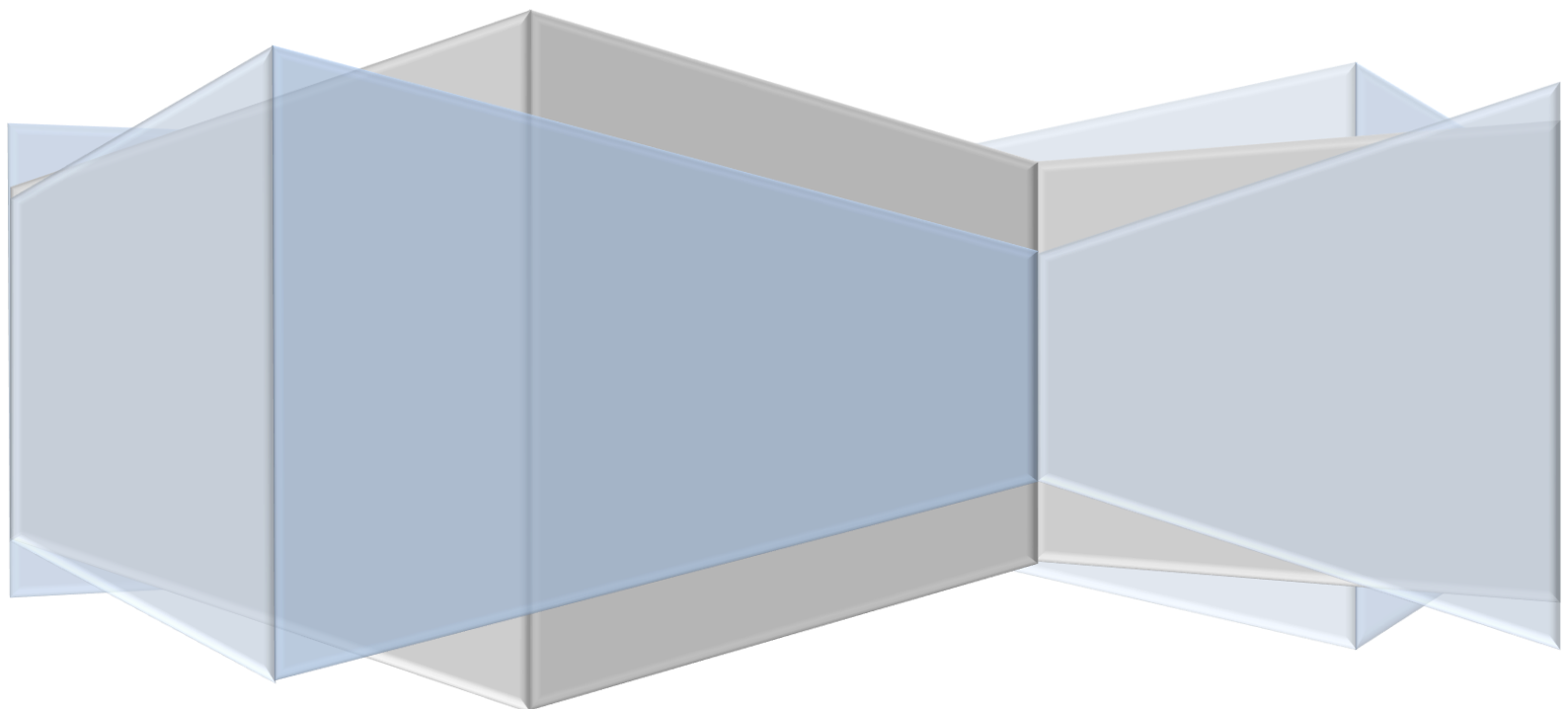


QATAR UNIVERSITY
DEPARTMENT OF CIVIL & ARCHITECTURAL ENGINEERING

ASPHALT TESTING LABORATORY MANUAL



DUCTILITY TEST OF BITUMINOUS MATERIALS

OBJECTIVES:

To obtain the ductility value of bituminous sample.

THEORY:

The ductility test is measure of cohesiveness and elasticity of the bitumen. Bitumen is binder of pavement construction, which binds from ductility thin films around the aggregates. This serves as satisfactory binders in improving the physical interlocking the aggregates. The binder material that does not possess sufficient ductility would crack and thus provides previous pavement surface. Bitumen paving engineers would however want that both test (penetration and ductility test) requirements be satisfied in the fiend jobs. Penetration and ductility cannot be replaced each other. The ductility is expressed as the distance in cm to which a standard briquette of bitumen can be stretched before the thread breaks. The test is conducted at $27 + 0.5^{\circ}\text{C}$ and rate of pull of $50 + 2.5\text{mm}$ per minute.

APPARATUS REQUIRED:

- Briquette mould: Length = 75mm
Distance between clips = 30mm
Width of mouth clip = 20mm
Cross section at minimum width=10mm x 10mm
- Ductility machine

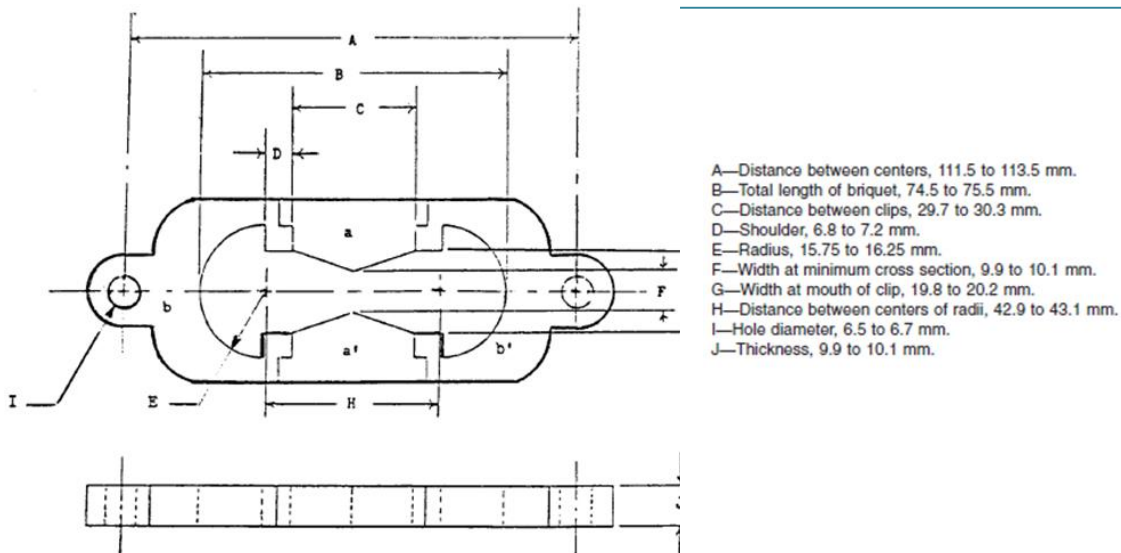
MATERIAL REQUIRED:

- Bitumen
- Water

PROCEDURE:

1. Heat the bitumen to become fluid. The temperature of oven should not exceed the 90°C above the softening point ($35 - 45^{\circ}\text{C}$). So, the maximum heating shouldn't exceed 135°C .
2. Assemble the mold on a brass plate. Coat the surface of the plate and interior surfaces of the sides a and a' of the mold with a thin layer of a mixture of release agent (Such as glycerin and Dextrin or mineral oil).

