Asphalt Mixtures

(Based on the Asphalt Institute SP 2)

- Asphalt is a paving material that consists of asphalt binder and mineral aggregate.
- Binder
  - glues aggregate particles into a dense mass
  - waterproofs the mixture
- Mineral Aggregate
  - acts as a stone framework to impart strength & toughness
- Performance of the mixture both by the properties of the individual components and their combined reaction in the mixture.

1

Asphalt Binder Behavior

(Based on the Asphalt Institute SP-2)

- Three binder characteristics are important in performance of mixture:
  - Temperature Susceptibility
    - asphalt is stiffer at colder temperatures
    - temperature must be specified or test results cannot be effectively interpreted
  - Viscoelasticity
    - it simultaneously displays both viscous and elastic characteristics.
    - high temperatures – viscous like motor oil
    - very low temperatures – elastic solid, rebounding to original shape
    - at intermediate temperatures found in most pavements, has both characteristics.

2

Binder - Asphalt Mixtures

(Based on the Asphalt Institute SP-2)

- The characteristics of asphalt cement (binder) under varying temperatures, rates of loading, and stages of aging determine its ability to perform as a binder in the pavement mixture (SP 2).
- Hence, it is obvious the importance of performing the volumetrics testing procedures within the specified PG Binder temperatures and time constraints to obtain accurate and comparable results.

3

Binder - Aging

- \- Aging
- \- asphalt is chemically organic & reacts with oxygen from the environment – oxidation
- Oxidation changes the structure & composition of the asphalt molecules, causing it to become more brittle
- Oxidation occurs more rapidly at higher temperatures
- \- Another term is "age hardening", and occurs during asphalt mixture production and when asphalt cement is heated to facilitate mixing and compaction (Asphalt Institute SP-2)

4

Coating Aggregate with PG graded Asphalt Binder

- Glues the aggregate mass together.
- Protects aggregate from absorbing moisture and stripping.

5

Mineral Aggregate Behavior

(Asphalt Institute SP 2)

- Natural Aggregates
- Processed Aggregates
- Synthetic Aggregate
- Reclaimed Asphalt Pavement
- Aggregate must provide enough shear strength to resist repeated load applications.
- Aggregate shear strength is critically important in HMA because it provides the mixture's primary rutting resistance.

6

Mineral Aggregate Behavior

(Asphalt Institute SP 2)

- Shear strength is primarily dependent on the resistance to movement, or internal friction, provided by the aggregates.
- Cubical, rough-textured aggregates provide more resistance than rounded, smooth-textured aggregates.
- Cubical aggregate particles tend to lock together, resulting in a stronger mass of material, creating internal friction.

7

Mineral Aggregate Behavior

(Asphalt Institute SP 2)

- Internal friction is accomplished by specifying a certain percentage of aggregates with crushed faces - Processed Aggregates.
- Processed Aggregates provide the interlocking characteristics that result in internal friction.
- Any aggregate that has been processed through a crusher and has at least two fractured faces (CDOT).

8

Mineral Aggregate Behavior
(Asphalt Institute SP 2)

- Synthetic aggregate is any material that is not mined or quarried and is often an industrial by-product, such as blast furnace slag.
- Occasionally, a synthetic aggregate will be included to enhance a particular performance characteristic of an asphalt mixture.
- An example would be, a lightweight expanded clay or shale is occasionally used as a component to improve the skid resistance properties of asphalt mixtures.

9

Mineral Aggregate Behavior
(Asphalt Institute SP 2)

- Reclaimed Asphalt Pavement – existing pavement is removed and reprocessed to produce new asphalt. RAP is an important source of aggregate.
- Economical.
- Recycling of existing material is environmentally friendly.

10

Asphalt Mixture Behavior

(Asphalt Institute SP 2)

- While the individual properties of asphalt mixture components are important, asphalt mixture behavior is best explained by considering asphalt cement (binder) and mineral aggregate acting together.
- There are three primary asphalt distress types that engineers try to avoid: permanent deformation, fatigue cracking and low temperature cracking.
- These are the distresses analyzed in Superpave.

