Pavement Materials & Design

ASTM D6927

Marshall Stability and Flow of Asphalt Mixtures|
اختبار المارشال | اختبار التدفق والثبات للخلطة الاسفلتية

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Designation: D6927 – 15

Standard Test Method for
Marshall Stability and Flow of Asphalt Mixtures[1]

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ASTM D6927

Terminology

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Compacted Specimens

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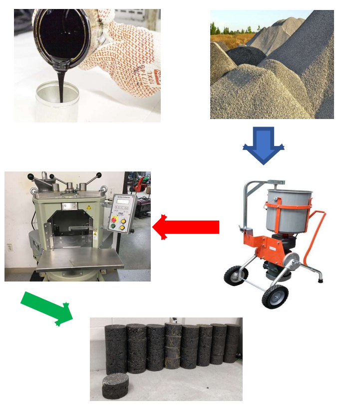
3. Terminology

3.1 *Definitions:*

3.1.1 *lab mix lab compacted (LMLC) asphalt mixture, n*—asphalt mix samples that are prepared in the laboratory by weighing and blending each constituent then compacting the blended mixture using a laboratory compaction apparatus.

3.1.1.1 *Discussion*—LMLC typically occurs during the asphalt mixture design phase. Laboratory compaction devices such as the Superpave Gyratory Compactor, Marshall Hammer, or other laboratory compaction devices may be used.



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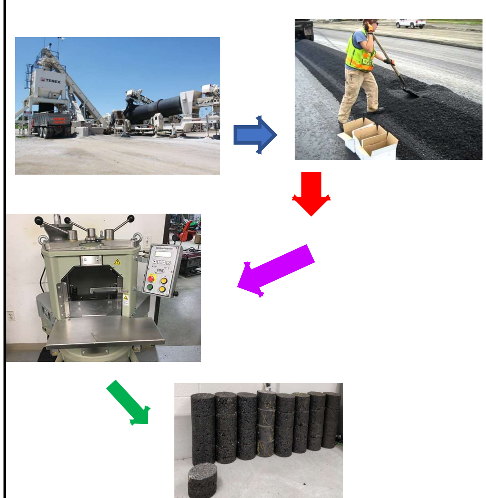
3.1.2 *plant mix laboratory compacted (PMLC) asphalt mixture, n*—asphalt mixture samples that are manufactured in a production plant, sampled prior to compaction, then immediately compacted using a laboratory compaction apparatus.

3.1.2.1 *Discussion*—PMLC specimens are often used for quality control testing. The asphalt mixture is not permitted to cool substantially and it may be necessary to place the mixture in a laboratory oven to equilibrate the mixture to the compaction temperature before molding. Laboratory compaction devices such as the Superpave Gyratory Compactor, Marshall Hammer, or other laboratory compaction devices may be used.



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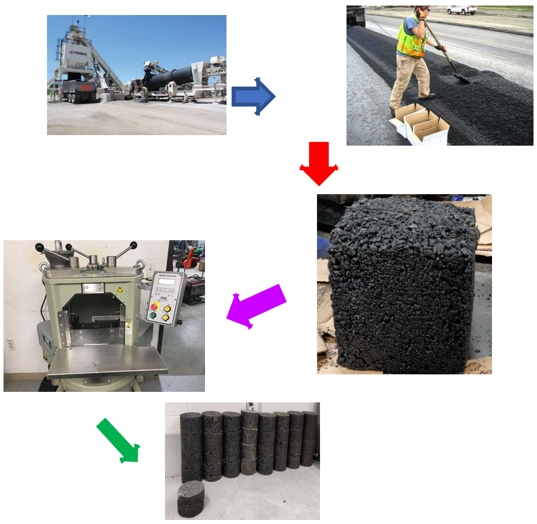
3.1.3 *reheated plant mix lab compacted (RPMLC) asphalt mixture, n*—asphalt mixture samples that are manufactured in a production plant, sampled prior to compaction, allowed to cool to room temperature, then reheated in a laboratory oven and compacted using a laboratory compaction apparatus.

3.1.3.1 *Discussion*—RPMLC are often used for quality acceptance and verification testing. The reheating time should be as short as possible to obtain uniform temperature to avoid artificially aging the specimens. Asphalt mixture conditioning, reheat temperature, and reheat time should be defined in the applicable specification. Laboratory compaction devices such as the Superpave Gyratory Compactor, Marshall Hammer, or other laboratory compaction devices may be used.



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Field Cores

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Scope

1. Scope

1.1 This test method covers measurement of resistance to plastic flow of 4 in. (102 mm) cylindrical specimens of asphalt paving mixture loaded in a direction perpendicular to the cylindrical axis by means of the Marshall apparatus. This test method is for use with dense graded asphalt mixtures prepared with asphalt cement (modified and unmodified), cutback asphalt, tar, and tar-rubber with maximum size aggregate up to 1 in. (25 mm) in size (passing 1 in. (25 mm) sieve).

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Referenced Documents

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2. Referenced Documents

2.1 *ASTM Standards:*[2]

C670 Practice for Preparing Precision and Bias Statements for Test Methods for Construction Materials

D1188 Test Method for Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Coated Samples

D2726 Test Method for Bulk Specific Gravity and Density of Non-Absorptive Compacted Bituminous Mixtures

D3549 Test Method for Thickness or Height of Compacted Bituminous Paving Mixture Specimens

D3666 Specification for Minimum Requirements for Agencies Testing and Inspecting Road and Paving Materials

D6752 Test Method for Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Automatic Vacuum Sealing Method

D6926 Practice for Preparation of Bituminous Specimens Using Marshall Apparatus

E2251 Specification for Liquid-in-Glass ASTM Thermometers with Low-Hazard Precision Liquids

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4. Summary of Test Method

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Marshall Mix Design Method Procedures

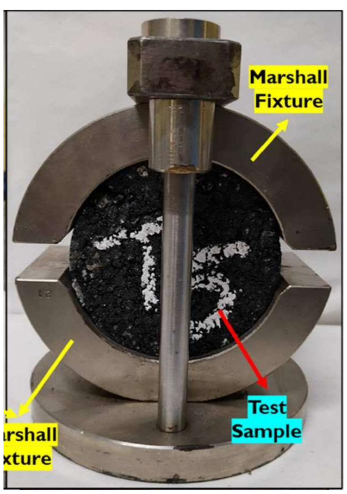

Image source: https://www.civil.iitb.ac.in/~vmtom/1100_LnTse/407_lnTse/plain/

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5. Apparatus

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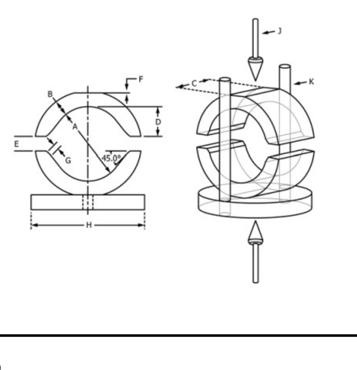
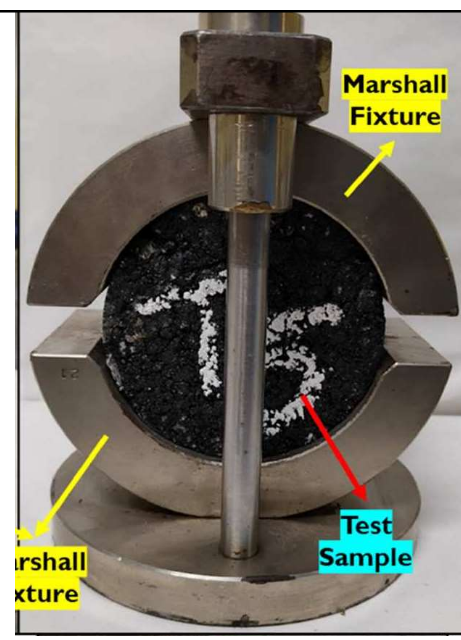
5.1 *Breaking Head*—The testing head (Fig. 2) shall consist of upper and lower cylindrical segments of cast gray or ductile iron, cast steel, or annealed steel tubing. The lower segment shall be mounted on a base having two perpendicular guide rods or posts (minimum ½ in. (12.5 mm) in diameter) extending upwards. Guide sleeves in the upper segment shall direct the two segments together without appreciable binding or loose motion on the guide rods. A circular testing head with an inside bevel having dimensions other than specified in Fig. 2 has been shown to give results different from the standard testing head.



	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.	



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5.2 *Compression Loading Machine*—The compression oading machine (Fig. 3) may consist of a screw jack mounted in a testing frame and shall be designed to load at a uniform vertical movement of 2.00 ± 0.15 in./min (50 ± 5 mm/min). The design in Fig. 3 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 2.00 ± 0.15 in./min (50 ± 5 mm/min).