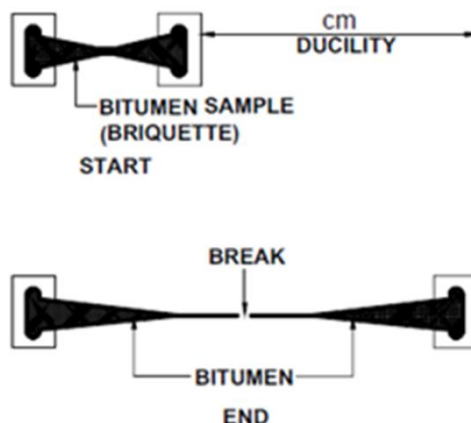
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3. Pour the bitumen in the mold and take care not to disarrange the pieces of the mold. Pour the material in a thin stream back and forth from end to end of the mold until the mold is more than level full.
4. Allow to cool in air at temp. 15 - 30°C for 35 min.
5. Then, place it in the water bath at test temperature (25°C) for 35 min.
6. Remove the test specimens from the water bath and immediately trim the excess material with the trimming tool to make the molds just level full.
7. Place the trimmed specimen and mold in the water bath at the specified temperature (25°C) for 90 min.
8. Then, remove the specimen from the plate, avoiding any bending of the specimen.
9. Remove the side pieces a and a' being careful not to distort or fracture the specimen.
10. Attach the rings at each end of the clips to the pins or hooks in the testing machine and start the test which will be in a uniform speed (5 cm/min) until the specimen ruptures or reaches the length limitations of the testing machine.
11. Measure the distance in centimeters through which produced

Mean of two observations rounded to nearest whole number is ductility value.

Note: Machine may have a provision to fix two or more moulds so as to test three specimens simultaneously.



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PRECAUTIONS:

- (i) The plate assembly upon which the mould is placed shall be perfectly flat and level so that the bottom surface of the mould touches it throughout.
- (ii) In filling the mould, care should be taken not to distort the briquette and to see that no air pocket is within the moulded sample.

OBSERVATIONS:

- (i) Bitumen Grade =
- (ii) Pouring Temperature =
- (iii) Test Temperature =
- (iv) Period of cooling in minutes
 - (a) In air =
 - (b) In water bath before trimming =
 - (c) In water bath after trimming =

	1	2	3
(a) Initial Reading			
(b) Final Reading			

RESULTS:

Ductility value =

DISCUSSIONS:

The ductility value gets seriously affected by following factors, which are as pouring temperature, dimensions of briquette, improper level of briquette placement, test temperature rate of pulling etc.

A certain minimum ductility is necessary for bitumen binder of the bitumen has low ductility values of bitumen vary of 50cm is specified for bituminous contraction.

REFERNCES:

ASTM D113 – 07

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Briquette Mould



Water Bath



Ductility Testing Machine



Thermometer

PENETRATION OF BITUMINOUS MATERIALS

OBJECTIVES:

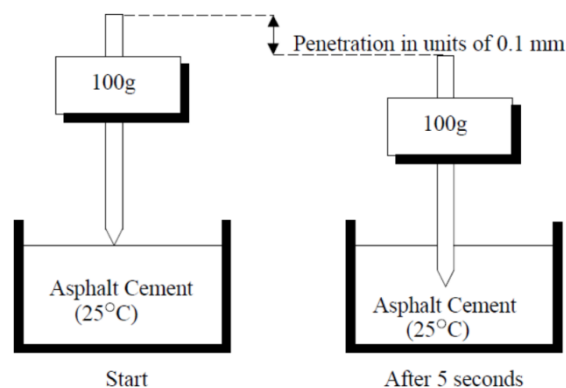
To examine the consistency of a sample of bitumen by determining the distance in tenths of a millimeter that a standard needle vertically penetrates the bitumen specimen under known conditions of loading, time and temperature.

SUMMARY OF TEST METHOD:

The sample is melted and cooled under controlled conditions. The penetration is measured with a penetrometer by means of which a standard needle is applied to the bitumen specimen under specific conditions.

PROCEDURE:

1. Heat the bitumen to become fluid. The temperature of oven should not exceed the 90°C above the softening point ($35 - 45^{\circ}\text{C}$). So, the maximum heating shouldn't exceed 135°C .
2. Pour the bitumen in the container (35mm depth X 55mm diameter)
3. Allow to cool in air at temp. $15 - 30^{\circ}\text{C}$ for
 - a. 45 - 90 min. for small containers (33 X 16 mm).
 - b. 60 – 90 min. for medium containers (55 X 35 mm).
 - c. 90 – 120 min. for large containers.
4. Place the container in the water bath at 25°C for
 - a. 45 - 90 min. for small containers (33 X 16 mm).
 - b. 60 – 90 min. for medium containers (55 X 35 mm).
 - c. 90 – 120 min. for large containers.and then put it under the penetrometer.
5. On the penetrometer bring the pointer to zero. Position the needle (100g) by slowly lowering it until its tip just makes contact with the surface of the sample.
6. Release the needle holder for 5 seconds only and adjust the instrument to measure the distance penetrated in tenths of a millimeter.
7. Make at least three determinations at points on the surface of the sample not less than 10 mm from the side of the container and not less than 10 mm apart (Use a clean needle for each determination).



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RESULTS:

The results are very sensitive to test conditions and bitumen specimen preparation and the requirements of the appropriate standard must be rigidly adhered to. The maximum difference between highest and lowest readings shall be:

DISCUSSION:

- Report the source and type of bitumen.
- Specify the conditions of the test (temperature, load, time). Note the three separate readings and quote the penetration as the average to the nearest whole unit.
- Comment on the difference between the highest and lowest readings and, if sub-standard, offer an explanation.
- Compare the average penetration with the manufacturer's quoted range and, if outside this, offer an explanation.
- Calculate the PI and comment on the value obtained. (Make sure the penetration and softening point values are obtained from the same batch of bitumen).

REFERNCES:

- BS EN 1426:2007
- ASTM D5 – 06



Needle



Water Bath



Timing Device



Container with asphalt



Thermometer



Penetrometer

SOFTENING POINT OF BITUMEN

OBJECTIVES

To determine the softening point of bitumen within the range 30 to 157 °C by means of the Ring-and-Ball apparatus.

BACKGROUND

Unlike some substances (e.g. water which changes from solid to liquid at 0 °C) bituminous materials do not have a definite melting point. Instead, as the temperature rises, these materials slowly change from brittle or very thick and slow-flowing materials to softer and less viscous liquids. For this reason, the determination of 'softening point' must be made by a fixed, arbitrary and closely defined method if results are to be comparable.

