mm from the side of the container. Set the indicator dial of the penetrometer to zero. Release the penetration assembly and allow it to penetrate the specimen for five seconds. Record the reading as ball penetration P in tenths of a mm.

Without returning the dial pointer to zero, press the ball down an additional 100 units (i.e. a reading of P + 100) at a rate of 10 units per second. Re-engage the clutch to hold the tool down for an additional five seconds (see 5.3). During this time set the dial pointer on zero for non springloaded spindles. Release the clutch, allow the specimen to recover for 20 seconds, engage the clutch and record the reading as F.

Determine the penetration and resilience, if possible, at three points equally spaced from each other and at least 10 mm away from the side of the container. Between each test, determine the temperature of the water in the transfer dish. If the temperature has dropped by more than 1 °C, replace the water with water from the water bath.

4 CALCULATIONS

Calculate the resilience for each test point to the nearest one percent as follows: Resilience (%) = P + 100 − F

where:

P = Ball penetration value (0.1 mm)
F = reading after recovery (0.1 mm)

Report the average ball penetration value and average resilience for the conditioned and unconditioned samples to the nearest one percent.

![Figure BR211](image-url)

**Ball penetration tool**

**Material steel mass of ball penetration tool:** 27.5 ± 0.1 g

**Total mass of ball and penetrometer shaft:** 75 ± 0.1 g

**NOTE:**
ONLY THE FOLLOWING DIMENSIONS ARE CRITICAL:

TOP DIAMETER OF SHAFT: 3.2 ± 0.1 mm
DIAMETER OF BALL: 17 ± 0.1 mm
MASS OF TOOL: 27.5 ± 0.1 g
5 NOTES

5.1 If the mass of the ball penetration tool is 27.5 g, it should only be necessary to remove the 50 g weight from the penetration shaft used for the normal bitumen penetration test in order for the assembly to have a total mass of 75 g.

5.2 Where metal tins are used as sample containers, the rims of the tins should not be much above the level of the sample for the operator to see exactly when the ball touches the surface of the material at the start of the test. If the container is seammed around its bottom rim, a suitable spacer should be placed under it to ensure a solid base. A plaster of Paris spacer, made as follows, has been found to work well. Mix plaster of Paris to a pasty consistency. Flatten the paste with a straight edge to approximately 5 mm thick. Coat the bottom of a metal container lightly with silicone grease and press it slowly into the plaster of Paris. (To assist in the removal of air under the tin, a small hole can be made with a nail in the centre of the bottom of the tin.) Cut the excess plaster of Paris at the sides of the tin to form a neat base. Leave the plaster of Paris to set and remove the tin. This base can remain in the transfer dish. Tins are placed on it for testing.

5.3 The clutch of the penetrometer may slip slightly during the rest period when testing material with a fairly high resilience. This may be prevented by holding the measuring plunger down and monitoring any slippage on the dial. Slippage can be corrected or prevented by slight downward pressure on the plunger.

REFERENCE

ASTM Designation D3407 and D3408

METHOD BR3 T

Determination of the compression recovery of bitumen-rubber blends

1 SCOPE

The elastic recovery of a bitumen-rubber cylinder is measured after it has been compressed to half its original height.

2 APPARATUS

2.1 A compression frame capable of reducing the height of the bitumen-rubber specimen from 25.4 mm to 12.7 mm (fixed). The frame shall have a removable metal base plate on which the specimen(s) can be formed (see Fig BR3/1).

2.2 Cylindrical moulds of silicone rubber or other suitable material capable of withstanding a temperature of 175 °C with inside dimensions: height 25.4 mm; diameter 19.0 mm. The moulds should be made in such a way that they can be easily removed (see 4.1).