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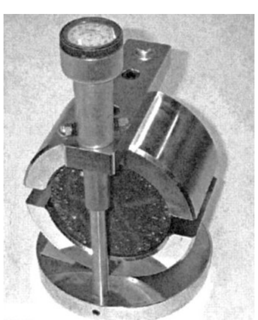
5.4 *Flowmeter*—The Marshall flowmeter consists of a guide sleeve and a gage (Fig. 4). The activating pin of the gage shall slide inside the guide sleeve with minimal friction and the guide sleeve shall slide freely over the guide post (see Fig. 4) of the breaking head. These points of frictional resistance shall be checked before tests. Graduations of the flowmeter gage shall be increments of 0.01 in. (0.25 mm) or finer. Instead of a flowmeter, 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.



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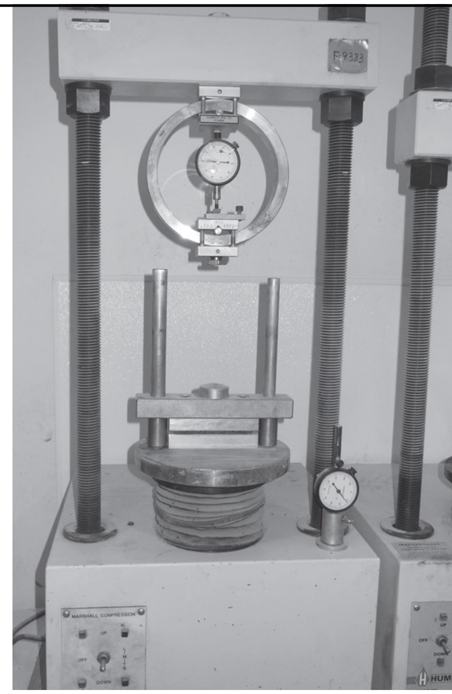

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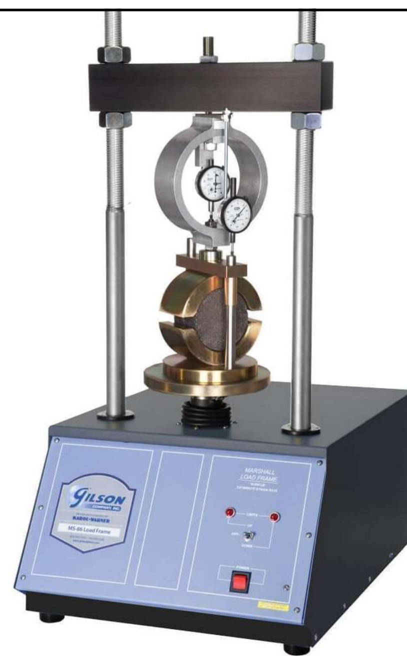
Method B



Method A

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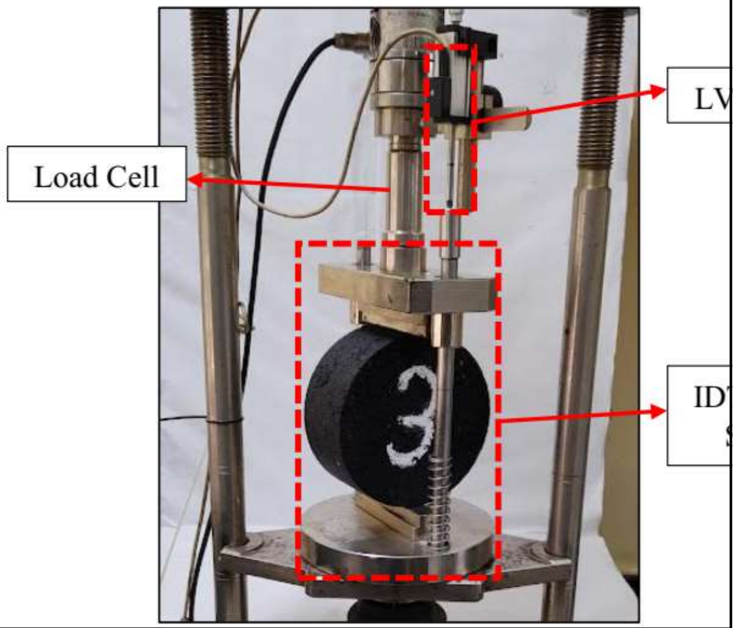

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5.5 *Water Bath*—The water bath shall be deep enough to maintain the water level a minimum of 1.25 in. (30 mm) above the top of specimens. The bath shall be thermostatically controlled so as to maintain the specified test temperature ±2°F (1°C) at any point in the tank. The tank shall have a perforated false bottom or be equipped with a shelf for supporting specimens 2 in. (50 mm) above the bottom of the bath and be equipped with a mechanical water circulator.

5.6 *Oven*—An oven capable of maintaining the specified test temperature ±2°F (1°C).

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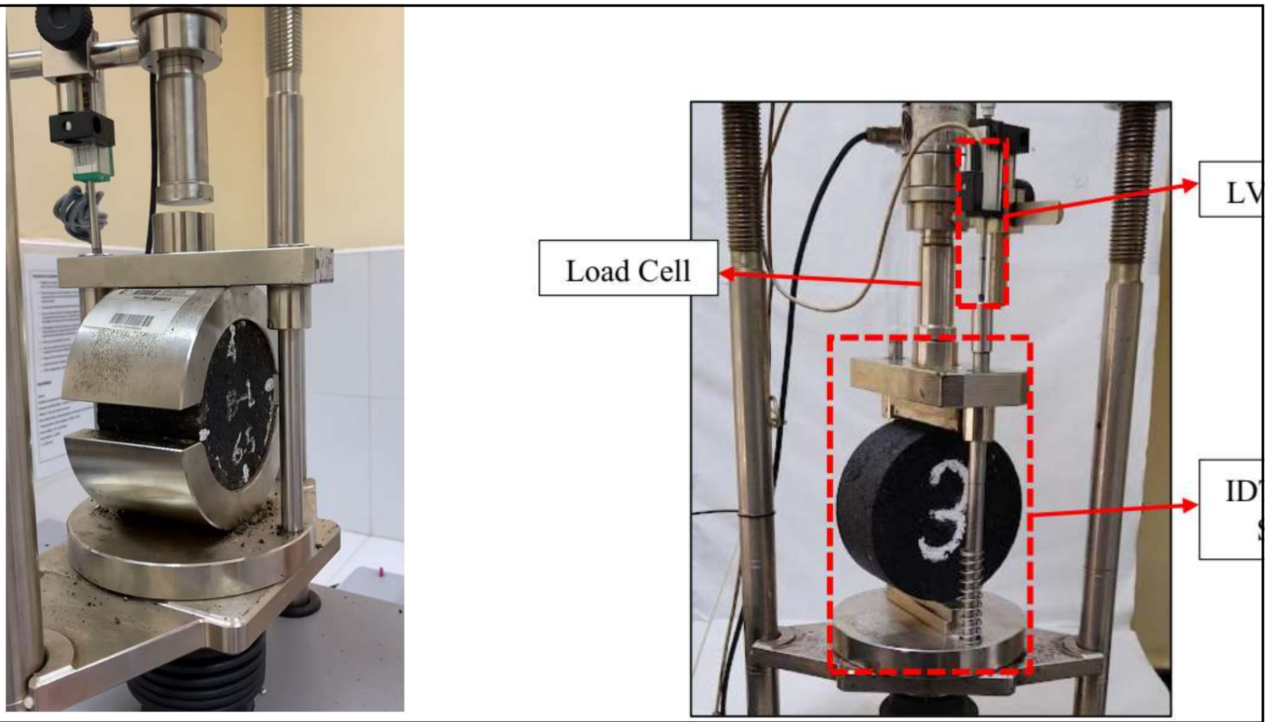
5.7 *Air Bath*—The air bath for mixtures containing cutback asphalt binder shall be thermostatically controlled and shall maintain the air temperature at 77 ± 2°F (25 ± 1°C).

5.3 *Load Measuring Device*—As a minimum, a calibrated nominal 5000 lb (20 kN) ring dynamometer (Fig. 3) with a dial indicator to measure ring deflection for applied loads is required. The 5000 lb (20 kN) ring shall have a minimum sensitivity of 10 lb (50 N). The dial indicator should be graduated in increments of 0.0001 in. (0.0025 mm) or finer. The ring dynamometer should be attached to the testing frame (see ring holding bar, Fig. 3) and an adapter (see ring dynamometer adapter, Fig. 3) 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.



