भारतीय मानक
Indian Standard

IS 17127 : 2019

मार्शल विधि द्वारा बिटुमिनस मिक्स की स्थिरता, प्रवाह और बल्क घनत्व का निर्धारण

Determination of Stability, Flow and Bulk Density of Bituminous Mixes by Marshall Method

ICS 75.140, 93.080.20

भारतीय मानक ब्यूरो
BUREAU OF INDIAN STANDARDS
मानक भवन, 9 बहादुरशाह ज़फर मार्ग, नई दिल्ली – 110002
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI-110002
www.bis.gov.in www.standardsbis.in

May 2019 **Price Group 5**

Bitumen, Tar and Related Products Sectional Committee, PCD 06

FOREWORD

This Indian Standard was adopted by the Bureau of Indian Standards after the draft finalized by the Bitumen, Tar and Related Products Sectional Committee, had been approved by the Petroleum, Coal and Related Product Division Council.

The Marshall method is used in the laboratory mix design of bituminous paving mixtures. Specimens are prepared in accordance with the method and tested for maximum load and flow. The testing section of this method may also be used to obtain maximum load and flow of core specimens obtained from the field. However, the results may differ from the ones obtained from laboratory compacted specimens.

Void properties may also be obtained from compacted specimen using the appropriate ASTM test methods. However, this test method is beyond the scope of this standard.

Considerable assistance has been drawn from the ASTM D6927-15 ‘Standard Test Method for Marshall Stability and Flow of Asphalt Mixtures’ in formulation of this standard.

For the purpose of deciding whether a particular requirement of this standard is complied with the final value, observed or calculated expressing the result of a test or analysis shall be rounded off in accordance with IS 2 : 1960 ‘Rules for rounding off numerical values (*revised*).’ The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

DETERMINATION OF STABILITY, FLOW AND BULK DENSITY OF BITUMINOUS MIXES BY MARSHALL METHOD

1 SCOPE

1.1 This standard prescribes the method of test for determination of stability, flow and bulk density of bituminous mixes, prepared with bitumen binder and aggregates of nominal maximum sizes 25.4 mm (1.0 in, Method A) and 37.5 mm (1.5 in, Method B).

1.2 Method A covers the measurement of stability, flow and bulk density of bituminous mix specimens with 102 mm (4 in) diameter for aggregates having nominal maximum size 25.4 mm, when loaded on the lateral surface by means of the Marshall Apparatus.

1.3 Method B covers the measurement of stability, flow and bulk density of bituminous mix specimens with 153 mm (6 in) diameter for aggregates having nominal maximum size 25.4 mm, when loaded on the lateral surface by means of the Marshall Apparatus.

2 REFERENCES

The following standards contain provisions which, through reference in the text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standard indicated below:

Other Publication	*Title*
ASTM D 6752 : 2018	Standard Test Method for Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Automatic Vacuum Sealing Method
ASTM D 1188 : 2015	Standard Test Method for Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Coated Samples
ASTM D 2726 : 2017	Standard Test Method for Bulk Specific Gravity and Density of Non-Absorptive Compacted Asphalt Mixtures

3 METHOD A

3.1 General

This test method is for bituminous mixtures prepared with bitumen binder with nominal maximum aggregate size up to 25.4 mm (1 in). It describes the preparation, compaction, and measurement of resistance to plastic flow and bulk density of 102 mm (4 in) diameter by 63.5 mm (2.5 in) high cylindrical bituminous paving mixture specimens.

3.2 Apparatus

3.2.1 *Specimen Mould Assembly*

Mould cylinders, base plates, and extension collars shall conform to the details as shown in Fig. 1.

3.2.2 *Specimen Extractor*

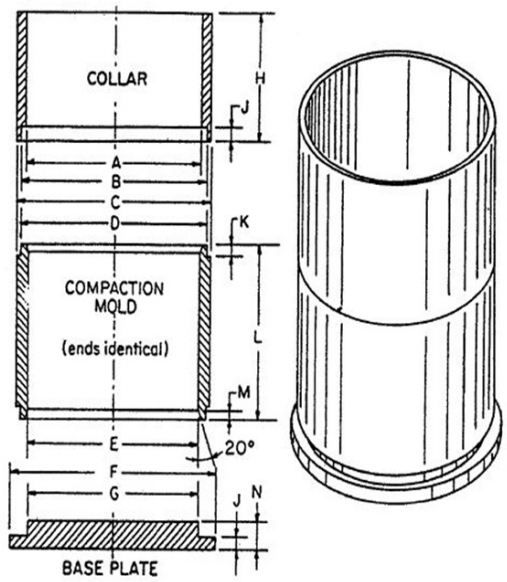
Any suitable extraction device such as a hydraulic jack apparatus may be used provided the specimens are not deformed during the extraction process. The specimen extractor shall have a steel disk that will enter the mould without bending and not be less than 100 mm in diameter and 12.5 mm thick.

3.2.3 *Compaction Hammers*

Compaction hammers (manually held or fixed handle), either mechanically or hand operated as shown in Fig. 2, with a flat, circular compaction foot and a 4.54 ± 0.01 kg sliding mass with a free fall of 457.2 ± 1.5 mm may be used.