Being very simple in concept and equipment, the Ring-and-Ball Test has remained a valuable consistency test for control in refining operations, particularly in the production of air-blown bitumens. It is also an indirect measure of viscosity or, rather, the temperature at which a given viscosity is evident. The softening point value has particular significance for materials which are to be used as thick films, such as joint and crack fillers and roofing materials.

A high softening point ensures that they will not flow in service. For a bitumen of a given penetration (determined at 25 °C), the higher the softening point the lower the temperature sensitivity. Research has shown that, for conventional paving grade bitumens, the Ring-and-Ball softening point temperature is the same as that which would give a penetration of 800 d-mm. This, together with the penetration at 25 °C, can be used to compute the Penetration Index.

SUMMARY OF TEST METHOD (ASTM 1988)

Two horizontal disks of bitumen, cast in shouldered brass rings, are heated at a controlled rate in a liquid bath while each supports a steel ball. The softening point is reported as the mean of the temperatures at which the two disks soften enough to allow each ball, enveloped in bitumen, to fall a distance of 25 mm.

PROCEDURE (Figure 1)

1. Specimens are prepared exactly as specified (ASTM D36-95) in precisely dimensioned brass rings and maintained at a temperature of not less than 10° C below the expected softening point for at least 30 minutes before the test.
2. The rings and assembly, and two ball bearings, are placed in a liquid bath filled to a depth of 105 ± 3 mm and the whole maintained at a temperature of 5 ± 1 ° C for 15 minutes. [Freshly boiled distilled water is used for bitumen with a softening point of 80° C or below, and glycerine is used for softening point greater than 80° C].
3. A 9.5 mm steel ball bearing (weighing 3.50 ± 0.05 g) is centered on each specimen and heat is then applied to the beaker so as to raise the temperature by 5 ± 0.5 ° C per minute.

4. The temperature at which each bitumen specimen touches the base plate is recorded to the nearest 0.2°C .

RESULTS

Rigid adherence to the prescribed preparation of specimens and heating is absolutely essential for reproducibility of the results. The mean temperature of the two specimens (**which shall not differ by more than 1°C**) is recorded as the softening point.

This temperature is to be used in conjunction with the penetration value to obtain the Penetration Index (PI).

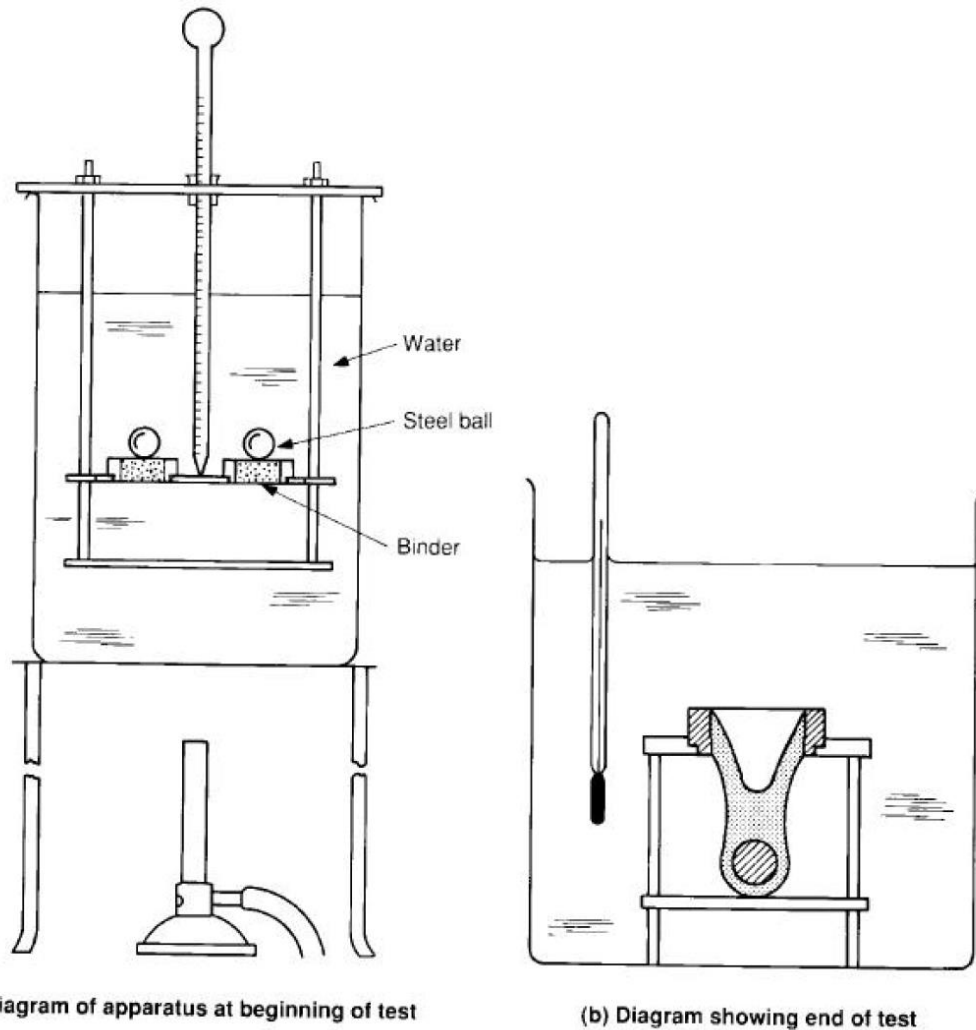


Figure 1. Apparatus for the bitumen Softening Point Test (Millard, 1993)

DISCUSSION

- (a) Report the source and type of bitumen.
- (b) Report the bath liquid used in the test and quote the mean softening point of your specimen. Comment on the value obtained.
- (c) If the two test temperatures differ by more than 1°C , offer an explanation

PREPARATION OF SPECIMENS FOR MARSHALL TEST

OBJECTIVES

To prepare standard specimens of asphalt concrete for measurement of stability and flow in the Marshall apparatus and to determine density, percentage air voids, and percentage of aggregate voids filled with binder.

BACKGROUND

The requirements of an asphalt concrete paving mix are many, viz.:

- Stability
- Durability
- Flexibility
- Fatigue Resistance: Thick Layers; Thin Layers
- Fracture Strength: Overload Conditions; Thermal Conditions
- Skid Resistance
- Impermeability
- Workability.

All these properties are governed to some extent by binder type and content, degree of compaction, aggregate gradation and shape. It is clearly impossible for one single test to cover all these factors but the Marshall Test gives the engineer considerable help. The complete test reveals:

- Stability
- Flow
- Density
- Voids in Total Mix (VTM)
- Voids in the Mineral Aggregate (VMA)
- Voids Filled with Binder (VFB)

These parameters plotted against binder content enable optima to be obtained for specific applications of the asphalt concrete or provide guidance for a change in the aggregate composition.