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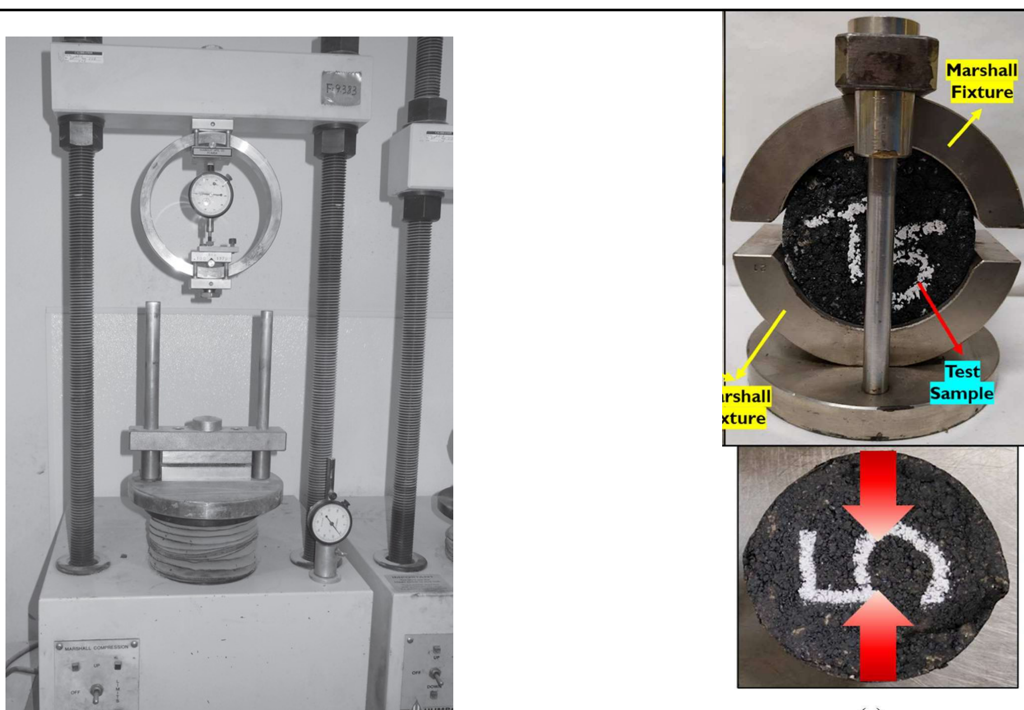

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5. Marshall Specimen Preparation

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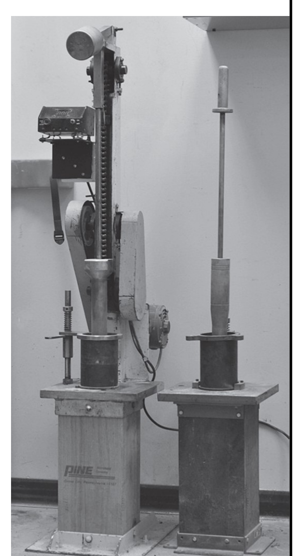
Step C : Preparation of Marshall Specimen

C-8: Compact the specimen at the required Blow/side according to Marshall specifications.

- The laboratory compaction effort is intended to replicate the ultimate or final compacted condition of the pavement after being exposed to several years of traffic loading.
- **Experience** has shown that pavements that maintain an air void level of around 4 percent provide the best long-term performance in the field.
- The Impact compaction is the method for volumetric mix design and quality control testing compaction used in Marshall



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Preparation of Marshall Specimen

- ❑ Place a filter or nonabsorbent paper disk cut to size in the bottom of the mold.
- ❑ Place the entire batch in the mold with collar, and then spade the mixture vigorously with a heated spatula or trowel 15 times around the perimeter and 10 times over the interior. Smooth the surface to a slightly rounded shape.
- ❑ The temperature of the mixture immediately prior to compaction shall be within the limits of the compaction temperature established in paragraph otherwise, it shall be discarded. In no case shall the mixture be reheated

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Preparation of Marshall Specimen

Video source: https://www.youtube.com/watch?v=SuJMH5RDFcQ

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Preparation of Marshall Specimen

- The number of blow/side is function with design traffic level

Marshall Method Criteria[1]	Light Traffic[3] Surface & Base		Medium Traffic[3] Surface & Base		Heavy Traffic[3] Surface & Base	
	Min	Max	Min	Max	Min	Max
Compaction, number of blows each end of specimen	35		50		75	

- Traffic classifications
  - *Light Traffic conditions resulting in a 20-year Design ESAL < 10^4*
  - *Medium Traffic conditions resulting in a 20-year Design ESAL between 10^4 and 10^6*
  - *Heavy Traffic conditions resulting in a 20-year Design ESAL > 10^6*

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SGC

Wheel roller

Marshall

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6. Procedure

6. Procedure

6.1 A minimum of three specimens of a given mixture shall be 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.

6.2 Specimens should be cooled to room temperature after compaction. During cooling they should be placed on a smooth, flat surface. Bulk specific gravity of each specimen shall be determined by Test Methods D2726, D1188, or D6752. The bulk specific gravities of replicate specimens for each binder content shall agree within ±0.020 of the mean as noted in Practice D6926.

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6.2.1 Measure specimen thickness according to Test Method D3549.

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6.3 Specimens can be conditioned for testing as soon as they reach ambient room temperature. Testing shall be completed within 24 h after compaction. Bring specimens prepared with asphalt cement, tar, or tar-rubber to the specified temperature by immersion in the water bath 30 to 40 min, or placement in the oven for 120 to 130 min. Maintain the bath or oven temperature at 140 ± 2°F (60 ± 1°C) for asphalt cement, 120 ± 2°F (49 ± 1°C) for tar-rubber specimens, and 100 ± 2°F (38 ± 1°C) for tar specimens. Bring specimens prepared with cutback asphalt to temperature by placing them in the air bath for 120 to 130 min. Maintain the air bath temperature at 77 ± 2°F (25 ± 1°C).

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Note 3—Temperature variation will affect test results. A dummy specimen with a thermocouple can be used to monitor temperature.

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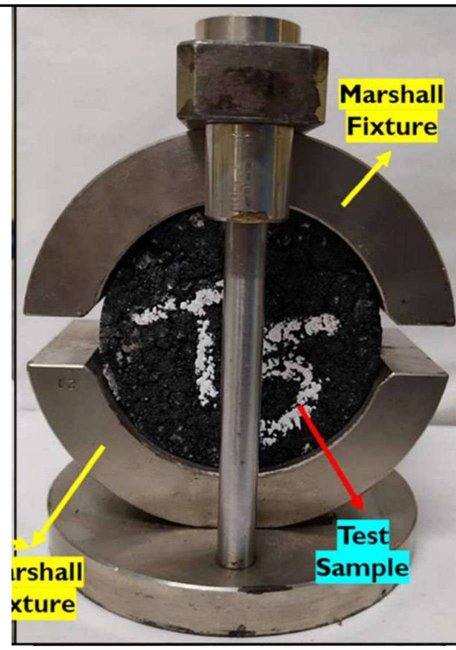
6.3.1 Thoroughly clean the guide rods and inside surfaces of the test head segments prior to conducting the test. Lubricate guide rods so that the upper test head segment slides freely over them. The testing head shall be at a temperature of 70 to 100°F (20 to 40°C). If a water bath is used, wipe excess water from the inside of the testing head segments.



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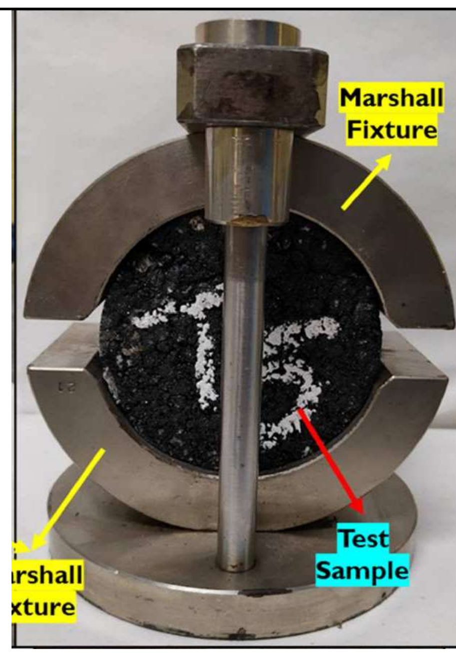
6.3.2 Remove a specimen from the water, oven, or air conditioning bath (in the case of a water bath remove excess water with a towel) and place in the lower segment of the testing head. Place the upper segment of the testing head on the specimen, and place the complete assembly in position in the loading machine. If used, place the flowmeter in position over one of the guide rods and adjust the flowmeter to zero while holding the sleeve firmly against the upper segment of the testing head. Hold the flowmeter sleeve firmly against the upper segment of the testing head while the test load is being applied.