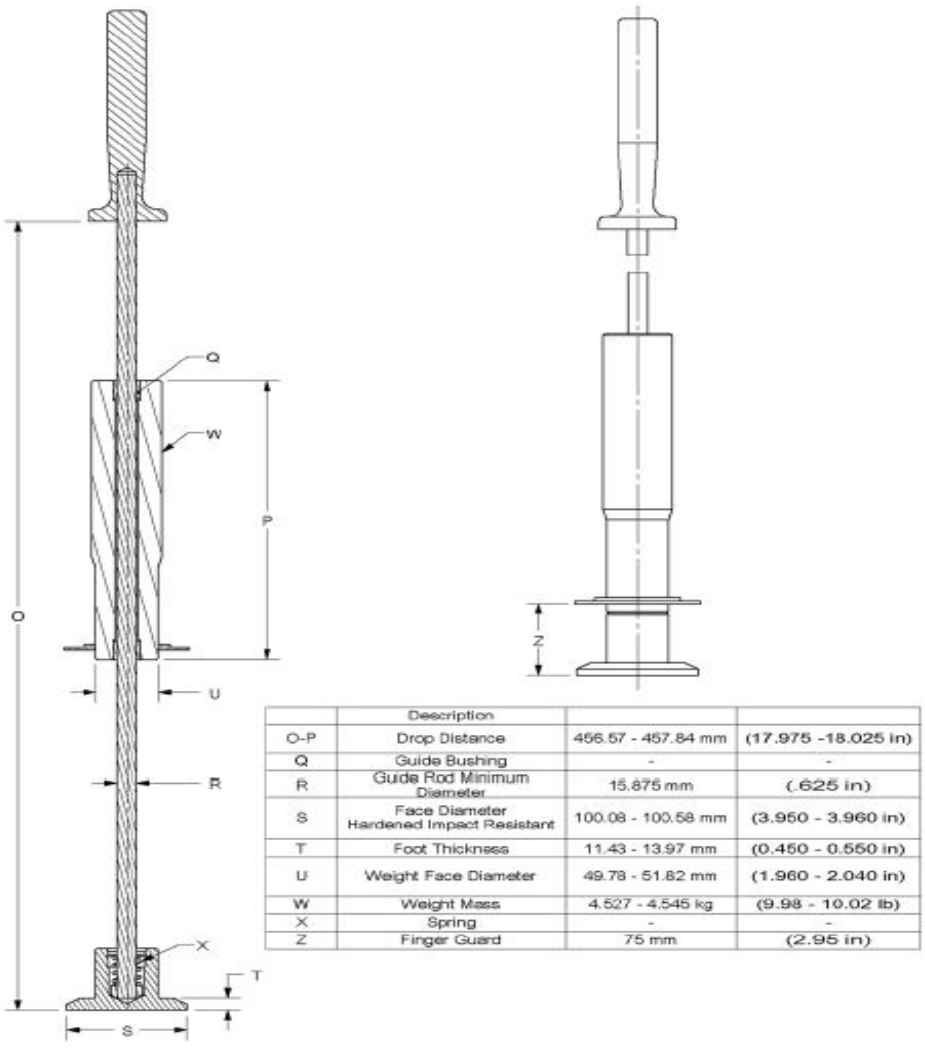
3.2.4 *Compaction Pedestal*

The compaction pedestal shall consist of a nominal 203.2 mm × 203.2 mm (8 in × 8 in) wooden post approximately 457 mm (18 in) long capped with a steel plate approximately 304.8 mm × 304.8 mm (12 in × 12 in) and 25.4 mm (1 in) thick. The wooden post shall be oak, pine, or other wood having an average dry weight of 0.67 − 0.77 g/cm^3. The wooden post is to be secured by four angle brackets to a solid concrete slab. The steel cap shall be firmly fastened to the post. The pedestal assembly shall be installed so that the post is plumb and the cap is level.



Abbreviation	Size (mm)
A	104.1 to 105.4
B	109.1 to 110.2
C	114.0 to 115.8
D	107.0 to 109.7
E	101.3 to 101.7
F	119.9 to 121.4
G	101.1 to 101.3
H	69.3 to 70.4
J	7.0 to 7.2
K	6.1 to 6.7
L	86.9 to 87.9
M	3.0 to 4.8
N	12.3 to 14.9

FIG. 1 COMPACTION MOULD



	Description		
O-P	Drop Distance	456.57 - 457.84 mm	(17.975 -18.025 in)
Q	Guide Bushing	-	-
R	Guide Rod Minimum Diameter	15.875 mm	(.625 in)
S	Face Diameter Hardened Impact Resistant	100.08 - 100.58 mm	(3.950 - 3.960 in)
T	Foot Thickness	11.43 - 13.97 mm	(0.450 - 0.550 in)
U	Weight Face Diameter	49.78 - 51.82 mm	(1.960 - 2.040 in)
W	Weight Mass	4.527 - 4.545 kg	(9.98 - 10.02 lb)
X	Spring	-	-
Z	Finger Guard	75 mm	(2.95 in)

FIG. 2 MANUAL COMPACTION HAMMER

3.2.5 *Specimen Mould Holder*

The holder shall be mounted on the compaction pedestal in order to centre the compaction mould over the centre of the post. The holders shall hold the compaction mould, collar, and base plate securely in position during compaction of the specimen.

3.2.6 *Ovens, Heating Pots or Hot Plates*

Circulating air ovens or thermostatically controlled heating pot and hot plates are required for heating aggregates, bituminous material, specimen moulds, compaction hammers, and other equipment to within 3°C of the required mixing and compaction temperatures.

3.2.7 *Mixing Apparatus*

Any type of mechanical mixer may be used; provided the mix is maintained at the required temperature and mixing will produce a well-coated, homogeneous mixture of the required amount in the allowable time. Furthermore, all of the batch must be recovered. A metal pan or bowl of sufficient capacity for hand mixing may also be used.

