

## Colorado Procedure – Laboratory 5106-15

### *Standard Method of Test for*

### **Resistance to Deformation of Bituminous Mixtures by Means of Hveem Apparatus**

(This procedure is based upon AASHTO T 246-93 (ASTM D 1560-81). AASHTO T 246-10 (ASTM D 1560-09) or any subsequent revision may not be used in-place of this procedure.)

#### **1. SCOPE**

- 1.1 This method covers the determination of the resistance to deformation of compacted bituminous mixtures by measuring the lateral pressure developed from applying a vertical load by means of the Hveem Stabilometer.

#### **2. APPARATUS**

- 2.1 *Stabilometer* - Hveem stabilometer (Figure 1) is a triaxial testing device consisting essentially of a rubber sleeve within a metal cylinder containing a liquid which registers the horizontal pressure developed by a compacted test specimen as a vertical load is applied. Pressure gauges must have increments to at least the nearest 1 psi.
- 2.2 *Testing Machine* - Compression testing machine having a minimum capacity of 44.5 kN (10,000 lbf).
- 2.3 *Oven* - An oven capable of maintaining a temperature of  $60^{\circ}\text{C} \pm 3^{\circ}$  ( $140^{\circ}\text{F} \pm 5^{\circ}$ ).
- 2.4 *Calibration Cylinder* - Hollow metal cylinder having the following dimensions:  $100.00 \pm 0.13$  mm ( $3.937 \pm 0.005$  in.) for specimens compacted in a mold having an internal diameter of 100 mm (3.937 in.) [e.g. Superpave compactor] and having a height of at least 4.5 inches (114 mm).
- 2.5 *Follower* - One solid wall metal follower sized according to the diameter of the specimens being tested. A  $100.3 \pm 0.25$  mm ( $3.949 \pm 0.010$  in.) diameter follower shall be used for samples compacted in a mold having an internal diameter of 100 mm (e.g. Superpave compactor). The follower shall be  $125 \pm 25$  mm ( $5 \pm 1$  in.) high.

#### **3. TEST SPECIMENS**

- 3.1 *Size of Specimens - Superpave gyratory compactor* - Test specimens shall be 100 mm (3.937 in.) in diameter as produced by the Superpave gyratory compactor in conformance with CP-L 5115. The Stabilometer value shall be corrected as indicated in Subsection 6.2 and by Figure 2.
- 3.2 *Compaction of Specimens* - Test specimens shall be formed and compacted in accordance with CP-L 5115.

- 3.3 *Bulk Specific Gravity of Test Specimens* - Test specimens shall have their bulk specific gravity determined according to CP 44 and their height determined to the nearest 0.1 mm (0.004 in.). Use the height determined by the compaction machine if the machine's height has been calibrated that day.

#### 4. ADJUSTMENT OF STABILOMETER

- 4.1 Adjust the Stabilometer base so that the distance from the bottom of the upper tapered ring to the top of the base is 89 mm (3.5 in.).

- 4.1.1 Heat the Stabilometer base, follower, and metal calibration cylinder in a  $60^{\circ}\text{C} \pm 3^{\circ}$  ( $140^{\circ}\text{F} \pm 5^{\circ}$ ) oven for a minimum of 1 hour. Place the Stabilometer on the heated base and insert the follower into the Stabilometer chamber. Turn the handle of the Stabilometer until the pressure gauge reads 20 psi. (138 kPa). Allow the pressure of the Stabilometer oil to stabilize. Remove the follower, remove the metal calibration cylinder from the oven and insert the metal calibration cylinder into the Stabilometer chamber. Turn the pump handle clockwise until the indicator on the pressure gauge reads 100 psi. Allow the oil pressure to stabilize.

- 4.1.2 As soon as the oil pressure stabilizes, adjust the amount of air in the air cell so that when the horizontal pressure is increased from 5 psi to 100 psi by turning the pump handle at the approximate rate of two turns per second, the turns indicator will show an increase of  $2.00 \pm 0.05$  with the calibration cylinder in place.