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6.4 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 2.00 ± 0.15 in./min (50 ± 5 mm/min) until the dial gage releases or the load begins to decrease.

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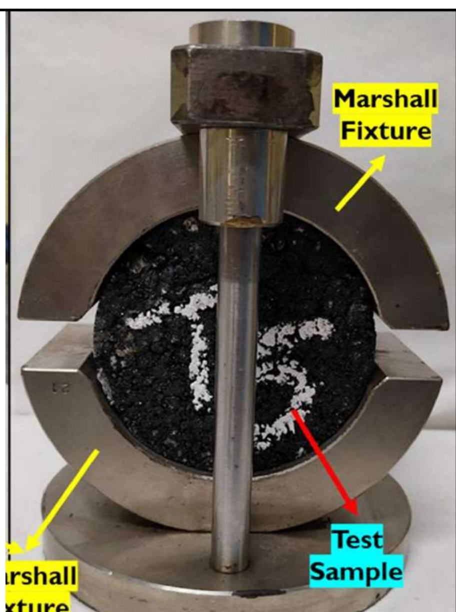

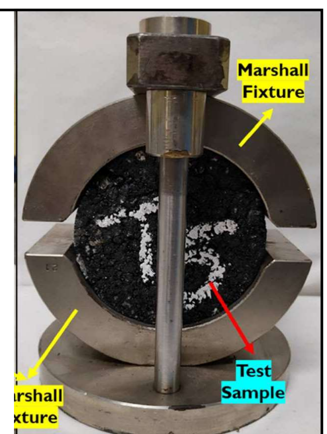

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Method A

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Test Outputs

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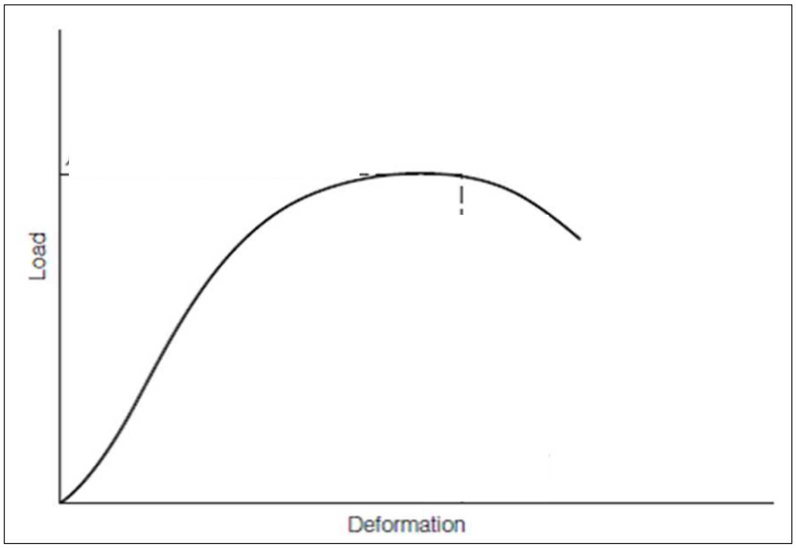

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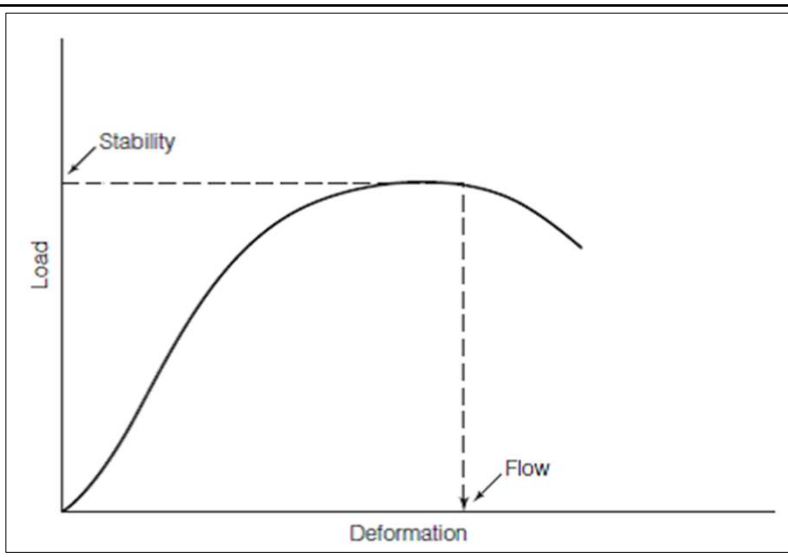

Flow value is reported in hundreds of an inch (0.01 inch) or (0.25 mm).
Stability value is reported in unit of load N, Ib, Kg

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Stability = 1875 ibs =8340 N

Stability value is reported in unit of load N, Ib, Kg

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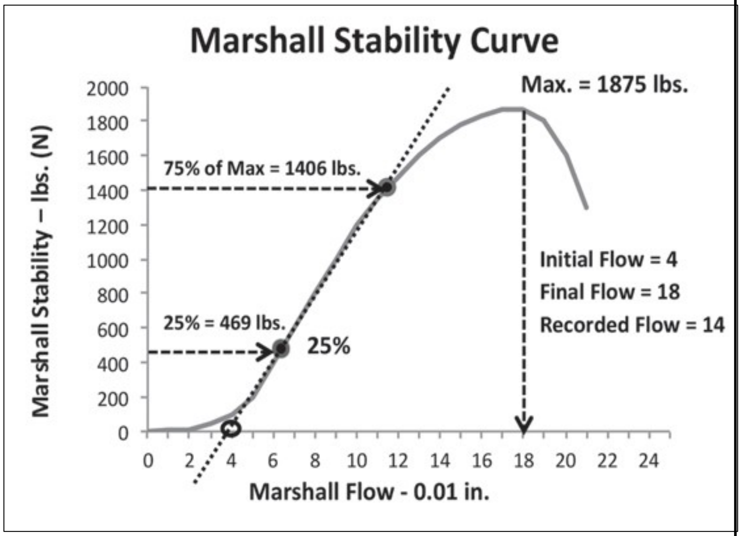

flow = 14 (0.01in) = 14 (0.25mm)

14 (0.25 mm) = 14 / 0.25 mm = 3.5 mm

14 (0.01 in) = 14 / 0.01 in = 0.14 in

1 in = 25.4 mm

0.14 in = 3.5 mm

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4. Significance and Use

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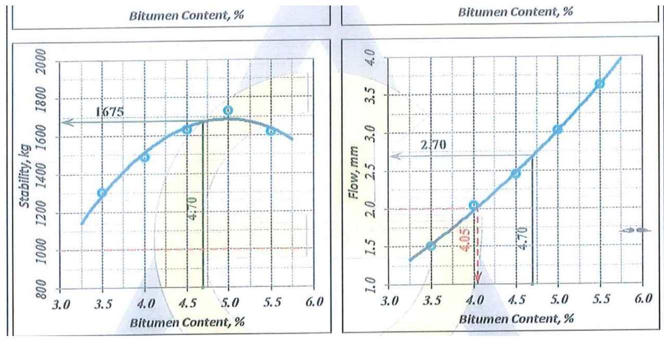
4.1 Marshall stability and flow values along with density; air voids in the total mix, voids in the mineral aggregate, or voids filled with asphalt, or both, filled with asphalt are used for laboratory mix design and evaluation of asphalt mixtures. In addition, Marshall stability and flow can be used to monitor the plant process of producing asphalt mixture. Marshall stability and flow may also be used to relatively evaluate different mixes and the effects of conditioning such as with water.

2. JOB MIX REQUIREMENTS

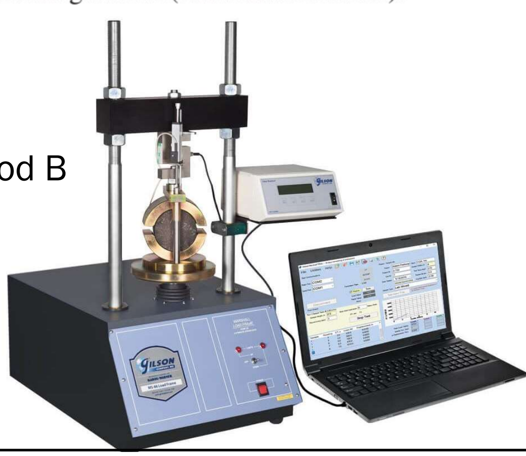
The design aimed at satisfying the job mix requirements for Wearing Course – Heavy Traffic as stated in the Project Special Specifications in addition to "Specifications for Highway and Bridge Construction-1991" of Ministry of Public Works and Housing (MPWH). Accordingly, the following job mix requirements were considered;

Marshall Stability, kg:	1225 (min.)	[12,000 N]
Marshall Flow, mm:	2.0 – 4.0	
Voids in Mineral Aggregate (VMA), %:	14 (min.)	
Air Voids, %:	3 – 6	
Marshall Stiffness, kg/mm:	500 (min.)	[4900 N/mm]
Loss of Stability, %:	25 (max.)	
Filler/Bitumen Ratio:	0.6 – 1.2	
Air Voids at Refusal, %:	2 (min.)	
Tensile Strength Ratio (TSR):	0.80 (min.)	