3.2.8 *Breaking Head*

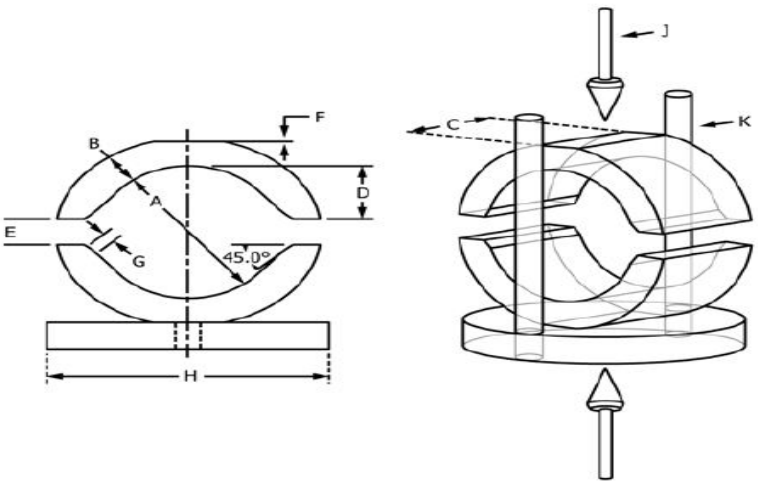
The testing head as shown in Fig. 3 shall consist of upper and lower cylindrical segments of cast gray or ductile iron, cast steel, or annealed steel tubing. The lower segment shall be mounted on a base having two perpendicular guide rods or posts [minimum 12.5 mm (0.5 in) in diameter] extending upwards. Guide sleeves in the upper segment shall direct the two segments together without appreciable binding or loose motion on the guide rods.

3.2.9 *Compression Loading Machine*

The compression loading machine as shown in Fig. 4 shall be designed to load at a uniform vertical movement of 50.8 mm/min (2 in/min). The design in Fig. 4 shows power being supplied by an electric motor. A mechanical or hydraulic compression testing machine may also be used provided the rate of loading can be maintained at 50.8 mm/min (2 in/min).

3.2.10 *Load Measuring Device*

As a minimum, a calibrated 20 kN (5 000 lb) ring dynamometer (Fig. 4) with a dial indicator to measure ring deflection for applied loads is required. The 20 kN (5 000 lb) ring shall have a minimum sensitivity of 50 N (10 lb). The ring dynamometer should be attached to the testing frame (ring holding bar, Fig. 4) and an adapter (ring dynamometer adapter, Fig. 4) should be provided to transmit load to the breaking head. The ring dynamometer assembly may be replaced with a load cell connected to a load-deformation recorder or computer provided capacity and sensitivity meet above requirements.



	mm	in.
A	101.5 to 101.7	3.995 to 4.005
B	21.7 minimum	0.855 minimum
C	76.2 minimum	3.0 minimum
D	41.15 to 41.40	1.620 to 1.630
E	18.92 to 19.18	0.745 to 0.755
F	2.0 reference	0.08 reference
G	8.89 to 9.09	0.350 to 0.358
H	101.3 minimum	3.990 minimum
J	Forces transmitted through one spherical and one flat surface.	
K	Geometry of guide system must be appreciably free of both play and binding. One test for binding is to lift or lower head by a single guide bushing.	