PROCEDURES

1. The aggregate, graded according to LTA (formerly PWD) W3B road mix (see Table 1 and Figure 2), is dried at 105-110 oC and sufficient amount is weighed (about 1200 g) to give a height of 63.5 + 1.3 mm when compacted in the mould.
2. The required quantity of bitumen is weighed out and heated to a temperature which will give a viscosity of 170 + 20 mm²/s (cSt).
3. The aggregate is heated in the oven to a temperature not higher than 28⁰ C above the binder temperature.
4. A crater is formed in the aggregate contained in a heated mixing bowl, the binder poured in and mixing carried out until all the aggregate is coated. The mixing temperature shall be within the limit set for the binder temperature.

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5. A thoroughly cleaned mould is heated on a hot plate or in an oven to a temperature between 93 and 149 oC. The mould is 101.6 mm diameter by 76.2 mm high and provided with base plate and extension collar.
6. A piece of filter paper is fitted in the bottom of the mould and the whole mix poured in. The mix is then vigorously trowelled 15 times round the perimeter and 10 times in the centre leaving a slightly rounded surface.
7. The mould assembly is placed on the compaction pedestal and given 75 blows of the 4536 g compacting hammer falling a height of 457.2 mm. The specimen in its mould is then reversed and given the same treatment on the other side. (The number of compaction blows could be 35, 50 or 75, depending on traffic loading condition in service; LTA specifies 75 blows each face).
8. The specimen is then carefully extruded from the mould, transferred to a smooth flat surface and allowed to cool to room temperature.
9. Finally, the specimen is measured and weighed in air and water (for volume determination). If the asphalt mix has an open (porous) texture the weighing in water will lead to error in the volume and so the specimen must be coated with a measured mass of paraffin wax. The specimen is then marked and stored for stability and flow measurements.

COMPUTATIONS

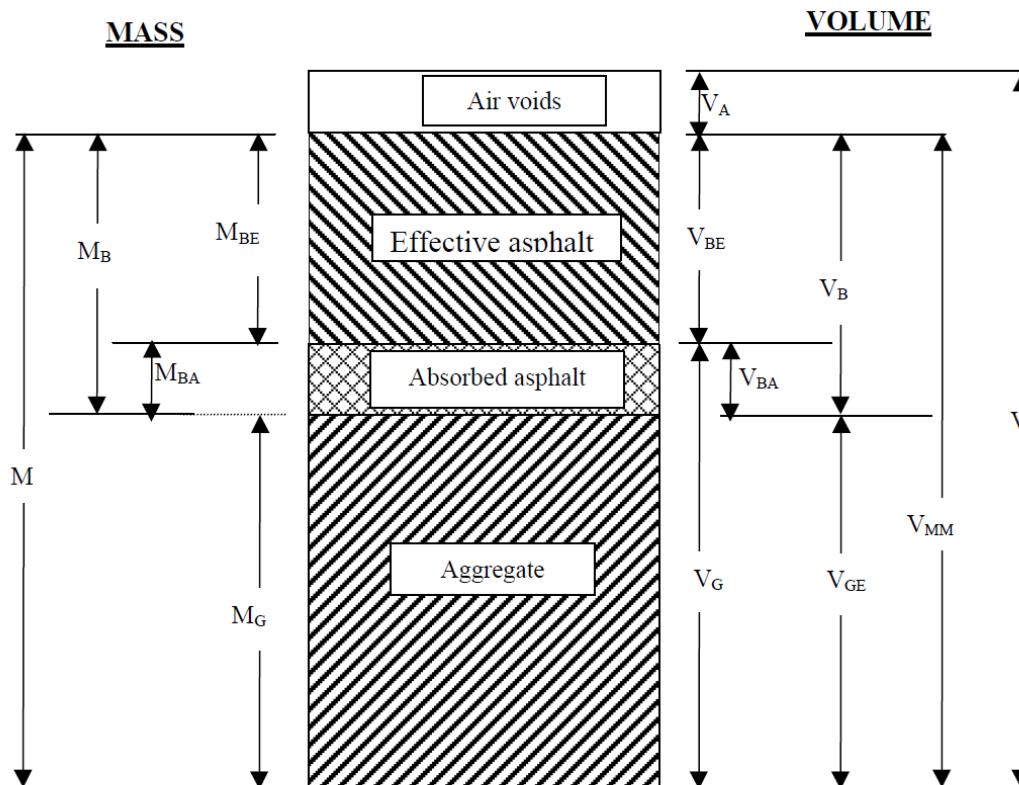


Figure 1. Mass/volume relationships in asphalt mix (adapted from Atkins, 1997)

M_{BA}

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Specimen

M	Mass of specimen (= $M_b + M_g$)
V	Bulk volume of specimen
V_{MM}	Volume of void-less mix
V_A	Volume of air between coated aggregate particles in the mix

Binder

M_{BA}, V_{BA}	Mass & volume of absorbed binder (within surface pores of aggregate particles)
M_{BE}, V_{BE}	Mass & volume of effective binder
M_B	Mass of constituent binder (= $M_{BE} + M_{BA}$)
V_B	Volume of constituent binder (= $V_{BE} + V_{BA}$)

Aggregate

M_G	Mass of aggregate
V_G	Bulk volume of aggregate (inclusive of all surface pores)
V_{GE}	Effective volume of aggregate (= $V_G - V_{BA}$)

(1) Mass & volume of Marshall specimen

If the specimen has a smooth compact surface, i.e. fairly impermeable, its bulk volume V is simply determined by weighing in air and submerged in water. Then:

$$V = (W_a - W_w) / \rho_w \quad \dots (1a)$$

where

W_a = weight of specimen in air (kg)

W_w = weight of specimen in water (kg)

ρ_w = density of water (= 1000 kg/m³)

If the specimen is porous, its surface should be sealed with paraffin wax before being weighed in water. Then:

$$V = \{W_{pa} - W_{pw} - [(W_{pa} - W_a)/G_p]\} / \rho_w \quad \dots (1b)$$

where

W_{pa} = weight of specimen and paraffin wax coating in air (kg)

W_{pw} = weight of specimen and paraffin wax coating in water (kg)

G_p = relative density of paraffin wax

The mass of the specimen is given by

$$M = W_a \quad \dots (1c)$$

(2) **Mass & volume of binder**

$$M_B = M \times P_B / 100 \quad \dots(2a)$$

$$M_G = M - M_B \quad \dots(3a)$$

$$M_{BA} = M_G \times P_{BAG} / 100 \quad \dots(2b)$$

$$M_{BE} = M_B - M_{BA} \quad \dots(2c)$$

$$V_B = M_B / \rho_B \quad \dots(2d)$$

$$V_{BA} = M_{BA} / \rho_B \quad \dots(2e)$$

$$V_{BE} = M_{BE} / \rho_B = V_B - V_{BA} \quad \dots(2f)$$

where

P_{BAG} = binder absorption, % of mass of aggregate (= $100 \times M_{BA} / M_G$)

P_B = binder content, % of total mass of specimen (= $100 \times M_B / M$)

ρ_B = density of binder (1.01-1.11 g/cm³)

(3) **Mass & volume of aggregate**

$$M_G = M - M_B \quad \dots(3a)$$

$$V_G = M_G / \rho_G \quad \dots(3b)$$

$$V_{GE} = V_G - V_{BA} \quad \dots(3c)$$

where

ρ_G = **bulk** density of aggregate (= M_G / V_G)