**Note:** One method for calibrating the Stabilometer is contained in the Appendix at the end of this procedure.

- 4.1.3 Approximately once per month during the calibration process, after the Stabilometer is in calibration and before testing begins, with the calibration cylinder still inserted and the gauge pressure at 5 psi (34.5 kPa) verify that the exposed piston length is  $2.8 \pm 0.2$  inches ( $71.0 \pm 5.0$  mm). Add or remove oil as necessary.

- 4.2 With the Stabilometer and stage base in position on the platen, adjust the testing machine so that the load will be applied at the rate of 0.05 in./min. (1.3 mm/min).

#### 5. PROCEDURE

- 5.1 Bring the specimen to a temperature of  $60^{\circ}\text{C} \pm 3^{\circ}$  ( $140^{\circ}\text{F} \pm 5^{\circ}$ ) by placing it in a  $60^{\circ}\text{C} \pm 3^{\circ}$  ( $140^{\circ}\text{F} \pm 5^{\circ}$ ) oven for a minimum of 2 hours and a maximum of 24 hours. The minimum sample heating time should be increased to 3 hours in ovens which do not have forced draft air flow.

- 5.2 Brush talc (talcum powder) on curved side of the sample or talc may be applied directly to the membrane to minimize sticking to the rubber membrane, thereby reducing maintenance between each specimen tested.

- 5.3 Place the compacted specimen into the Stabilometer. Make sure that the specimen goes into the Stabilometer straight and that it is firmly seated level on the base. Place the follower on top of the specimen and turn the displacement pump until a horizontal pressure of exactly 34.5 kPa (5 psi) is recorded on the Stabilometer gauge. If the testing machine has a spherically seated type of upper head, the locking shims used during the fabrication of the test specimen must be removed prior to performing the Stabilometer test. Start the vertical movement of the press at a speed of 1.3 mm/min. (0.05 in./min.). Stop the vertical movement of the press when the vertical load reaches 22.3 kN (5,000 lbf). The Stabilometer gauge reading shall be obtained immediately upon reaching 22.3 kN (5,000 lbf). Reduce the vertical load to 4.45 kN (1,000 lbf) and then adjust the horizontal pressure to 34.5 kPa (5 psi). When adjusting the horizontal pressure, decrease the horizontal pressure to below 34.5 kPa (5 psi) and then raise the pressure up to 34.5 kPa (5 psi) to ensure that any play is removed from the "turns" indicator assembly. This will result in a further reduction of the vertical load to less than 4.45 kN (1,000 lbf); this is normal and no compensation need be made. Measure the number of turns of the pump handle required to raise the horizontal pressure from 34.5 to 689 kPa (5 to 100 psi) with the specimen in place. Turn the pump handle in a single, smooth, continuous motion at approximately two turns per second when applying this pressure. The number of turns measured is the displacement reading, D. In measuring the displacement the vertical load will increase and at times exceed 4.45 kN (1,000 lbf). As before, these changes in load are characteristic and no adjustment or compensation is required.

## 6. CALCULATIONS

- 6.1 Determine the Stabilometer value of the specimen as follows:

$$S = \frac{22.2}{[(P_h \times D)/(P_v - P_h)] + 0.222}$$

Where:

S = Stabilometer value,

P<sub>h</sub> = horizontal pressure, for corresponding P<sub>v</sub> in kPa (or psi),

D = displacement on specimen,

P<sub>v</sub> = Vertical pressure (typically 2830 kPa (410 psi) for Superpave Gyrotory compacted specimens.

- 6.2 Calculate a height correction for each sample as follows:

For specimen heights greater than 2.5"

$$C = (H - 2.5) \times (0.107 + 0.786S - 0.009886S^2)$$

For specimen heights less than 2.5"

$$C = (H - 2.5) \times (0.15 + 1.10S - 0.01384S^2)$$

Where:

C = correction factor added to the stability value calculated in Subsection 6.1.

S = Stabilometer value,

H = specimen height in inches to 0.1.