FIG. 3 TESTING HEAD DIMENSIONS

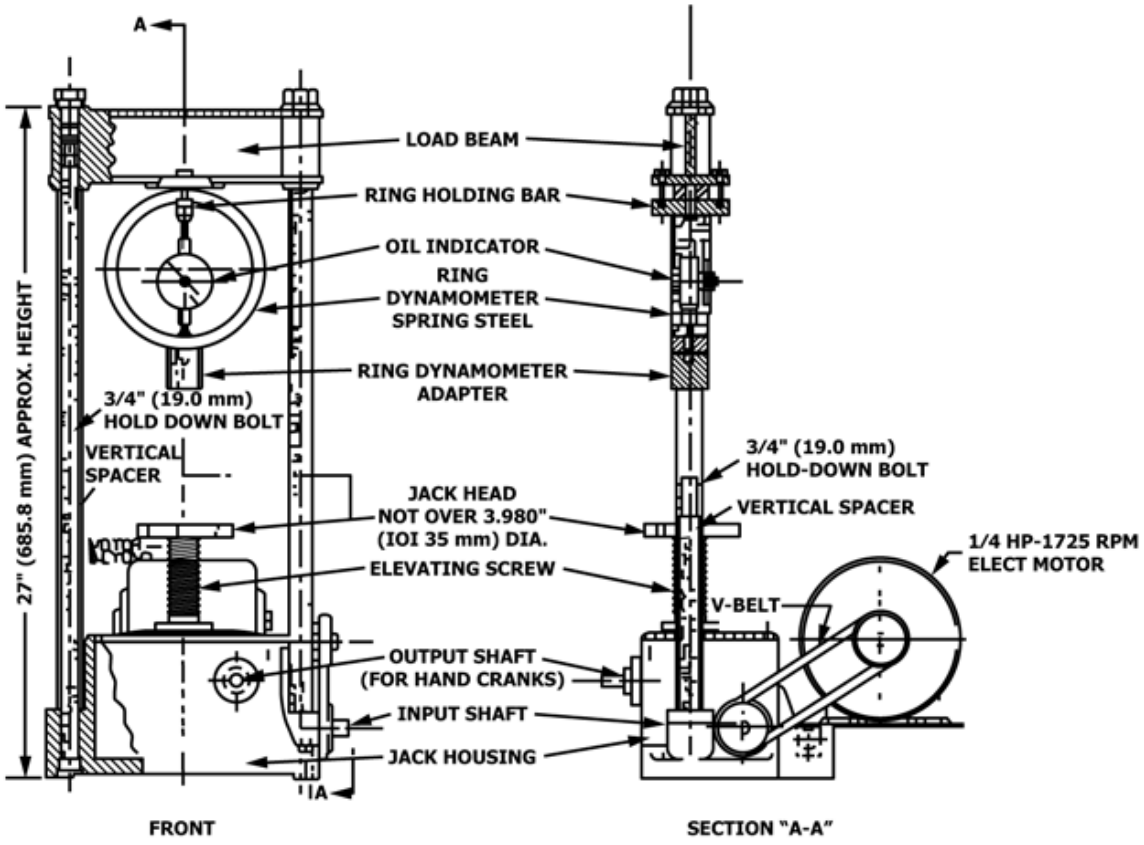


FIG. 4 COMPRESSION MACHINE

3.2.11 *Flow Meter*

3.2.11.1 The Marshall Flow meter consists of a guide sleeve and a gauge. The activating pin of the gauge shall slide inside the guide sleeve with minimal friction and the guide sleeve shall slide freely over the guide post of the breaking head. These points of frictional resistance shall be checked before tests. Graduations of the flow meter gauge shall be increments of 0.25 mm or finer.

3.2.11.2 Instead of a flow meter, other devices such as an indicator dial or linear variable differential transducer (LVDT) connected to a load-deformation recorder or computer may be used. These alternate devices should be capable of indicating or displaying flow (deformation) to the required sensitivity. These devices must be designed to measure and record the same relative movement between the top of the guide-post and the upper breaking head.

3.2.12 *Water Bath*

Water bath shall be deep enough to maintain the water level a minimum of 30 mm (1.25 in) above the top of specimens of 63.5 mm (2.5 in) height. The bath shall be thermostatically controlled so as to maintain the specified test temperature ±1°C at any point in the tank. The tank shall have a perforated false bottom or be equipped with a shelf for supporting specimens 50 mm above the bottom of the bath and be equipped with a mechanical water circulator.

3.2.13 *Thermometers*

Armoured-glass or dial-type thermometers with metal stems are recommended, with a range from 10 to 200°C and least count of ± 1°C for checking mixing and compacting temperatures.

3.2.14 *Balance*

For batching mixtures readable to at least 0.1 g.

3.3 Procedure

3.3.1 *Preparation of Test Specimens*

A minimum of three specimens of a given mixture shall be prepared and tested. The specimens should have the same aggregate type, quality, and grading; the same mineral filler type and quantity; and the same binder source, grade and amount. In addition, the specimens should have the same preparation, that is, temperatures, cooling, and compaction.

NOTE — Marshall stability and flow test results should consist of a minimum of three specimens at each increment of binder content, where the binder content normally varies in one-half percent increments over a range of binder contents.

3.3.2 *Preparation of Aggregates*

Dry the aggregates to constant weight. Oven drying should be done at 105 to 110°C. After cooling, separate the aggregates by dry-sieving into the desired size fractions.

3.3.3 *Determination of Mixing and Compaction Temperature*

The bitumen binder used in preparing the samples must be heated to produce viscosities of 0.17 ± 0.02 Pa.s (170 ± 20 cP) and 0.28 ± 0.03 Pa.s (280 ± 30 cP) for mixing and compacting, respectively. However, selection of mixing and compaction temperatures at viscosities of 170 ± 20 cP and 280 ± 30 cP respectively, may not apply to modified bitumen binders. In such cases, the user should contact the manufacturer to establish appropriate mixing and compaction temperature ranges.

3.3.4 *Preparation of Bituminous Mix Specimens*

Specimens may be prepared from single batches or multiple batches containing sufficient material for three or four specimens. Weigh into separate containers the amount of each aggregate size fraction required to produce a batch that will result in one, two, three, or four compacted specimens 63.5 ± 2.5 mm in height (about 1 200, 2 400, 3 600 or 4 800 g respectively). Heat the aggregate batches on a hot plate or in an oven to the temperature as per *3.3.3,* but not exceeding more than 28°C. Charge the mixing container with the heated aggregate and dry mix thoroughly (approximately 5 s). Form a crater in the dry blended aggregate and weigh the required amount of bituminous binder at mixing temperature into the mixture. Care must be exercised to prevent loss of the mix during mixing and subsequent handling. At this point, the mixture temperature shall be within the limits of the mixing temperature as per **3.3.3**. Mix the aggregate and bituminous material rapidly until thoroughly coated for approximately 60 s for single-specimen batches and approximately 120 s for multiple-specimen batches.

NOTE — Binder content range is generally selected based on experience and historical testing data of the component materials, but may involve trial and error to include the desirable range of mix properties.