(4) **Volume of air in total mix**

$$V_A = V - V_{BE} - V_G = V - V_B - V_{GE} \quad \dots (4)$$

(5) **Volume of void-less mix**

$$V_{MM} = V - V_A = V_{BE} + V_G = V_B + V_{GE} \quad \dots (5)$$

(6) **Binder contents**

Effective binder content is given by:

$$P_{BE} = 100 \times M_{BE} / M \quad (\%) \quad \dots (6a)$$

Absorbed binder content is given by:

$$P_{BA} = 100 \times M_{BA} / M \quad (\%) \quad \dots (6b)$$

(7) **Bulk density, d**

Bulk density of specimen is given by:

$$d = M/V \quad \dots (7)$$

(8) **Maximum theoretical density, D**

Maximum theoretical density of specimen is given by:

$$D = M/V_{MM} \quad \dots (8)$$

(9) **Voids in total mix, VTM**

Voids in total mix is given by:

$$VTM = 100 \times V_A / V \quad (\%) \quad \dots (9)$$

(10) **Voids in mineral aggregate, VMA**

Voids in mineral aggregate is given by:

$$VMA = 100 \times (V_{BE} + V_A) / V \quad (\%) \quad \dots (10)$$

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(11) Voids filled with binder, VFB

Voids filled with binder is given by:

$$VFB = 100 \times V_{BE} / (V_{BE} + V_A) \quad (\%) \quad \dots (11)$$

DISCUSSION (to be included in a later report on Marshall stability & flow)

(a) Report the followings:

- the source and type (including geological descriptions) of the aggregate.
- the source, type and percentage (by mass) of the binder.
- the mixing temperature, and number of blows of the compaction hammer.

(b) Calculate d, D, VTM, VMA and VFB (see *Sample Calculations*).

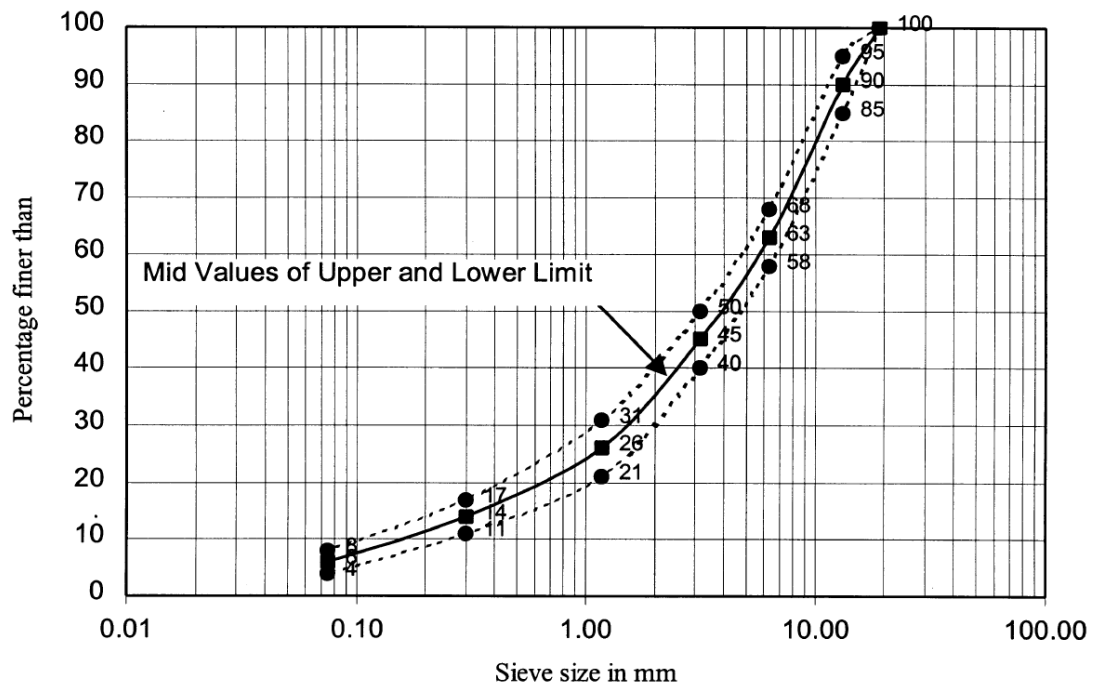
(c) Collect results for the other specimens (containing different binder percentages), and plot graphs of d, D, VTM, VMA, VFB against binder content (see Figure 3).

Table 1. LTA W3B Mix Specification (see also PWD 1992)

Type of mix	W3B Wearing Course	
Thickness of course	45-65 mm	
Sieve size (mm)	% Passing	Mid-value
19.0	100	100
13.2	85-95	90
6.3	58-68	63
3.15	40-50	45
1.18	21-31	26
0.3	11-17	14
0.075	4-8	6
% Soluble bitumen (60/70 penetration grade) (% by mass of total mix)	5 ± 0.5	

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Figure 2. LTA W3B Gradation Envelope



MASS-VOLUME RELATIONSHIP - *Sample Calculations*

Volume of specimen, V

Mass of the specimen $M =$ weight in air, $W_a = 1241.8$ g (given)

Weight of the specimen suspended in water, $W_w = 718.0$ g (given)

Volume of the specimen, $V = (W_a - W_w) / \rho_w = 523.8$ cm³

Mass & volume of binder

Binder absorption (% of aggregate mass), $P_{BAG} = 1.5$ % (given)

Binder content (% of specimen mass), $P_B = 5.5$ % (given)

Density of binder, $\rho_B = 1.01$ g/cm³ (given)

Mass of binder, $M_B = (0.055)(1241.8) = 68.3$ g

Mass of aggregate, $M_G = (1241.8 - 68.3) = 1173.5$ g

Mass of absorbed binder, $M_{BA} = (0.015)(1173.5) = 17.6$ g

Mass of effective binder, $M_{BE} = (68.3 - 17.6) = 50.7$ g

Volume of binder, $V_B = 68.3 / 1.01$ g = 67.6 cm³

Volume of absorbed binder, $V_{BA} = 17.6 / 1.01$ g = 17.4 cm³

Volume of effective binder, $V_{BE} = (67.6 - 17.4)$ g = 50.2 cm³

Mass & volume of aggregate

Bulk density of aggregate, $\rho_G = 2.65$ g/cm³ (given)