**7. REPORT**

7.1 There is no designated CDOT Form used for recording or reporting information for this CP-L.

7.2 The report shall include the following:

7.2.1 Stabilometer value.

7.2.2 Bitumen content.

DRAWING BELOW NOT TO SCALE

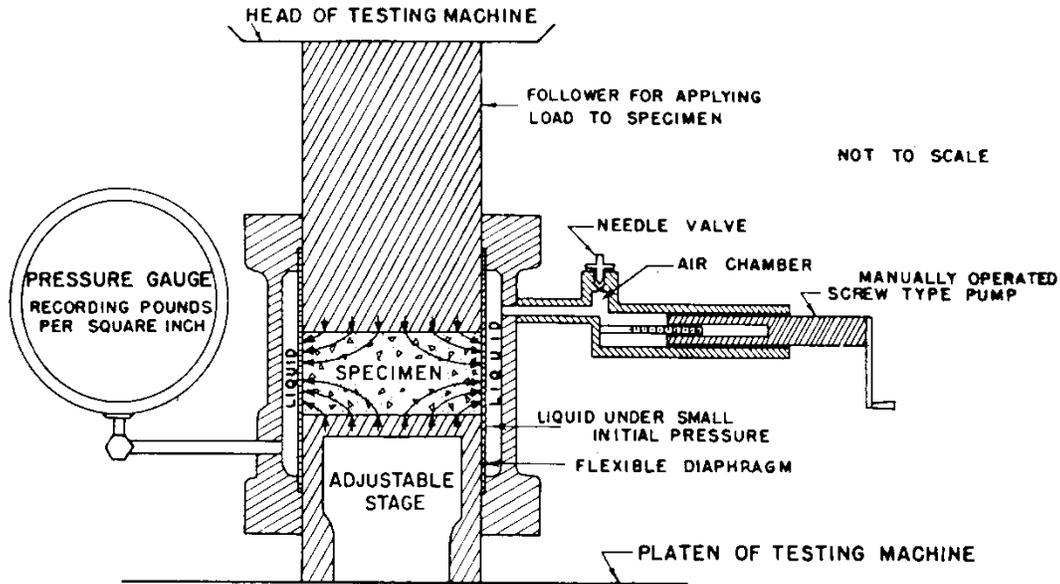


Figure 1: Diagrammatic Sketch of the Hveem Stabilometer

**Note:** The specimen is given lateral support by the flexible sidewall, which transmits horizontal pressure to the liquid. The magnitude of the pressure can be read on the gauge.

CHART FOR CORRECTING STABILOMETER VALUES TO SPECIMEN HEIGHT OF 2.50" (64mm)

Height correction should be made using the table and chart below.

Example: Overall height of 2.74" (69mm), select correction curve "B". Stabilometer value uncorrected = 35  
 Stabilometer value corrected = 38.

Overall Specimen Ht.	Correction Curve
2.80" to 3.00" (71mm to 76mm)	A
2.60" to 2.79" (66mm to 70mm)	B
2.40" to 2.59" (61mm to 65mm)	C
2.20" to 2.39" (56mm to 60mm)	D
2.00" to 2.19" (51mm to 55mm)	E