3.3.5 *Compaction of Specimens*

3.3.5.1 Thoroughly clean the specimen mould assembly and the face of the compaction hammer and heat them in an oven or on a hot plate to a temperature between 90 and 150°C. Place a piece of non-absorbent paper, cut to size, in the bottom of the mould before the bituminous mixture is introduced. Place the mixture in the mould, spade the mixture vigorously with a heated spatula or trowel 15 times around the perimeter and 10 times over the interior. Place another piece of non-absorbent paper cut to fit on top of the mix. Temperature of the mixture immediately prior to compaction shall be within the limits of the compaction temperature as per **3.3.3.**

3.3.5.2 Place the mould assembly on the compaction pedestal in the mould holder and apply the required number of blows with the specified compaction hammer. Remove the base plate and collar, and reverse and reassemble the mould. Apply the same number of compaction blows to the face of the reversed specimen. After compaction, remove the collar and base plate. Allow the specimen to cool sufficiently to prevent damage and extract the specimen from the mould. Carefully transfer specimens to a smooth, flat surface and allow cooling at room temperature. A fan can be used to facilitate cooling. When compaction is accomplished with a manually held and operated hammer, hold the axis of the compaction hammer by hand, as nearly perpendicular as possible to the base of the mould assembly during compaction.

NOTE — It has been determined that 50 and 75 compaction blows applied to a 4 in (101.6 mm) diameter specimen using the apparatus and procedure in this standard give densities equivalent to 75 and 112 compaction blows, respectively, applied to a 6 in (152.4 mm) diameter specimen used in Method B.

3.3.6 *Determination of Bulk Density*

Bulk Density of each specimen shall be determined by Test Methods ASTM D 2726/ASTM D 1188/ASTM D 6752. The bulk specific gravities of replicate specimens for respective binder content shall be within ± 0.020 of the mean.

3.3.7 *Determination of Marshall Stability and Flow*

3.3.7.1 *Conditioning of the specimens*

Specimens shall be first conditioned for testing as soon as they reach ambient room temperature. Testing shall be completed within 24 h after compaction. Bring specimens prepared with bitumen binder to the specified temperature by immersion in the water bath for 30 to 40 min. Maintain the bath temperature at 60 ± 1°C. Thoroughly clean the guide rods and inside surfaces of the test head segments prior to conducting the test. Lubricate guide rods so that the upper test head segment slides freely over them. The testing head shall be at a temperature of 20 to 40°C. Remove the specimen from the water bath; remove excess water with a towel; and place in the lower segment of the testing head. Place the upper segment of the testing head on the specimen, and place the complete assembly in position in the loading machine. If used, place the flow meter in position over one of the guide rods and adjust the flow meter to zero while holding the sleeve firmly against the upper segment of the testing head. Hold the flow meter sleeve firmly against the upper segment of the testing head while the test load is being applied.

3.3.7.2 The elapsed time from removal of the test specimens from the water bath to the final load determination shall not exceed 30 s. Apply load to the specimen by means of the constant rate of movement of the loading jack or loading machine head of 52.8 mm/min (2 in/min) until the dial gauge releases or the load begins to decrease. Release the flow meter sleeve or note the micrometre dial reading, where used, the instant when the load decreases, or stop the test when the load cell indicates that the incremental rate of loading, which is driving the constant rate of deformation, has begun to decrease. Record the maximum load in Newton (stability) noted on the testing machine or converted from the maximum micrometre dial reading. Record the indicated flow meter value (flow) in 0.25 mm units.

3.4 Calculation

Laboratory moulded specimen shall satisfy the thickness requirement of 63.5 ± 2.5 mm. Specimens within the thickness tolerance may be corrected based on specimen volume or thickness. Stabilities determined on field cores with large variation in volume or thickness shall also be corrected. However, results with larger corrections should be used with caution. Correction factors (correlation ratios) are specified in Table 1. The correlation ratio is used in the following manner.

$$A = B \times C$$

where,

A = corrected stability,

B = measure of stability (load), and

C = correlation ratio from Table 1.

3.5 Report

The mean of the Marshall Stability and flow of the three compacted specimens of the bituminous mix tested shall be reported. The converted stability shall be reported in Newton (N). The flow value shall be reported in units of 0.25 mm (0.01 in).

4 METHOD B

4.1 General

This test method is for use with large stone bituminous mixtures prepared with nominal maximum aggregate size up to 37.5 mm (1.5 in). It also describes the preparation, compaction, and measurement of resistance to plastic flow of 152.4 mm (6 in) diameter by 95.2 mm (3.75 in) high cylindrical bituminous paving mixture specimens.

4.2 Apparatus

4.2.1 *Specimen Mould Assembly*

Mould cylinders of nominal 165.1 mm (6 in) outside diameter steel tubing with 152.4 ± 0.2 mm (6 in ± 0.008 in) inside diameter by 114.3 mm (4.5 in) in height, base plates, and extension collars shall conform to the details as shown in Fig. 5.

4.2.2 *Specimen Extractor*

Made of steel, in the form of a disk with a diameter from 151.1 to 152.1 mm and 13 mm thick for extracting the compacted specimen from the specimen mould.