Mass of aggregate, $M_G = (1241.8 - 68.3) = 1173.5$ g

Bulk volume of aggregate, $V_G = 1173.5 / 2.65 = 442.8$ cm³

Effective vol. of aggregate, $V_{GE} = (442.8 - 17.4) = 425.4$ cm³

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Volume of air, V_A

$$\text{Volume of air, } V_A = 523.8 - 50.2 - 442.8 = 30.8 \text{ cm}^3$$

Bulk density, d

$$d = M / V = 1241.8 / 523.8 = 2.37 \text{ g/cm}^3$$

Maximum theoretical density, D

$$D = M / V_{MM} = 1241.8 / (67.6 + 425.4) = 2.52 \text{ g/cm}^3$$

Voids in total mix, VTM

$$VTM = V_A / V = 30.8 / 523.8 = 0.0588 = 5.88 \%$$

Voids in mineral aggregate, VMA

$$VMA = (V_{BE} + V_A) / V = (50.2 + 30.8) / 523.8 = 0.155 = 15.5 \%$$

Voids filled with binder, VFB

$$VFB = V_{BE} / (V_{BE} + V_A) = 50.2 / (50.2 + 30.8) = 0.620 = 62.0 \%$$

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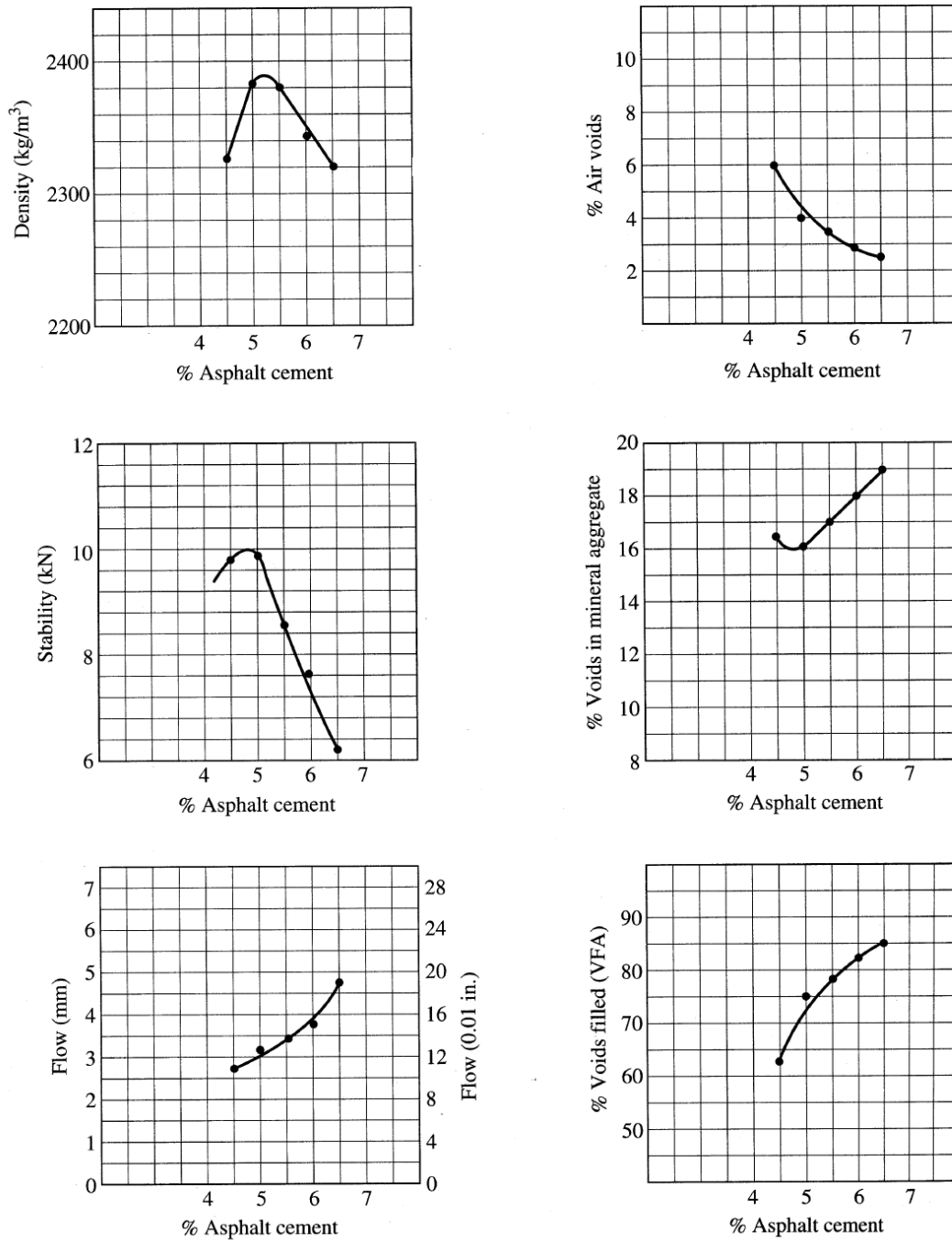


Figure 3. Sample test results from a Marshall mix design.

SKID RESISTANCE TEST

OBJECTIVES

To measure texture depth and skid resistance of a road surface using the BS Pendulum Skid Resistance Tester and to estimate the vulnerability of an aggregate to polishing under traffic by determining its Polished Stone Value (PSV).

BACKGROUND

Skidding, i.e. loss of adhesion between a vehicle's tyres and the road surface, occurs in many road accidents whether or not it is the actual cause of the accident. Over the years, tyre manufacturers have done a lot of research into different types of rubber and tread patterns to improve the safety of motor vehicles. Governments have introduced regulations concerning the tread depth and general condition of the tyres. Highway engineers have also researched ways to improve the skid resistance of road surfaces. The impetus for this research came from the Transport and Road Research Laboratory (TRRL) of UK. One of the first things they did was to devise the Pendulum Skid Tester which, being portable, can be taken to the site or used in laboratory experiments. This device simulates the skid resistance offered by a road surface to a motor car travelling at 50 km/h. It gives a number, being a percentage, somewhat akin to a coefficient of friction. Subsequently, they devised the Sideways Force Coefficient Routine Investigation Machine (SCRIM). This is a lorry with a fifth wheel set at an angle to the direction of travel and the lateral force on this wheel is measured and recorded. The lorry travels at 50 km/h and continually monitors the Sideways Force Coefficient (SFC). Other devices include braking force trailer and the mumeter. These can be used at the high speeds required for testing airport runways.

With devices to measure skidding resistance, researchers then monitored changes during the life of road pavements. It was found that skid resistance falls rapidly after a road is opened to traffic but the rate of deterioration slows down, eventually settling to a constant value. This latter value is dependent on the surface texture, rock type and traffic volume. Coarse-textured surfaces offer greater resistance because rainwater drains away better, allowing rubber to stone contact even at reasonably high speed. Sedimentary rocks (excluding most limestones) are better than igneous or metamorphic rocks. All mineral particles polish but, with sandstone, the small particles get worn off exposing fresh sharp crystals to the tyres. With igneous rocks, which are tougher, the polished particles remain in place. Finally, better correlation has been obtained using commercial traffic volumes rather than total traffic.