2.3 A water bath and air cabinet capable of maintaining a temperature of 25 ± 0.2 °C.

2.4 Releasing agent such as a 1:1 mixture of glycerine and dextrine.

2.5 A height measuring device such as a T-gauge to measure to an accuracy of at least 0.5 mm.

2.6 Self-releasing or plastic coated paper circles of 20 mm diameter (see 4.2).

3 METHOD

3.1 Preparation of test cylinders

Prepare the bitumen-rubber as described in Method BR1 T. Place two cylindrical moulds on the clean base plate, each approximately halfway between the centre of the base plate and the guide holes. If moulds other than silicone rubber are used they should
be treated with the releasing agent. Fill the moulds to excess with the bitumen-rubber. Allow to cool to room temperature and remove the excess material with a hot spatula.

3.2 Testing

Immerse the test specimens together with the base plate in the water bath at 25 ± 0.2 °C for one hour ± 5 min. Take it from the water bath and carefully remove the moulds from the cylinders. Place the base plate in the test rig. Place a round of paper on top of each bitumen-rubber cylinder. Place the compression plate on top and, by means of the lever, compress the bitumen-rubber cylinders with a smooth quick action until the spacer rings touch the compression plate.

Immediately remove the compression plate and the paper rounds and note the time accurate to five seconds. If a stopwatch or other timing device is used, set it in operation.

Measure the height of each of the cylinders after five minutes ± five seconds, one hour ± five minutes, four hours ± 15 minutes, 24 hours ± 30 minutes and four days ± one hour recovery. During this time the samples should be placed in the air cabinet and kept from vibrations and shock (see 4.3).

3.3 Calculations

Calculate and report the percentage recovery as follows:

\[ \% \text{ Recovery} = \frac{h}{25.4} \times 100 \]

where: \( h \) = height of recovered specimen in mm.

Report the results accurate to 0.1 % for five minutes, one hour, four hours, 24 hours and four days recovery.

4 NOTES

4.1 Silicone rubber moulds may be made using a self curing or two-part silicone rubber compound or similar material. Metal moulds can be used to make the silicone rubber moulds. The silicone rubber mould is cut vertically on one side to facilitate removal of the bitumen-rubber cylinder. It is held together with an elastic band when in use.

4.2 The backing paper used for self-stick labels or film has been found to work well.

4.3 If an air cabinet is not available the samples may be kept in a room where the temperature is controlled at 25 ± 2 °C. This fact should be mentioned in the test report.

Figure BR3/1
Apparatus for compression/recovery test
Flow test for bitumen-rubber blends

1 SCOPE
This test measures the flow properties of bitumen-rubber blends at high temperatures.

2 APPARATUS
2.1 Moulds consisting of a brass or copper plate 3,2 mm thick with a rectangle 20 x 60 mm cut out of it. Multiple specimen moulds can also be used with the cut-outs not less than 20 mm apart.

2.2 Smooth, flat, tinned oven trays or similar stiff metal plates at least 200 x 200 mm (see 5.1).

2.3 A force draft drying oven capable of maintaining a temperature of 60 ± 1 °C, free from vibration (see 5.2).

2.4 A water bath or air cabinet capable of maintaining a temperature of 25 ± 1 °C and big enough to accommodate the tray in 2.2.

2.5 A firm frame or support to keep the tray (2.2) at an angle of 35 ± two degrees in the oven.

2.6 A scale or other measuring instrument to measure accurately to 1 mm.

2.7 A spatula with a 25 mm wide blade.

2.8 Water soluble releasing agent such as a 1:1 mixture of dextrine and glycerine.

3 METHOD

3.1 Preparation of test specimen
Prepare the bitumen-rubber as described in method BR1 T. Prepare at least two moulds for each sample to be tested by coating it thoroughly with the releasing agent. Place the moulds not less than 20 mm apart with one short side approximately 10 mm from one side of the tray. (Multiple specimen moulds can also be used – see 2.1.) This will be the top side of the specimens. Fill the moulds with an excess of bitumen-rubber.

When cool, trim the top surface level with the sides of the moulds using a hot spatula. The excess material is levelled off by holding the flat side of the blade of the spatula at an angle to the specimen. It should not be scraped off with the sharp edge of the blade. The slight bulge that is formed behind the spatula is acceptable.