Table 1 Stability Correlation Factors

(*Clause* 3.4)

Sl No.	Volume of Specimen (cm^3)	Thickness of Specimen (mm)	Correlation Ratio
(1)	(2)	(3)	(4)
i)	200 to 213	25.4	5.56
ii)	214 to 225	27.0	5.00
iii)	226 to 237	28.6	4.55
iv)	238 to 250	30.2	4.17
v)	251 to 264	31.8	3.85
vi)	265 to 276	33.3	3.57
vii)	277 to 289	34.9	3.33
viii)	290 to 301	36.5	3.03
ix)	302 to 316	38.1	2.78
x)	317 to 328	39.7	2.50
xi)	329 to 340	41.3	2.27
xii)	341 to 353	42.9	2.08
xiii)	354 to 367	44.4	1.92
xiv)	368 to 379	46.0	1.79
xv)	380 to 392	47.6	1.67
xvi)	393 to 405	49.2	1.56
xvii)	406 to 420	50.8	1.47
xviii)	421 to 431	52.4	1.39
xxi)	432 to 443	54.0	1.32
xx)	444 to 456	55.6	1.25
xxi)	457 to 470	57.2	1.19
xxii)	471 to 482	58.7	1.14
xxiii)	483 to 495	60.3	1.09
xxiv)	496 to 508	61.9	1.04
xxv)	509 to 522	63.5	1.00
xxvi)	523 to 535	65.1	0.96
xxvii)	536 to 546	66.7	0.93
xxviii)	547 to 559	68.3	0.89
xxix)	560 to 573	69.8	0.86
xxx)	574 to 585	71.4	0.83
xxxi)	586 to 598	73.0	0.81
xxxii)	599 to 610	74.6	0.78
xxxiii)	611 to 626	76.2	0.76

4.2.3 *Mechanical Compactor and Compaction Hammer*

Compactor with 250W (1/3hp) minimum motor, chain lift, frame, and automatic sliding weight release. The compaction hammer as shown in Fig. 6 shall have a flat, circular tamping face 149.4 mm in diameter and a 10.21 ± 0.01 kg sliding weight with a free fall of 457.2 ± 2.5 mm (18 in). Two compaction hammers are usually recommended. A manually operated hammer shall also be permitted for compaction.

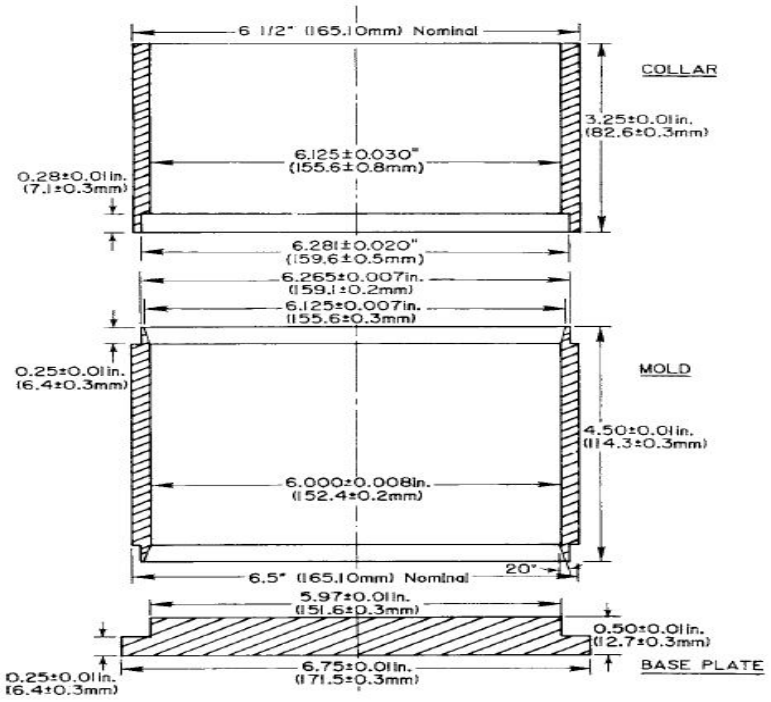


FIG. 5 COMPACTION MOULD

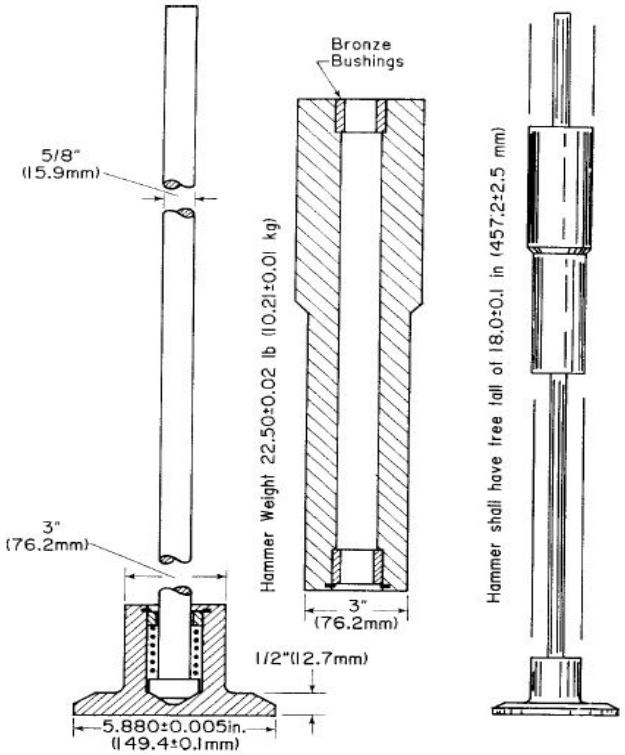


FIG. 6 COMPACTION HAMMER

4.2.4 *Compaction Pedestal*

Requirements are same as given in **3.2.4**

4.2.5 *Specimen Mould Holder*

Requirements are same as given in **3.2.5**

4.2.6 *Breaking Head*

The breaking head as shown in Fig. 7 shall consist of upper and lower cylindrical segments or test heads having an inside radius of curvature of 3 in (76.2 mm) accurately machined. The lower segment shall be mounted on a base having two perpendicular guide rods or posts extending upward. Guide sleeves in the upper segments shall be in such a position as to direct the two segments together without appreciable binding or loose motion on the guide rods. When a 6 in (152.4 mm) diameter by 4 in (100 mm) thick metal block is placed between the two segments, the inside diameters and the gaps between the segments shall confirm to Fig. 7.