As highway engineers are concerned about the aggregate, TRRL devised the Accelerated Polishing Machine which simulates the polishing action of tyres, grit and water on road surfaces. Specimens are polished by a rubber tyre with coarse grit and water for three hours, followed by another three hours using very fine grit. After that, the skid resistance is measured with the pendulum and the reading is called the Polished Stone Value (PSV). Having set target values

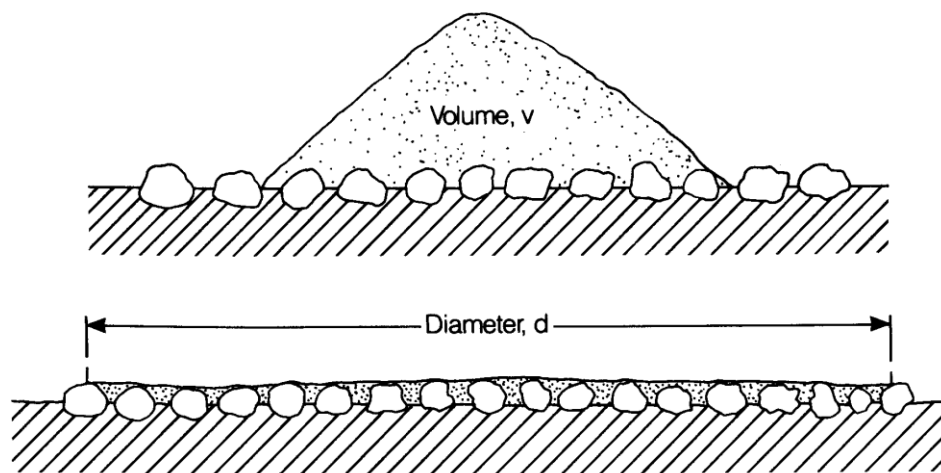
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for skid resistance of road surfaces for various sites and traffic volumes, the British authorities now specify minimum values of PSV for the aggregate used in the surfacing.

TEXTURE DEPTH (Figure 1)

Procedure (TRRL 1969)

1. Select the spot on the road to be tested, normally in the nearside wheel track. Ensure that the area to be tested is dry and free from loose materials.
2. A known volume of sand is spread on the road surface; the average macrotexture depth is calculated from the area of the circular patch produced. [The sand particles are those passing a No. 52 sieve and retained on a No. 100 B.S. sieve].



$$\text{Texture depth} = \frac{\text{volume of sand}}{\text{area of patch}}$$

Figure 1. Sand-patch method of measuring texture depth

Results

Report the sand circle diameter in millimeter to the nearest 5 mm. Textures producing diameters in excess of 350 mm (which cannot be measured accurately by this procedure) are to be reported as 'greater than 350 mm'. Report the average texture depth to the nearest 0.1 mm. A suggested classification of the surface texture is:

Average Texture Depth (mm)	Texture Classification
<0.25	Fine
0.25-0.50	Medium
>0.50	Open

SKID RESISTANCE TEST

Procedure:

1. Select the spot in which the texture depth has been measured.

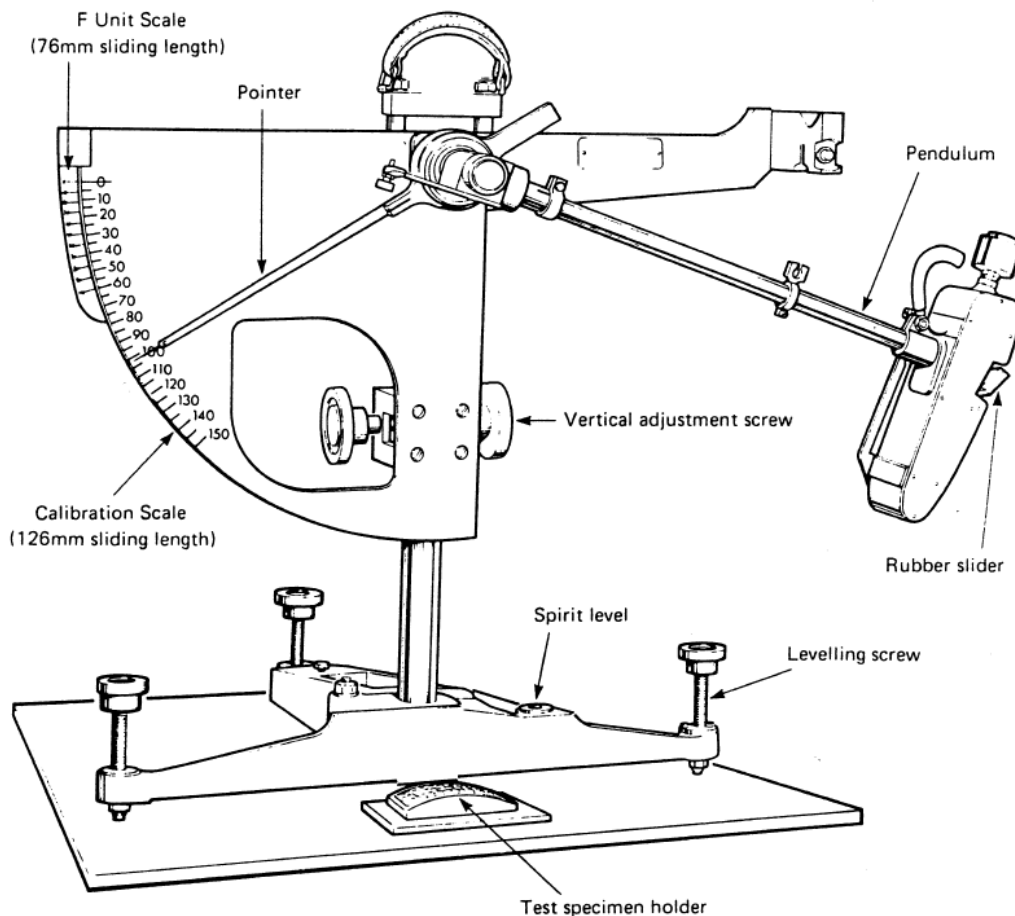


Figure 2. Pendulum Skid Resistance Tester (BSI, 1990)

2. Set the apparatus (Figure 2) on the road so that the slider will swing in the direction of traffic flow and level the base screws.
3. Raise the swinging arm clear of the road and clamp in the horizontal position. Release the arm and check that the pointer reads zero.
4. With the pendulum arm free and hanging vertically, place the spacer, attached to a chain on the base of the column, under the lifting handle setting screw to raise the slider. Lower the head of the tester so that the slider just touches the road surface and clamp in position. Remove the spacer.
5. Check the sliding length of the rubber slider over the road surface by gently lowering the pendulum arm until the slider just touches the surface first on one side of the vertical and then on the other. When passing the arm through the vertical, use the lifting handle so that the slider does not touch the road. The sliding length should be between 125 and 127 mm. If not, adjust by raising or lowering the head.
6. Place the pendulum arm in the horizontal and clamp in position.
7. Wet the road surface and slider with water.

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8. Bring the pointer to its stop then release the pendulum by pressing the button. Take care to catch the arm on its return swing before it hits the ground.
9. Return the arm and pointer to the release position keeping the slider off the road surface by means of the lifting handle. Repeat the test, wetting the surface between swings. Record the mean of five successive readings, provided they do not differ by more than three units. If the range is greater than this, repeat swings until three successive readings are constant; record this value.
10. Record the temperature of the water on the road surface.