Remove the moulds carefully from the specimens after cooling and wash the test specimens and plate clean of releasing agent. Make a mark opposite and in line with the bottom end of each of the specimens on the bottom of the tray with an indelible heat resistant pen or soft pencil. Place the tray with specimens in a water bath or air cabinet at 25 ± 1 °C for 30 ± five minutes prior to testing.

3.2 Testing
Remove the tray from the waterbath or air cabinet and dry it and the specimens with an absorbent cloth or paper towel. Place the tray in the oven at 60 ± 1 °C at an angle of 35 ± two degrees with the top side facing up. The oven should not vibrate as this may influence the results. Leave the specimens in the oven for four hours ± five minutes, remove and allow to cool to room temperature. Make a mark opposite the lower end of the specimen below the previous mark. Measure the distance between the two marks as the flow distance accurately to 1 mm.

4 CALCULATIONS
Report the flow distance in mm accurately to 1 mm for the average of the two samples. Also indicate in the report if any separation of bitumen from the bitumen-rubber is noticed.
5 NOTES

5.1 Research indicates that the metal the tray is made of does not influence the results. The only important prerequisite is that the surface should be smooth and free from scratches. When cleaning the tray it is very important not to scratch it.

5.2 It may be impossible to find a force draft oven without any internal vibration. Every effort should be made to reduce vibration in the oven as far as possible because it may influence the results.

METHOD BR5 T

Determination of the dynamic viscosity of bitumen-rubber blends using a rotary viscometer

1 SCOPE

This method describes the determination of the dynamic viscosity of bitumen-rubber blends using a hand-held, battery operated, rotary viscometer.

2 APPARATUS

2.1 A hand-held rotary viscometer with a rotor-cup to measure dynamic viscosity in the range 0,5 to 10 Pa.s, accurate to 0,1 Pa.s. For laboratory use the instrument should be mountable on a stand (see also 5.2).

2.2 A purpose-made stand or retort stand and clamps to hold the viscometer rigidly for viscosity determinations in the laboratory.

2.3 An oven, thermostatically controlled and capable of maintaining temperatures of 150 °C to 300 °C accurate to ± 5 °C.

2.4 A 0 - 300 °C thermometer accurate to ± 1 °C.

2.5 Asbestos gloves.

2.6 A stirring rod or spatula capable of mixing and stirring of the viscous bitumen material.

2.7 Metal tins or glass beakers with capacities of approximately one litre and with a diameter of at least 100 mm allowing a sample depth of at least 80 mm. If the tins are also used as sample containers they should have tightly fitting lids.
3 METHOD

3.1 In the field

Take a representative sample of bitumen-rubber blend as described in Method BRI T using the sample containers in 2.7 above. Directly after taking the sample, stir it well with a suitable stirring rod. Measure and record the temperature (see 5.1).

Attach the correct viscosity cup-rotor to the viscometer such that viscosity measurements will be between 0.5 and 10 Pa.s (see 5.2). Ensure that the vent hole on top of the rotor is open. Place the sampling tin or beaker on a firm non-heatable base and immerse the viscometer rotor in the centre of the sample up to the depth mark on the stem. After approximately 30 seconds start the rotation of the rotor while holding the instrument absolutely horizontal (see 5.3). If possible, a stand should be used. Take and record the viscosity reading to an accuracy of 0.1 Pa.s approximately 10 seconds after the rotor is set in motion. Remove and clean the rotor (see 5.6).

3.2 In the laboratory

Take a representative sample of the bitumen-rubber blend as described in Method BRI T.

5 NOTES

5.1 In seal work it is necessary to measure the viscosity of the bitumen-rubber blend before, during and after spraying to determine its sprayability. To make the results meaningful the viscosity and temperature should be determined as soon as possible after sampling to prevent heat loss.

5.2 The metric standard for expressing dynamic viscosity is Pa.s. Most viscometers are, however, calibrated in either centipoise (cP) or dPa.s with 1 cP = 1 dPa.s x 10^-2 = 1 Pa.s x 10^-3. Therefore 1.5 Pa.s = 15 dPa.s = 1500 cP.