4.2.7 *Loading Jack*

The loading jack as shown in Fig. 4 shall produce a uniform vertical movement of 50.8 mm per min (2 in per min). Other requirements are same as given in **3.2.9** of Method A for the compression-loading machine.

4.2.8 *Ring Dynamometer Assembly*

One ring dynamometer as shown in Fig. 4 of 4 536 kg capacity and sensitivity of 4.536 kg up to 453.6 kg and 11.340 kg between 453.6 and 4 536 kg shall be equipped with a micrometre dial. Instead of the loading jack, a mechanical or hydraulic testing machine may be used provided the rate of movement can be maintained to 50.8 mm/min (2 in/min) while the load is applied.

4.2.9 *Flow meter*

Requirements are same as in **3.2.11**

4.2.10 *Ovens or Hot Plates*

Requirements are same as in **3.2.6**

4.2.11 *Mixing Apparatus*

Requirements are same as in **3.2.7**

4.2.12 *Water Bath*

The water bath shall be at least 228.6 mm (9 in) deep and shall be thermostatically controlled to maintain the bath at 60 ± 1.0 °C. The tank shall have a perforated false bottom or be equipped with a shelf for supporting specimens 50.8 mm above the bottom of the bath.

4.2.13 *Thermometers*

Armoured-glass or dial-type thermometers with metal stems are recommended, with a range from 10 to 200°C and sensitivity of ± 1°C for checking mixing and compacting temperatures.

4.2.14 *Balance*

For batching mixtures readable to at least 0.1 g.

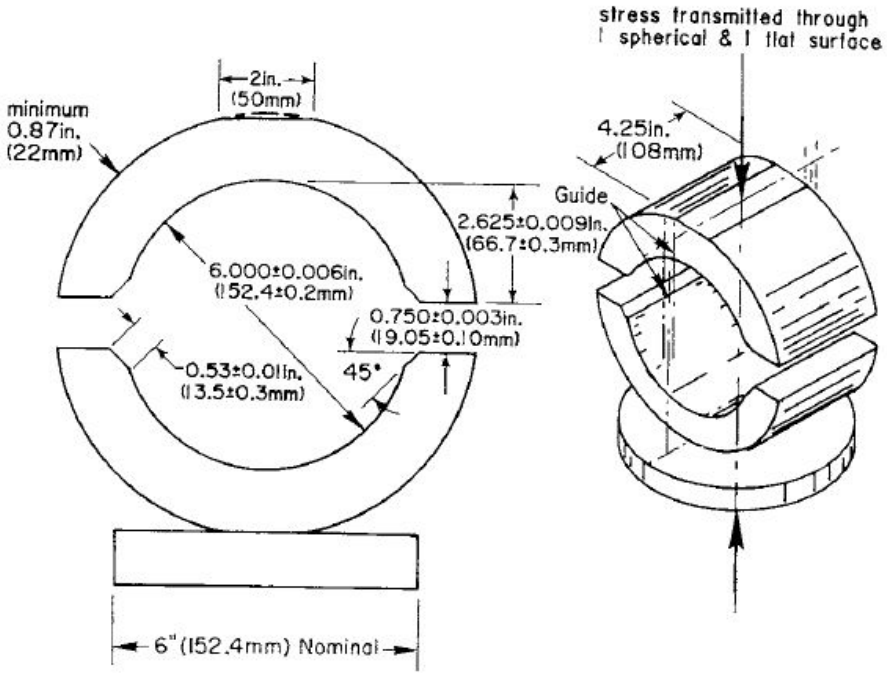


FIG. 7 BREAKING HEAD FOR METHOD B

4.3 Procedure

4.3.1 *Preparation of Test Specimens*

4.3.1.1 *Number of specimens*

Prepare at least three specimens for each combination of aggregates and bitumen content.

NOTE — Marshall stability and flow test results should consist of a minimum of three specimens at each increment of binder content, where the binder content normally varies in one-half percent increments over a range of binder contents.

4.3.1.2 *Preparation of aggregates*

Dry the aggregates to constant weight. Oven drying should be done at 105 to 110°C. After cooling, separate the aggregates by dry sieving into the desired size fractions.

4.3.4 *Determination of Mixing and Compaction Temperature*

The bitumen binder used in preparing the samples must be heated to produce viscosities of 0.17 ± 0.02 Pa.s (170 ± 20 cP) and 0.28± 0.03 Pa.s (280 ± 30 cP) for mixing and compacting, respectively. However, selection of mixing and compaction temperatures at viscosities of 170 ± 20 cP and 280 ± 30 cP respectively, may not apply to modified binders. The user should contact the manufacturer to establish appropriate mixing and compaction temperature ranges.

4.3.5 *Preparation of Bituminous Mix Specimens*

Weigh into separate pans for each test specimen the amount of each size fraction required to produce a batch that will result in a compacted specimen 95.2 ± 2.54 mm in height (about 4050 g). Place aggregate batches in containers on a hot plate or in an oven and heat to a temperature not exceeding the mixing temperature as per **4.3.4** more than 28°C. Charge the mixing container with the heated aggregate and dry mix thoroughly (approximately 5 s). Form a crater in the dry blended aggregate and weigh the required amount of bituminous binder at mixing temperature into the mixture. Mix the aggregate and bituminous material rapidly until thoroughly coated.