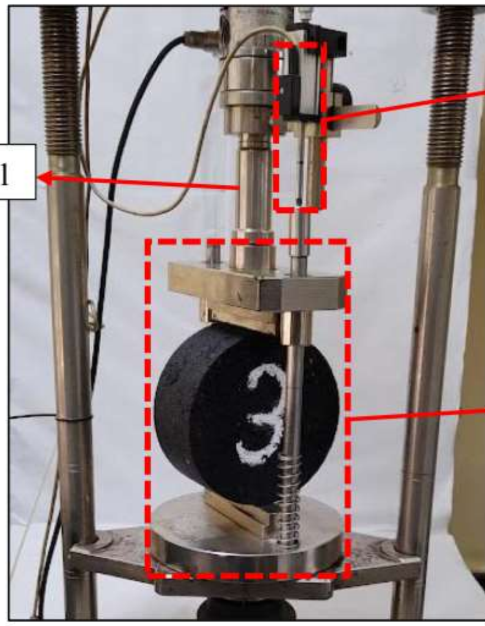


4.1.1 Marshall stability and flow are asphalt mixture characteristics determined from tests of compacted specimens of a specified geometry. The Marshall Test can be conducted with two different types of equipment: (*1*) Method A—using a loading frame with a load ring and a dial gauge for deformation or flow meter (Traditional Method) or (*2*) Method B—using a load-deformation recorder in conjunction with a load cell and linear variable differential transducer (LVDT) or other automatic recording device (Automated Method).

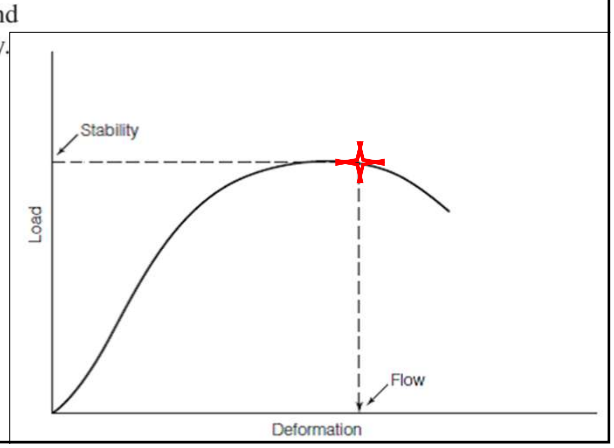
Method B



Method A



4.1.2 Typically, Marshall stability is the peak resistance load obtained during a constant rate of deformation loading sequence. However, depending on the composition and behavior of the mixture, a less defined type of failure has been observed, as illustrated in Fig. 1. As an alternative method, Marshall stability can also be defined as the load obtained, when the rate of loading increase begins to decrease, such that the curve starts to become horizontal, as shown in the bottom graph of Fig. 1. The magnitude of Marshall Stability varies with aggregate type and grading and bitumen type, grade and amount. Various agencies have criteria for Marshall stability.



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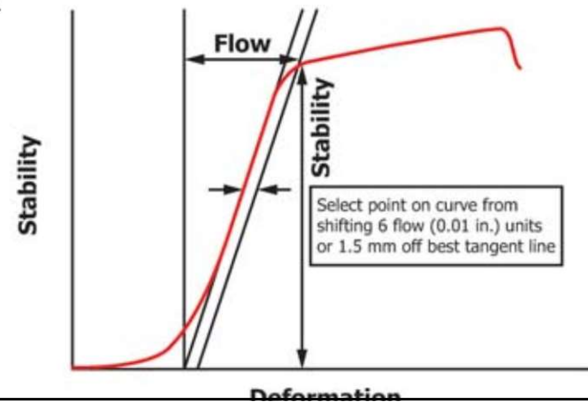

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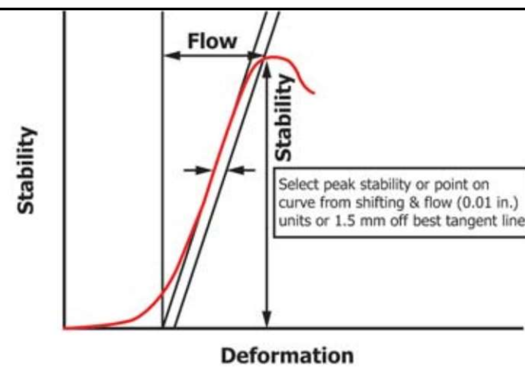
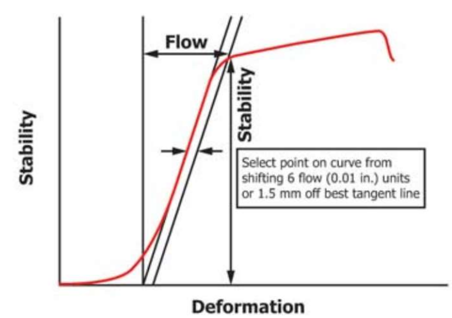
4.1.3 Marshall flow is a measure of deformation (elastic plus plastic) of the asphalt mix determined during the stability test. In both types of failure, the Marshall flow is the total sample deformation from the point where the projected tangent of the linear part of the curve intersects the *x*-axis (deformation) to the point where the curve starts to become horizontal. As shown in Fig. 1, this latter point usually corresponds to the peak stability; however, as an alternative when the failure condition is not clearly defined, it can be selected as the point on the curve which is six flow points or 0.01 in. (1.5 mm) to the right of the tangent line. There is no ideal value but there are acceptable limits. If flow at the selected optimum binder content is above the upper limit, the mix is considered too plastic or unstable and if below the lower limit, it is considered too brittle.





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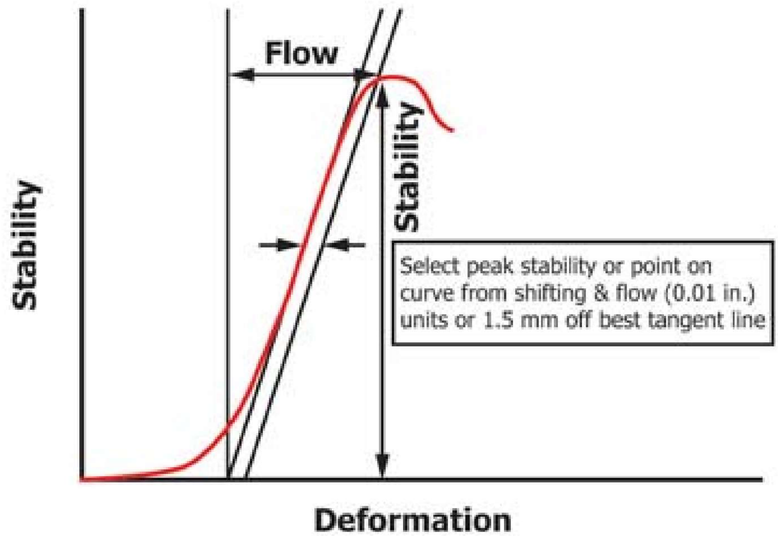
Flow value is reported in hundreds of an inch (0.01 inch) or (0.25 mm).
Stability value is reported in unit of load N, Ib, Kg



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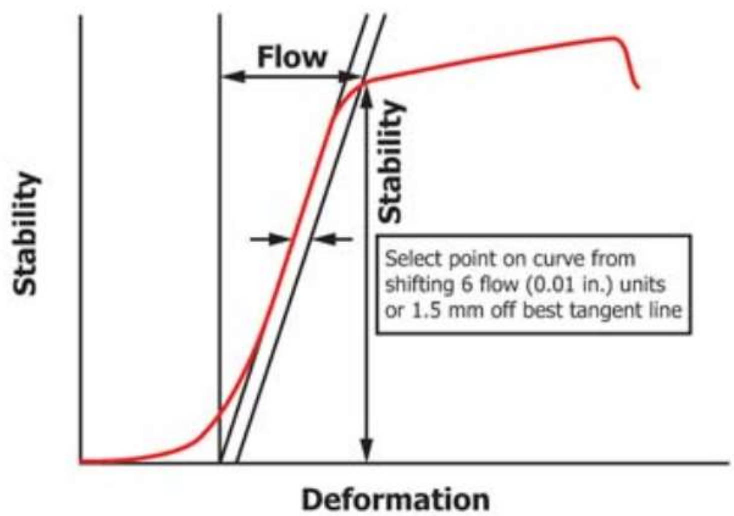
Stability value is reported in unit of load N, Ib, Kg