5.3 To prevent damage to the instrument some manufacturers stipulate that the viscometer is set in motion before the cup is immersed. In order to comply with this requirement, while still allowing for the cup to heat up to the temperature of the bitumen-rubber, it is suggested that the cup is immersed for 30 seconds, pulled more than halfway out of the binder, the motion started and the cup immersed to the mark. The viscosity reading should then be taken approximately 10 seconds after this second immersion.

5.4 The viscosity should be measured at the spraying temperature.

5.5 The bitumen-rubber sample should be heated and tested in the same manner as described in 3.1. If the sample is not as specified in 2.7 above, the sample can be used directly. Otherwise, transfer the sample to a container at a temperature as specified in 2.7. Take a sample with a suitable heater while the temperature is specified. When the temperature of the container is reached (see 5.4), immerse the heater and thermostated and determine the viscosity as described in 3.1.1. The viscometer should be cleaned with a stand to hold it in an horizontal position and clean the rotor (see 5.6).
Determination of the grading and loose fibre content of rubber crumbs used in bitumen-rubber blends

1 SCOPE

In this method a dry sieve analysis is carried out on the rubber crumbs intended for use in bitumen-rubber blends. The loose fibres are collected during the sieving operation as a rough indicator of fibre content.

2 APPARATUS

2.1 The following test sieves, 200 mm diameter, complying with SABS 197: 2,36 mm; 1,18 mm; 0,600 mm; 0,300 mm; 0,150 mm; 0,075 mm with a lid and receiver.

2.2 A suitable nylon or bristle sieve brush.

2.3 A balance accurate to 0,01 g to weigh up to at least 200 g.

3 METHOD

Obtain a representative sample of approximately 500 g of rubber crumbs either from randomly selected individual bags as delivered on site or from the rubber crumbs container at the blending or mixing plant at random intervals.

Mix the sample thoroughly and break down any lumps that it may contain (see 5.3). Scoop out duplicate test samples of more or less 50 g each and test each sample as follows:

Nest the sieves on the receiver in descending order of size and transfer the sample to the top sieve. Place the lid in position and hand sieve the sample for approximately two minutes by rocking and tapping the sieves. Mechanical sieving can be used for this initial operation especially when the presence of fibres is suspected, but the final sieving should be done by hand.

Remove the lid and gently rub the rubber crumbs in the uppermost sieve. Hand sieve the material until nothing more passes that specific sieve. If fibre is present it can be clearly seen in the sample as short light coloured hairs. These will form a ball during the sieving operation. Collect the fibre balls carefully and place them in a clean receptacle. Remove the sieve and repeat the operation for each sieve in the series. For the 1,18 mm and other finer sieves the fibres collected on a specific sieve are placed back on the next coarser sieve and re-sieved to remove rubber particles sticking to the fibres. The fibres are then carefully collected and placed in the fibre receptacle (see 5.2).

Weigh the material retained on each sieve accurately to 0,01 g. Also determine the mass of the fibres collected from the sieves. A sieve analysis reporting form such as form B4/1 in TMH1 method B4 can be used for reporting the results.

4 CALCULATIONS

Calculate the percentages passing the sieves as described in TMH1 method B4 and report the results on a form such as B4/2 or B4/3, adapted for this purpose, to the nearest 0,1 %:

Calculate the fibre content as a percentage of the total sample by mass and report together with the grading results.

In the report the following should be noted:
The batch number and sampling date if available.
The condition of the bags in which the rubber was stored.
The height of the rubber bag stockpile.
The presence of foreign materials in the rubber such as steel wire, string etc.
If the rubber crumbs are loose or lumpy.
If fibre particles are visible or not.

5 NOTES

5.1 Although the fibre particles in rubber crumbs are fairly short they tend to form a ball during the sieving operation. The same happens during the blending and/or mixing operation and their presence creates construction problems and may lead to an unacceptable end product.

It is impossible to separate or collect all the fibres in the crumbs but usually the specifications state that no fibre or a very small percentage is allowable. This method will therefore be sufficient in most instances where fibre could be a problem.
5.2 The sieving operation and collection of fibres is a tedious process and care should be taken that the operator does not hurry the test.