NOTE — Binder content range is generally selected based on experience and historical testing data of the component materials, but may involve trial and error to include the desirable range of mix properties.

4.3.6 *Compaction of Specimens*

Same as given in **3.3.5**. It has been found that that 75 and 112 compaction blows applied to a 152.4 mm (6 in) diameter specimen using the respectively, applied to a 101.6 mm (4 in) diameter specimen.

4.3.7 *Determination of Bulk Density*

Bulk density of the bituminous mixture specimens shall be determined by Test Methods ASTM D 2726/ASTM D 1188/ASTM D 6752. The bulk specific gravities of replicate specimens for respective binder content shall be within ± 0.020 of the mean.

4.3.8 *Determination of Marshall Stability and Flow*

Bring the specimens to the specified temperature by immersing in the water bath for 45 to 60 min. Maintain the bath temperature at 60 ± 1.0°C. Remove the specimen from the water bath, remove excess water with a towel, and place in the lower segment of the testing head. Place the upper segment of the testing head on the specimen, and place the complete assembly in position in the loading machine. Apply the load to the specimen by means of the constant rate of movement of the load jack or testing-machine head of 50.8 mm/min (2 in) until the maximum load is reached and the load decreases as indicated by the dial. Record the maximum load noted on the testing machine or converted from the maximum micrometre dial reading. Release the flow meter sleeve or note the micrometre dial reading, where used, the instant the maximum load begins to decrease. Note and record the indicated flow value or equivalent units in twenty-five hundredths of a millimetre if a micrometre dial is used to measure the flow. The elapsed time for the test from removal of the test specimen from the water bath to the maximum load determination shall not exceed 30 s. Ensure that the core specimens have smooth sides; otherwise point loading can occur, resulting in low stability values.

4.4 Calculation

For core specimens, correct the load when thickness is other than 95.2 mm (3.75 in) by using the proper correction factor as specified in Table 2.

Table 2 Marshall Stability Correction factors for 6 inch Specimens (Method B)

(*Clause* 4.4)

Sl No.	Average Thickness of Bituminous Specimens (mm)	Volume of Specimens, (cm^3)	Correction Factor
(1)	(2)	(3)	(4)
i)	88.9	1608 to 1626	1.12
ii)	90.5	1637 to 1665	1.09
iii)	92.1	1666 to 1694	1.06
iv)	93.7	1695 to 1723	1.03
v)	95.2	1724 to 1752	1.00
vi)	96.8	1753 to 1781	0.97
vii)	98.4	1782 to 1810	0.95
Viii)	100.0	1811 to 1839	0.92
ix)	101.6	1840 to 1868	0.90

NOTE — These correction factors are used to convert the measured Marshall Stability values to an equivalent value for a specimen with 95.2 mm thickness, if the actual thickness varies.

4.5 Report

The mean of the Marshall Stability and flow of the three compacted specimens of the bituminous mix tested shall be reported. The converted stability shall be reported in Newton (N). The flow value shall be reported in units of 0.25 mm (0.01 in).

Bureau of Indian Standards

BIS is a statutory institution established under the *Bureau of Indian Standards Act*, 2016 to promote harmonious development of the activities of standardization, marking and quality certification of goods and attending to connected matters in the country.

Copyright

Review of Indian Standards

Amendments are issued to standards as the need arises on the basis of comments. Standards are also reviewed periodically; a standard along with amendments is reaffirmed when such review indicates that no changes are needed; if the review indicates that changes are needed, it is taken up for revision. Users of Indian Standards should ascertain that they are in possession of the latest amendments or edition by referring to the latest issue of 'BIS Catalogue' and 'Standards: Monthly Additions'.

This Indian Standard has been developed from Doc No.: PCD 06 (13075).

Amendments Issued Since Publication

Amend No.	Date of Issue	Text Affected

BUREAU OF INDIAN STANDARDS

Headquarters:

Manak Bhavan, 9 Bahadur Shah Zafar Marg, New Delhi 110002
Telephones: 2323 0131, 2323 3375, 2323 9402 *Website*: www.bis.gov.in

Regional Offices: *Telephones*

Central : Manak Bhavan, 9 Bahadur Shah Zafar Marg, NEW DELHI 110002 — 2323 7617, 2323 3841

Eastern : 1/14 C.I.T. Scheme VII M, V.I.P. Road, Kankurgachi, KOLKATA 700054 — 2337 8499, 2337 8561, 2337 8626, 2337 9120

Northern : Plot No. 4-A, Sector 27-B, Madhya Marg, CHANDIGARH 160019 — 265 0206, 265 0290

Southern : C.I.T. Campus, IV Cross Road, CHENNAI 600113 — 2254 1216, 2254 1442, 2254 2519, 2254 2315

Western : Manakalaya, E9 MIDC, Marol, Andheri (East), MUMBAI 400093 — 2832 9295, 2832 7858, 2832 7891, 2832 7892

Branches : AHMEDABAD. BENGALURU. BHOPAL. BHUBANESHWAR. COIMBATORE. DEHRADUN. DURGAPUR. FARIDABAD. GHAZIABAD. GUWAHATI. HYDERABAD. JAIPUR. JAMMU. JAMSHEDPUR. KOCHI. LUCKNOW. NAGPUR. PARWANOO. PATNA. PUNE. RAIPUR. RAJKOT. VISAKHAPATNAM.

Published by BIS, New Delhi