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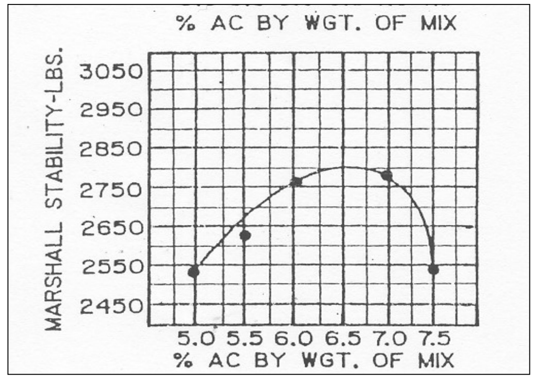
4.1.4 The Marshall stability and flow test results are applicable to dense-graded asphalt mixtures with maximum size aggregate up to 1 in. (25 mm) in size. For the purpose of mix design, Marshall stability and flow test results should consist of the average of a minimum of three specimens at each increment of binder content where the binder content varies in one-half percent increments over a range of binder content. The binder content range is generally selected on the basis of experience and historical testing data of the component materials, but may involve trial and error to include the desirable range of mix properties. Dense-graded mixtures will generally show a peak in stability within the range of binder contents tested. Stability, flow, density, air voids, and voids filled with asphalt binder, may be plotted against binder content to allow selection of an optimum binder content for the mixture. The above test properties may also be weighted differently to reflect a particular mix design philosophy. In addition, a mixture design may be required to meet minimum voids in the mineral aggregate based on nominal maximum aggregate size in the mixture.



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4.1.5 Field laboratory Marshall stability and flow tests on specimens made with plant mix laboratory compacted (PMLC) asphalt mixture mix may vary significantly from laboratory design values because of differences in plant mixing versus laboratory mixing. This includes mixing efficiency and aging.

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4.1.6 Significant differences in Marshall stability and flow from one set of tests to another or from an average value of several sets of data or specimens, prepared from plant-produced mix may indicate poor sampling, incorrect testing technique, change of grading, change of binder content, or a malfunction in the plant process. The source of the variation should be resolved and the problem corrected.

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4.1.7 Specimens will most often be prepared using Practice D6926 but may be prepared using other types of compaction procedures as long as specimens satisfy geometry requirements. Other types of compaction may cause specimens to have different stress strain characteristics than specimens prepared by Marshall impact compaction. Marshall stability and flow may also be determined using field cores from in situ pavement for information or evaluation. However, these results may not compare with results from Lab Mix Lab Compacted (LMLC) Asphalt Mixture, Plant Mix Laboratory Compacted (PMLC) Asphalt Mixture, or Reheated Plant Mix Lab Compacted (RPMLC) Asphalt Mixture specimens and shall not be used for specification or acceptance purposes. One source of error in testing field cores arises when the side of the core is not smooth or perpendicular to the core faces. Such conditions can create stress concentrations in loading and low Marshall stability.


SGC


Marshall


Wheel roller

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- ❑ If the flow at the selected optimum binder content is above the upper specified limit,
  - ➢ *the mix is considered too plastic or unstable.*
- ❑ If the flow is below the lower specified limit
  - ➢ *the mix is considered too brittle*

2. JOB MIX REQUIREMENTS

The design aimed at satisfying the job mix requirements for Wearing Course – Heavy Traffic as stated in the Project Special Specifications in addition to "Specifications for Highway and Bridge Construction-1991" of Ministry of Public Works and Housing (MPWH). Accordingly, the following job mix requirements were considered;

➢ Marshall Stability, kg:	1225 (min.)	[12,000 N]
➢ Marshall Flow, mm:	2.0 – 4.0	
➢ Voids in Mineral Aggregate (VMA), %:	14 (min.)	
➢ Air Voids, %:	3 – 6	
➢ Marshall Stiffness, kg/mm:	500 (min.)	[4900 N/mm]
➢ Loss of Stability, %:	25 (max.)	
➢ Filler/Bitumen Ratio:	0.6 – 1.2	
➢ Air Voids at Refusal, %:	2 (min.)	
➢ Tensile Strength Ratio (TSR):	0.80 (min.)	

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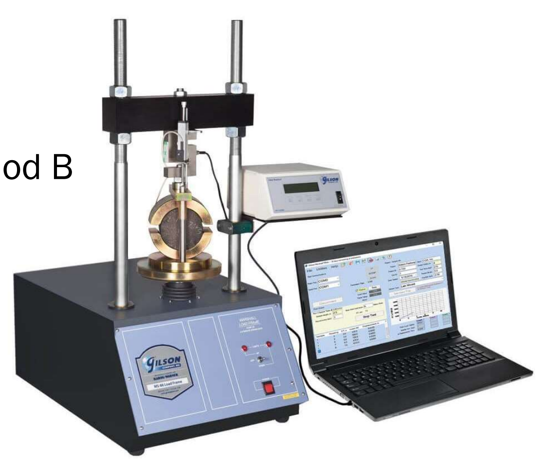
6.5 In Method A, release the flowmeter sleeve or note the micrometer dial reading, where used, the instant when the load decreases, or in Method B, stop the test when the load cell indicates that the incremental rate of loading, which is driving the constant rate of deformation, has begun to decrease. The

Method A

Method B



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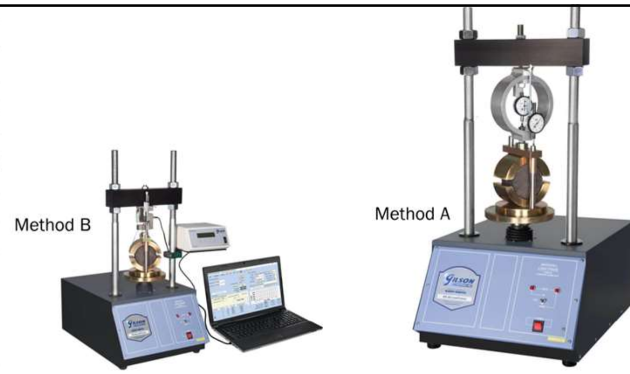
6.5 In Method A, release the flowmeter sleeve or note the micrometer dial reading, where used, the instant when the load decreases, or in Method B, stop the test when the load cell indicates that the incremental rate of loading, which is driving the constant rate of deformation, has begun to decrease. The Marshall flow is the total sample deformation from the point where the projected tangent of the linear part of the curve intersects the *x*-axis (deformation) to the point where the curve starts to become horizontal. As shown in Fig. 1, the termination of flow usually corresponds to the peak stability; however, as an alternative when the failure condition is not clearly defined, it can be selected as the point on the curve which is six flow points or 0.01 in. (1.5 mm) to the right of the tangent line. The flow value is usually recorded in units of 0.01 in. (0.25 mm); for example, 0.12 in. (0.31 mm) is recorded as a flow of 12. The Marshall Stability is defined as the load corresponding to the flow. This procedure may require two people to conduct the test and record the data, depending on the type of equipment and the arrangement of dial indicators. Depending on chart speed, Marshall flow may be read directly from the load-deformation chart or be determined after converting the chart reading with an appropriate factor.



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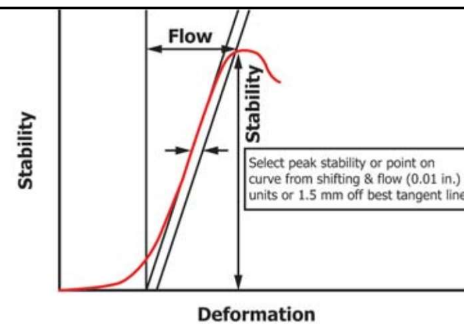
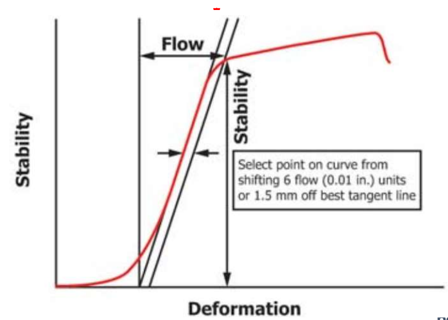
6.5 In Method A, release the flowmeter sleeve or note the micrometer dial reading, where used, the instant when the load decreases, or in Method B, stop the test when the load cell indicates that the incremental rate of loading, which is driving the constant rate of deformation, has begun to decrease. The Marshall flow is the total sample deformation from the point where the projected tangent of the linear part of the curve intersects the *x*-axis (deformation) to the point where the curve starts to become horizontal. As shown in Fig. 1, the termination of flow usually corresponds to the peak stability; however, as an alternative when the failure condition is not clearly defined, it can be selected as the point on the curve which is six flow points or 0.01 in. (1.5 mm) to the right of the tangent line. The flow value is usually recorded in units of 0.01 in. (0.25 mm); for example, 0.12 in. (0.31 mm) is recorded as a flow of 12. The Marshall Stability is defined as the load corresponding to the flow. This procedure may require two people to conduct the test and record the data, depending on the type of equipment and the arrangement of dial indicators. Depending on chart speed, Marshall flow may be read directly from the load-deformation chart or be determined after converting the chart reading with an appropriate factor.