Results

The skid resistance value (SRV) is the mean of five readings or the constant of three readings as stated above.

As the stiffness of the rubber slider will vary with temperature a correction has to be made if the temperature is not 20°C. Use the temperature curve (Figure 3) for this purpose.

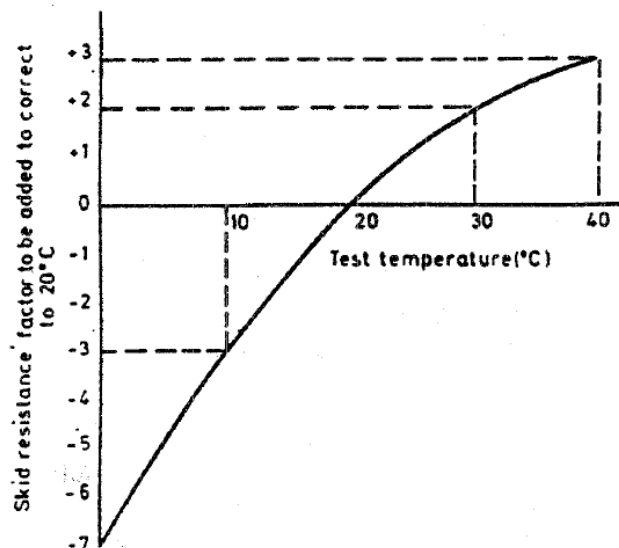


Figure 3. Skid resistance/ temperature correction relationship (TRRL, 1969)

Discussion – Texture depth and SRV

- (a) Describe the site and the nature of the road surface, i.e. material state of wear, etc.
- (b) Describe the average texture depth and texture classification.
- (c) Report the temperature-corrected skid resistance value (SRV) and comment on suitability of this value for the current use of the road (see Table 1). Compare results obtained by other group(s).

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Table 1. Suggested minimum values of 'skid resistance' (measured with the portable tester) (TRRL, 1969)

Category	Type of site	Minimum skid resistance (surface wet)
A	Difficult sites such as: 1. Roundabouts 2. Bends with radius less than 150 m on unrestricted roads 3. Gradients 1 in 20 or steeper of lengths greater than 100 m 4. Approaches to traffic lights on unrestricted roads	65
B	Motorways, trunk and class 1 roads and heavily trafficked roads in urban areas (carrying more than 2000 vehicles per day)	55
C	All other sites	45

ABRASION OF SURFACING AGGREGATES

OBJECTIVES

To assess the resistance to crushing and abrasive wear of an aggregate by means of the Los Angeles Abrasion Machine.

BACKGROUND

Aggregates are subjected to crushing and abrasive wear during the manufacture, placing and compaction of asphalt paving mixes. They are also subjected to abrasion under traffic loads. There does not appear to be a really satisfactory test for measuring aggregates' resistance to abrasion but the Los Angeles Test is one of those most commonly applied. This test is both an abrasion and impact test and appears to be more suitable for aggregates used in the wearing course / surface dressing than for asphalt concrete in other layers. Resistance to abrasion is necessary for maintaining surface macro-texture but (unfortunately) the tougher an aggregate is, the more likely it is to polish under the action of vehicle tyres.

SUMMARY OF TEST METHOD (ASTM 1994)

A sample of chippings is loaded together with steel balls into a steel drum revolving on a horizontal axis. The Los Angeles Abrasion Value (LAV) is the percentage of fines passing the 1.7 mm sieve after a specified number of revolutions of the drum at specified speed.

PROCEDURE

1. The Los Angeles machine (Figure 1) is constructed according to the dimensions and specification of ASTM C131. A washed and oven-dried sample of aggregate, graded according to the job application is weighed (W_1) and placed in the drum with the appropriate number of steel balls (46.0 to 47.6 mm diameter, weighing 400 to 440 g each) (Tables 1 & 2).4. The temperature at which each bitumen specimen touches the base plate is recorded to the nearest 0.2° C.

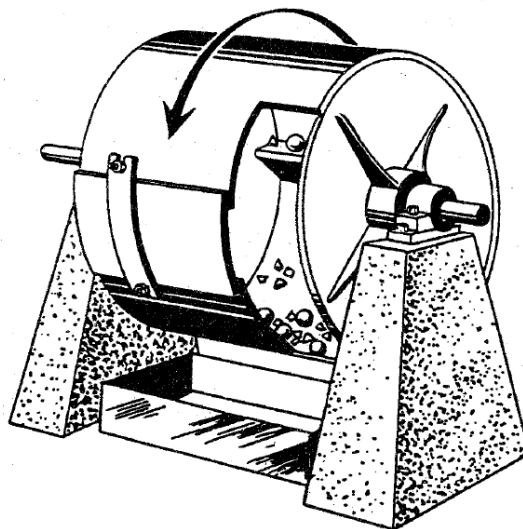


Figure 1. Los Angeles Abrasion Machine

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Table 1. Grading of test samples (ASTM, 1994)

Sieve sizes (square openings), mm		Mass of indicated sizes, g			
Passing	Retained on	Grading (see Table 2 below)			
		A	B	C	D
37.5	25.0	1250 ± 25	...	...	...
25.0	19.0	1250 ± 25	...	...	...
19.0	12.5	1250 ± 10	2500 ± 10	...	...
12.5	9.5	1250 ± 10	2500 ± 10	...	...
9.5	6.3	...	...	2500 ± 10	...
6.3	4.75	...	...	2500 ± 10	...
4.75	2.35	...	...		5000 ± 10
Total		5000 ± 10	5000 ± 10	5000 ± 10	5000 ± 10

Table 2. Grading and mass of charge

Grading	Number of balls	Mass of charge, g
A	12	5000 ± 25
B	11	4584 ± 25
C	8	3330 ± 20
D	6	2500 ± 15

2. The drum is rotated for 500 revolutions at a speed of 30 to 33 rpm.
3. After this, the sample is separated on a sieve larger than 1.7 mm (say 4.75 mm), then the material passing is washed through a 1.7 mm sieve. If the aggregate is free from dust, the washing requirement may be waived.
4. The material which does not pass the 1.7 mm sieve (and any larger sieve used) is then weighed to the nearest gram (W_2).
5. The difference in weight of the sample is expressed as a percentage of the original and is reported as the abrasion value given by

$$LAV = \frac{(W_1 - W_2)}{W_1} \times 100\% \quad \dots (1)$$

6. The results of two tests by the same operator on the same aggregate should not differ from each other by more than 5.7% of their average. For two different operators/laboratories the difference should not be more than 12.7% of the average.

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DISCUSSION

- (a) Report the geological description of the aggregate, the source quarry and particle size.
- (b) Record the original and final weights, and the abrasion value. Comment on any loss in the sample mass in the course of the experiment.
- (c) Comment on the LAV value obtained with regard to the aggregate's potential use. [Local requirements are $LAV \leq 35\%$ for wearing course, $LAV \leq 40\%$ for binder course, and $LAV \leq 45\%$ for road base].
- (d) Compare your result with those of other groups and comment on the precision of the test results.