5.3 Rubber crumbs should be dry when sampled. If damp, they should be dried in a drying oven at 60 °C for one hour prior to testing. Higher temperatures and prolonged heating may change the characteristics of the rubber and should be avoided.

Footnote: Duplicate samples should be tested.

METHOD BR7 T

**Determination of the resilience of rubber crumbs used in bitumen-rubber blends**

1 **SCOPE**

In this test the resilience of the rubber crumbs is determined to characterise the performance of the rubber when used in bitumen-rubber blends.

2 **APPARATUS**

2.1 An oven capable of maintaining a temperature of 160 ± 5 °C for at least one hour.

2.2 Bitumen penetration apparatus and a ball penetration tool as described in Method BR2 T.

2.3 A standard brass bitumen penetration cup with an internal diameter of 55 mm, a depth of 35 mm and wall thickness of 1 mm.

2.4 A brass disc with a diameter of 54 mm and a thickness of 2.65 mm. A slight hollow is made in the centre of the disc to a depth bringing the mass of the disc to 50 ± 0.1 g.

2.5 A pan, 250 ± 5 mm square and 20 mm high, made from stainless steel with a thickness of 2 mm.

2.6 A stopwatch or timing device to measure periods of 10 seconds accurately to 0.1 second.

3 **METHOD**

3.1 Keep the rubber sample to be tested in the laboratory in a closed container to obtain a temperature of 25 ± 2 °C (see 5.1). Fill the penetration cup loosely with the rubber by pouring it into the cup until it overflows. Give the cup a light shake sideways to remove most of the surplus rubber. Level the surface of the rubber by scraping it off with a straight edge or side of a spatula. Do not compact the rubber at all. (see 5.2).
3.2 Carefully place the brass disc on top of the rubber and position the cup under the penetration apparatus with the ball penetration tool fitted to it. Centre it to allow the ball to fit in the hollow without any sideways movements. Zero the gauge with the ball just touching the disc. Release the clutch of the penetrator. Depress the ball evenly to read 100 (10 mm) on the dial in three seconds. Hold the dial spindle and ball there for three seconds. Release the spindle and ball and let the rubber recover for 10 seconds and then engage the clutch. During this time the dial pointer should be returned to zero if it is not spring loaded. After the recovery period, record the reading as Y.

3.3 Heating of second sample:

Pour rubber crumb from the sample container into the square pan to an even depth of 20 mm.

Place the pan with rubber in an oven at 160 °C for one hour ± one minute. Remove it from the oven and cover the pan with a suitable cover such as a bigger pan or glass plate while it is allowed to cool to 25 ± 2 °C.

Repeat the test as described above on the baked rubber and record the result as X.

4 CALCULATION

Calculate the resilience of the original rubber as follows:

Resilience (Raw) : 100 – Y

Calculate the resilience of the rubber after heating to 160 °C for one hour as follows:

Resilience (Baked) : 100 – X

Calculate the loss in resilience of the rubber as:

\[
\frac{\text{Res (Raw)} - \text{Res (Baked)}}{\text{Res (Raw)}} \times 100\%
\]

Report the results to the nearest whole number together with the following information:
Sample number
Date
Rubber batch number/Date
Manufacturer

5 NOTES

5.1 If the environmental temperature of the laboratory is outside these limits, the rubber should be placed in a hot box or brought to the test temperatures by any means other than by direct heating.