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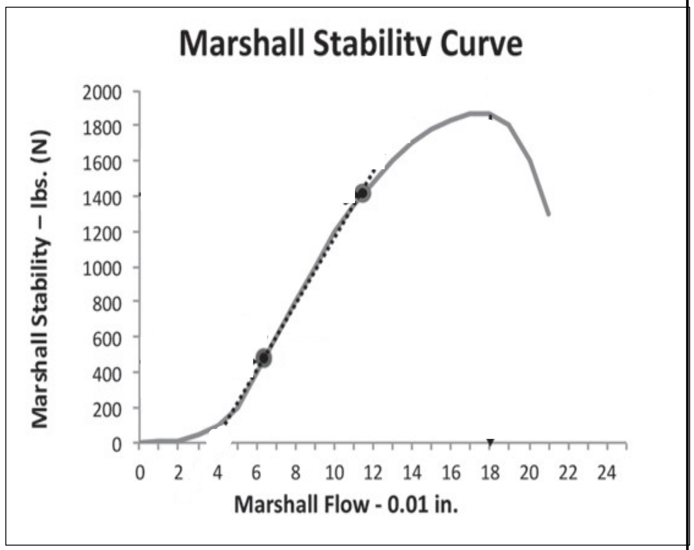
Curve correction when using an automatic recording

- The bottom portion of the Marshall stability versus Marshall flow curve shows the effects of irregularities on the specimen surface until full contact (seating) of the testing heads and the specimen surface is achieved.
- Therefore, when using an automatic recording device, the recorded Marshall flow must be corrected by subtracting the flow portion during "seating" of the specimen (as shown in Figure).



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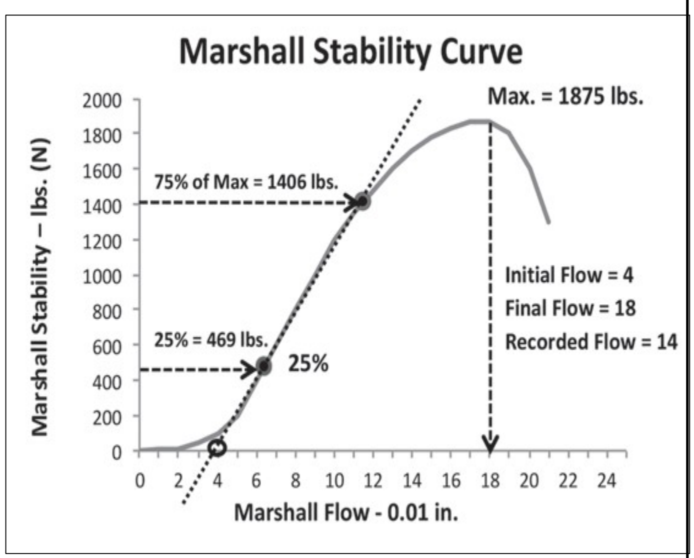
Curve correction when using an automatic recording

- To determine the correct start of the flow reading,
  - *A tangent line shall be drawn connecting two points on the stability–flow curve, representing*
  - *25 percent and 75 percent of Marshall stability.*
  - *Where this tangent line intersects the x-axis is the start of Marshall flow*



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7. Calculations

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7. Calculation

7.1 Laboratory molded specimens shall satisfy the thickness requirement of 2.50 ± 0.10 in. (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 given in Table 1. The correlation ratio is used in the following manner.

$$A = B \times C \quad (1)$$

where:

A = corrected stability,
B = measure of stability (load), and
C = correlation ratio from Table 1.

TABLE 1 Stability Correlation Factors[A]

Volume of Specimen, cm³[B]	Thickness of Specimen[B]		Correlation Ratio
	in.	mm	
200 to 213	1.00 (1)	(25.4)	5.56
214 to 225	1.06 (1 1/16)	(27.0)	5.00
226 to 237	1.12 (1 1/8)	(28.6)	4.55
238 to 250	1.19 (1 3/16)	(30.2)	4.17
251 to 264	1.25 (1 1/4)	(31.8)	3.85
265 to 276	1.31 (1 5/16)	(33.3)	3.57
277 to 289	1.38 (1 3/8)	(34.9)	3.33
290 to 301	1.44 (1 7/16)	(36.5)	3.03
302 to 316	1.50 (1 1/2)	(38.1)	2.78
317 to 328	1.56 (1 9/16)	(39.7)	2.50
329 to 340	1.62 (1 5/8)	(41.3)	2.27
341 to 353	1.69 (1 11/16)	(42.9)	2.08
354 to 367	1.75 (1 3/4)	(44.4)	1.92
368 to 379	1.81 (1 13/16)	(46.0)	1.79
380 to 392	1.88 (1 7/8)	(47.6)	1.67
393 to 405	1.94 (1 15/16)	(49.2)	1.56
406 to 420	2.00 (2)	(50.8)	1.47
421 to 431	2.06 (2 1/16)	(52.4)	1.39
432 to 443	2.12 (2 1/8)	(54.0)	1.32
444 to 456	2.19 (2 3/16)	(55.6)	1.25
457 to 470	2.25 (2 1/4)	(57.2)	1.19
471 to 482	2.31 (2 5/16)	(58.7)	1.14
483 to 495	2.38 (2 3/8)	(60.3)	1.09
496 to 508	2.44 (2 7/16)	(61.9)	1.04
509 to 522	2.50 (2 1/2)	(63.5)	1.00
523 to 535	2.56 (2 9/16)	(65.1)	0.96
536 to 546	2.62 (2 5/8)	(66.7)	0.93
547 to 559	2.60 (2 11/16)	(68.3)	0.89
560 to 573	2.75 (2 3/4)	(69.8)	0.86
574 to 585	2.81 (2 13/16)	(71.4)	0.83
586 to 598	2.88 (2 7/8)	(73.0)	0.81
599 to 610	2.94 (2 15/16)	(74.6)	0.78
611 to 626	3.00 (3)	(76.2)	0.76

[A] The measured stability of a specimen multiplied by the ratio for the thickness of the specimen equals the corrected stability for a 2½ in. (63.5 mm) specimen.
[B] Volume-thickness relationship is based on a specimen diameter of 4 in. (101.6 mm).

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12. Report

8. Report

8.1 The report shall include the following information:

8.1.1 Type of sample tested (laboratory mixed sample, plant mixed sample, or pavement core specimen).

8.1.2 If available, the nature of asphalt mixture, including aggregate type and grading, binder grade, and binder content.

8.1.3 Individual and average specimen bulk specific gravities.

8.1.4 Height of each test specimen in inches (millimetres) to the nearest 0.01 in. (0.25 mm).

8.1.5 Individual and average values of Marshall stability (uncorrected and corrected if required) to the nearest 10 lbf (50 N).

8.1.6 Individual and average value of Marshall flow in units of 0.01 in. (0.25 mm) or in units of mm directly, where Flow (0.01 in.) = 4 x Flow (mm), as well as the method used for determining flow (peak or tangent offset).

8.1.7 Test temperature to the nearest 0.4°F (0.2°C).

Final thoughts

Recommendations for Stability correction

Volume of Specimen, cm³	Approximate Thickness of Specimen mm	in.	Correlation Ratio
200 to 213	25.4	1	5.56
214 to 225	27.0	1 1/16	5.00
226 to 237	28.6	1 1/8	4.55
238 to 250	30.2	1 3/16	4.17
483 to 495	60.3	2 3/8	1.09
496 to 508	61.9	2 7/8	1.04
509 to 522	63.5	2 1/2	1.00
523 to 535	65.1	2 9/16	0.96
536 to 546	66.7	2 5/8	0.93
547 to 559	68.3	2 11/16	0.89

Corrected stability = Measured stability * Correction ratio

Effect of Specimen Thickness on Marshall Test Results

ROBERT F. WEBB, JAMES L. BURATI, Jr., and HOKE S. HILL, Jr.