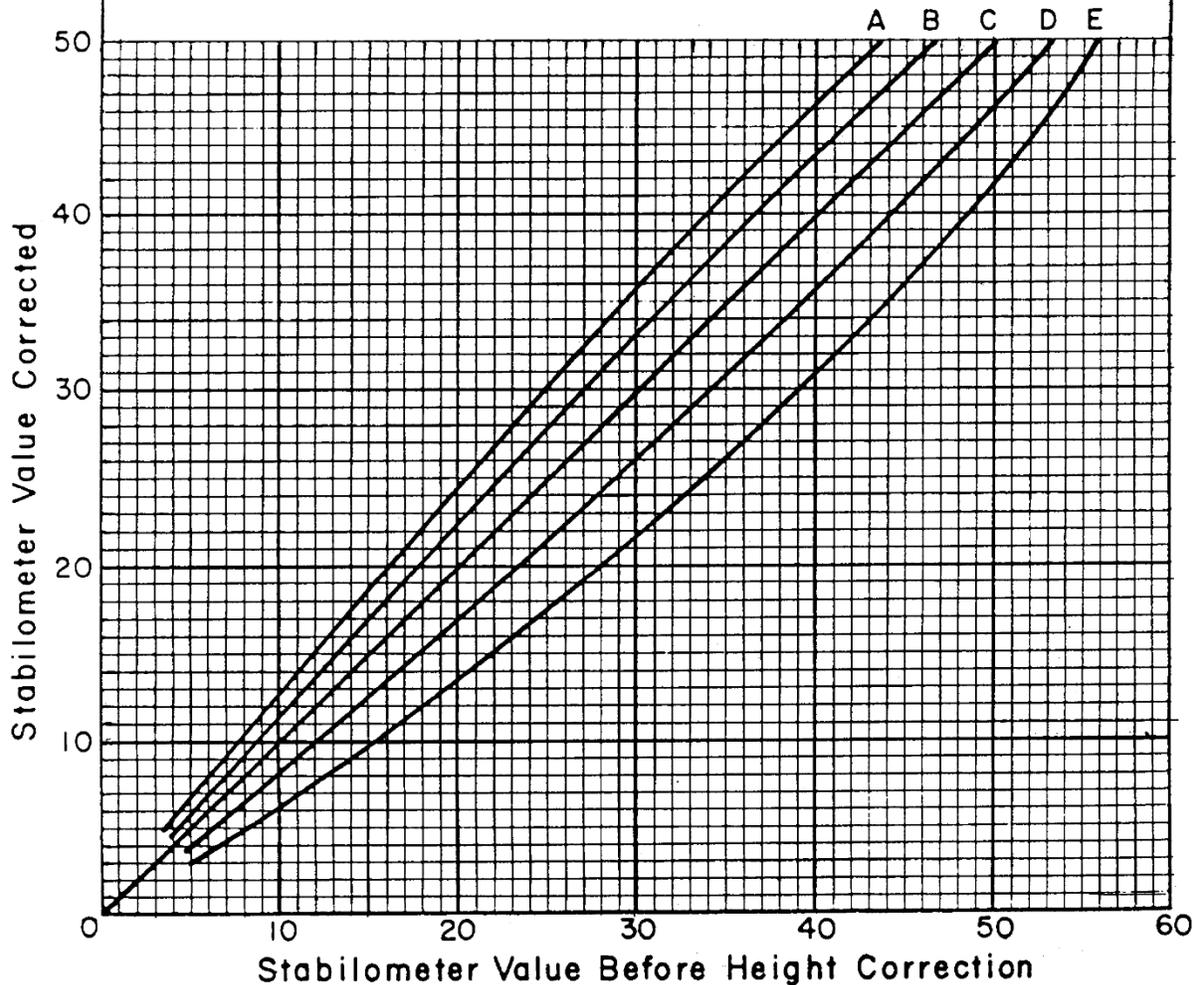


FIGURE 2: CHART FOR CORRECTING STABILOMETER VALUES TO SPECIMEN HEIGHT

**APPENDIX**Calibrating the Stabilometer.

1. Perform Subsections 4.1, 4.1.1, and 4.1.2 of CP-L 5106. As soon as the oil pressure stabilizes, turn the pump handle clockwise until the horizontal pressure slightly exceeds 100 psi, and then back off the pressure to 100 psi.
2. Immediately adjust the turns-displacement dial gauge to 4.0.
3. Immediately turn the pump handle smoothly counter-clockwise exactly two turns, making sure that the turns indicator dial gauge does not stick.
4. The horizontal pressure should be  $5 \pm 0.5$  psi.
5. If the horizontal pressure is too high, you can bleed off the excess by placing a finger over the opening in the air cell valve, opening the valve and barely lifting the finger off the valve by slowly rolling the finger off and back over the opening until the needle indicates 5 psi. Close the valve.
6. If the horizontal pressure is too low, turn the pump handle counter-clockwise an additional 0.75 to 1.75 turns. Open the air cell valve to allow air into the air cell and then close it again. **(Note: This step will work whether the horizontal pressure is too high or too low, so this step can be followed instead of step 5.)** To check the calibration, lower the horizontal pressure to 1 to 2 psi, and then raise it back to 5 psi.
7. Zero the turns indicator dial (or set it on a whole number, such as 2.00). Raise the horizontal pressure to 100 psi by turning the pump handle at a rate of two turns per second.
8. If the turns indicator dial does not show an increase of  $2.00 \pm 0.05$ , repeat steps 1 through 7.

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