5.2 To classify rubber crumbs it is also necessary to know their bulk density. For referee purposes method BR8 T should be used. For classification purposes the following method has been found to be accurate enough. Weigh the penetration cup (2.3) accurately to 0.1 g as Ce. Fill it as described in 3.1 with rubber prepared according to method BR8 T. Weigh it again with rubber as Cr. After the test has been completed determine the volume of the cup by filling it with distilled water at 25 ± 0.2 °C, putting a small glass plate on top, removing all air bubbles, drying and weighing it as Mf. Also determine the mass of the cup and glass plate as Mc. The volume of the cup is calculated as follows:

\[
\text{Volume of cup } V_c = \frac{M_f - M_c}{0.99707} \text{ cm}^3
\]

The bulk density of the rubber is calculated as follows:

\[
\text{Bulk density of rubber} = \frac{C_r - C_e}{V_c} \times 1000 \text{ kg/m}^3
\]
Determination of the bulk density of rubber crumbs used in bitumen-rubber blends

1 SCOPE

This test determines the bulk density in water of rubber crumbs in the particle size range 0,600 to 0,300 mm used in bitumen rubber manufacture. The method in BR7 T (5.2) can be used as a quick test but this method will be regarded as the referee method.

2 APPARATUS

2.1 The following test sieves, 200 mm in diameter, complying with the requirement of SABS 197: 0,300 mm and 0,600 mm and a receiver.

2.2 A balance to weigh up to at least 50 g accurate to 0,01 g.

2.3 A glass measuring cylinder, at least class B, of 100 ml capacity with 1 ml graduations.

2.4 A glass beaker with a capacity of 250 ml with graduations not greater than 50 ml apart.

2.5 Glass stirring rods of lengths suitable for use in the glass beaker and measuring cylinder.

2.6 A wash bottle with jet.

2.7 A hotplate, thermostatically controlled, capable of gently boiling a beaker of water.

2.8 An anionic wetting solution such as a 10 % Teepol solution.

3 METHOD

3.1 Preparation of samples

Obtain a bulk sample of the rubber of at least 1 kg mass by taking small sub-samples from at least 10 randomly selected bags of rubber crumbs. Thoroughly mix the crumbs and pour out into a large pan or similar container. Using a small scoop, such as a teaspoon, scoop out small quantities of rubber crumbs randomly to obtain a test sample of 20-25 g. If the sample is wet, air dry it. Prepare at least two samples.

3.2 Sieving of material

Clean and dry the test sieves to be used. Stack the two sieves on a receiving pan. Add the test sample to the 0,600 mm sieve and hand sieve it for approximately two minutes by rocking and tapping the sieves. Check whether the mass of material retained on the 0,300 mm sieve exceeds 20 g. If it does, divide the material in two and resieve one half for at least another two minutes on the 0,300 mm sieve. If there is less than 7,5 g of material on the 0,300 mm sieve prepare and sieve a second lot of material as described above. After sieving, mix the two lots thoroughly. Treat the duplicate sample similarly.

3.3 Determination of the bulk density

Transfer 7,5 ± 0,1 g of the material retained on the 0,300 mm sieve to a clean dry 250 ml beaker. Add 70 ml of distilled or deionised water and bring it to boil on the hotplate.

Allow to boil for 30 minutes while stirring occasionally with a stirring rod. Wash particles deposited on the wall of the beaker down with water from the wash bottle. Keep the total volume of material in the beaker between 60 and 70 ml.

After the 30 minute period, transfer the contents of the beaker to a 100 ml measuring cylinder using the wash bottle to wash it in. Make the volume in the measuring cylinder up to 100 ml.

Add 10 ml of the prepared wetting agent and thoroughly agitate the contents by stirring rapidly in a circular motion. Reverse the direction of stirring to stop rotation of the suspension and allow it to remain undisturbed for 15 minutes.
After the 15 minutes, measure the settled volume of the rubber particles to the nearest 0.5 ml, neglecting any floating particles. Similarly test the duplicate sample.

4  CALCULATIONS

Calculate the bulk density of each test sample as follows:

$$\text{Bulk density (kg/m)} = \frac{7.5}{V} \times 1000$$

where: $V = $settled volume of the rubber particles (ml)

Calculate the average bulk density for the two samples. If the results differ by more than four per cent (repeatability), another sample should be tested and the result, differing by more than four per cent from any one of the others, rejected.

REFERENCE

OLIVER J.W.H. A bulk density test to characterise the morphology of rubber particles. ARRB Internal Report, AIR 286-3 Australian Road Research Board, April 1981.