ABSTRACT

A problem inherent in many standard test methods in materials engineering is the preparation of a standard test specimen. The Marshall test, ASTM D1559-76, "Standard Test Method for Resistance to Plastic Flow of Bituminous Mixtures Using Marshall Apparatus," is subject to variability introduced by nonstandard specimens. The Marshall test allows the testing of standard sized specimens prepared under laboratory conditions and cored specimens of varying thickness. This study investigated the effects of variations in specimen size, specifically specimen height, on Marshall stability and flow. To determine the adequacy of accepted correction methods, the observed variability introduced by nonstandard specimen heights was compared with the accepted correction method. Recommendations concerning the correction of stability and flow values resulting from nonstandard specimens are presented.

https://onlinepubs.trb.org/Onlinepubs/trr/1985/1034/1034-016.pdf

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DISCUSSION

The results of this study can be divided into two areas, those that relate to the Marshall stability results and those that relate to the Marshall flow values.

Stability Correction Procedure

The results of this study indicate a high correlation between specimen height and Marshall stability readings. This finding supports the concept of linear adjustment that is presented in published testing procedures. However, the table of correlation ratios that is presented in published testing procedures is not consistent with the experimental results of this study. The application of the published correction method to each of the mixes tested would have yielded inaccurate estimates. Table 5 gives correlation ratios derived from the experimental correction line (Figure 4). These factors differ significantly from the accepted values.

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Accounting for the Effect of Air Voids on Asphalt Mix Monotonic Cracking Testing Results

Reference

H. Alkuime, E. Kassem, T. Al-Rousan, R. O. Mujalli, and K. A. Alshraiedeh, "Accounting for the Effect of Air Voids on Asphalt Mix Monotonic Cracking Testing Results," *Journal of Testing and Evaluation* 51, no. 6 (November/December 2023): 3662–3681. https://doi.org/10.1520/JTE20220694

ABSTRACT

Various monotonic cracking resistance assessment tests and indicators of asphalt mixes have their own merits; however, they provide illogical interpretations of mix resistance to cracking under different air void (AV) contents. This study aims to investigate and address the limitations of the monotonic tests and indicators in evaluating the cracking resistance of asphalt mixes with different AV contents. The results show that the shape of the load-displacement curve, curve basic elements, and monotonic indicators are significantly sensitive to variation in AV content. However, the currently proposed correction ratios could not address this dependency of cracking assessment on AV content. This study therefore proposes and evaluates a new approach and correction ratios for monotonic tests and performance indicators. The results demonstrate that the newly proposed correction ratios could normalize the effect of AV content on the examined performance assessment indicators.

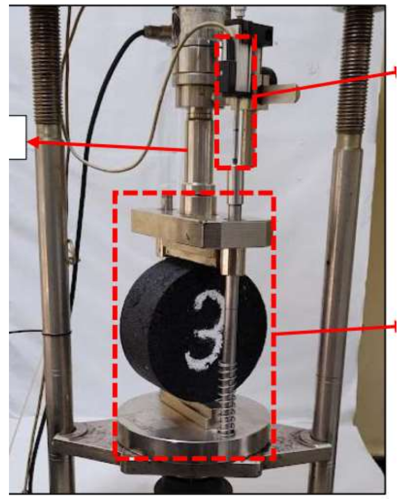

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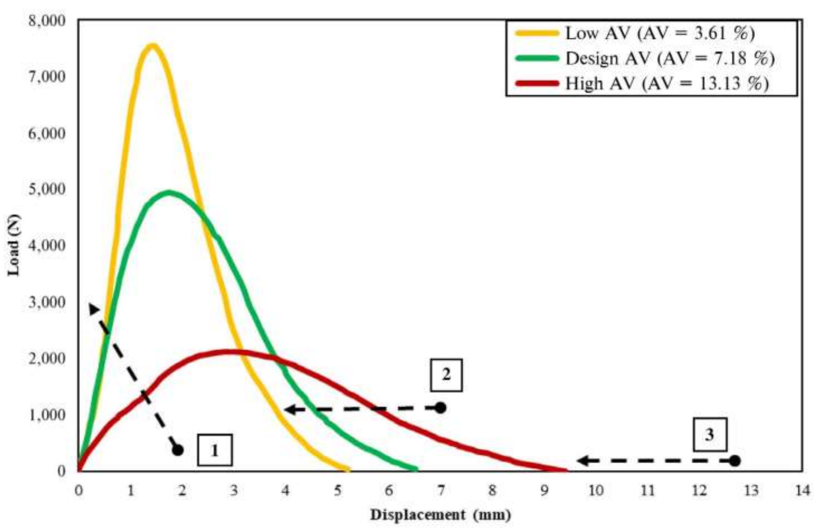
FIG. 2 Variation in the shape of the L-D curve with the decrease in AV content: (1) increasing pre-peak slope ($m_{pre\text{-}load}$), (2) increasing post-peak slope ($m_{post\text{-}load}$), and (3) decreasing failure displacement (L_o).



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mpact of Testing and Specimen Configurations on Monotonic High-Temperature Indirect Tensile (High-IDT) Rutting Assessment Test

lamza Alkuime[1]

eceived: 15 November 2022 / Revised: 1 February 2023 / Accepted: 22 March 2023

bstract

ecently, more attention has been paid to implementing the Indirect Tension Test (IDT) conducted at high-testing temperature .e., High-IDT) and IDT strength ($IDT_{strength}$) indicator to assess asphalt mix resistance to rutting. However, although it is cheaper, more accessible, simpler, quicker, and repeatable test, no standardized testing protocol is yet developed. Therebre, this study aimed to identify the best testing and specimen configurations to conduct the High-IDT to pave the way for eveloping a testing protocol, which would advance its implementation to be part of the balanced mix design.

he impact of four testing variables was examined, including testing temperature and loading rate, specimen thickness, nd air void content. Statistical analysis was used to examine the significance of their impact on High-IDT testing results. tudy findings recommend conducting the test at a fast-loading rate at any high-test temperatures. The author recommends AQ6 onducting the test at a rate of 50 mm/min at a predefined testing temperature to minimize the financial investment by the aboratory or the training needed, which would ease the acceptance of this test for routine use. Specimen configurations also ignificantly affected the testing results and may provide improper rutting assessment using High-IDT. The study evaluated sing correction ratios to normalize the measured $IDT_{strength}$ to a target value corresponding to target specimen thickness and V content. The ratios significantly eliminated the effect of specimen configuration on $IDT_{strength}$

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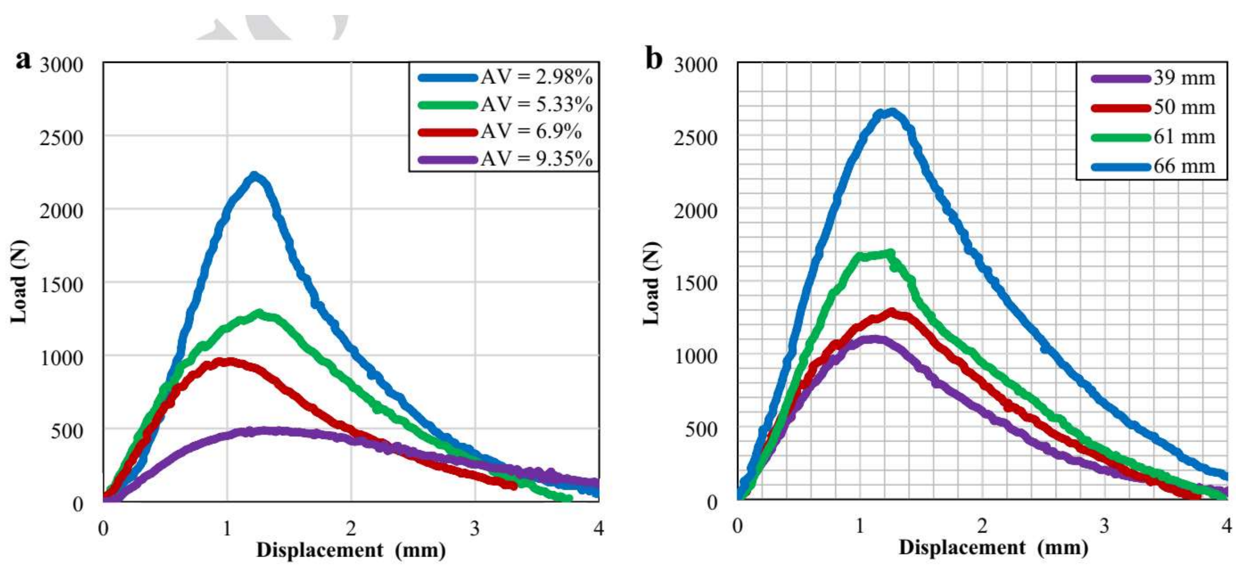

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