11

Superpave Mixture Design

(Asphalt Institute SP-2)

- Superpave Gyratory Compactor (SGC)
- Compacts specimens at specified temperatures (PG Binder) and specified design gyrations (based on expected traffic loads).
- Can provide information about the compactability of a mixture by capturing data during compaction.
- Used to design mixtures that do not exhibit tender mix behavior and mixes that do not densify to dangerously low air void contents under traffic action.

12

Volumetrics?

- A factor that must be taken into account when considering asphalt mixture behavior is the volumetric proportions of asphalt binder and aggregate components, or more simply, asphalt mixture volumetrics.

- The volumetric properties of a compacted paving mixture provide some indication of the mixture's probable pavement service performance

  (Asphalt Institute SP 2)

13

Volumetric Properties of a compacted paving mixture are…

- Air Voids (Va)

- Voids in the Mineral Aggregate (VMA)
  - Which includes the effective asphalt content (Pbe) and air voids (Va) of the compacted mixture.

- Voids filled with asphalt (VFA) (effective asphalt)

- Another important factor
  - Binder Absorption

  (Asphalt Institute SP 2)

14

Definition of Air Voids (Va)

- The total volume of the small pockets of air between the coated aggregate particles throughout a compacted paving mixture, expressed as percent of the bulk volume of the compacted paving mixture.

  (Asphalt Institute SP 2)

15

Definition of Voids in the Mineral Aggregate (VMA)

- Is the volume of inter-granular void space between the aggregate particles of a compacted paving mixture that includes the air voids and the effective binder (asphalt) content, expressed as a percent of the total volume of the sample.

  (Asphalt Institute SP 2)

16

Definition of Effective Asphalt Content (Pbe)

- The effective binder (asphalt) content, Pbe, of a paving mixture is the total (asphalt) binder content minus the quantity of asphalt lost by absorption into the aggregate particles. It is the portion of the total (asphalt) binder that remains as a coating on the outside of the aggregate particles, and is the (asphalt) binder content that governs the performance of an asphalt mixture.

(Asphalt Institute SP 2)

17

Definition of Voids Filled with Asphalt (VFA)

- The percentage portion of the volume of inter-granular void space between the aggregate particles that is occupied by the effective binder (asphalt). It is expressed as the ratio of (VMA-Va) to VMA.

(Asphalt Institute SP 2)

18

Superpave Volumetrics

- The Superpave mix design procedures require the calculation of VMA values for compacted paving mixtures in terms of the aggregate's bulk specific gravity, Gsb.
- (Asphalt Institute SP 2)

19

CP **48 Determination of Voids in the Mineral Aggregate (VMA)**

- 1.1 Voids in the mineral aggregate (VMA) are the void spaces between the aggregate particles of the **compacted** mix. This void space includes the air voids and effective asphalt content.
- Calculation:

VMA = 100-(**G**mb * **P**s/ **G**sb)

(Notice that two values, the Gmb & Gsb are from physical tests that are run. The Gsb is run on the aggregate proposed to be used in the mix design. If aggregate changes significantly during production, this test would need to be run again for an accurate VMA to be calculated. VMA is a specification & therefore a pay factor.)

Gsb = Bulk SpG of aggregate

Gmb = Bulk SpG of compacted mix (CP 44)

Ps = Aggregate, percent by total weight of mix

Gsb = $G = \frac{P_1 + P_2 + \ldots P_n}{\frac{P_1}{G_1} + \frac{P_2}{G_2} + \ldots \frac{P_n}{G_n}}$

20

Superpave Volumetrics

- Air voids, VMA and VFA are volume quantities, and therefore cannot be weighed, a paving mixture must first be designed or analyzed on a volume basis.
- For design purposes, this volume approach can easily be changed over to a mass basis to provide a job-mix formula (JMF).

(Asphalt Institute SP 2)

22

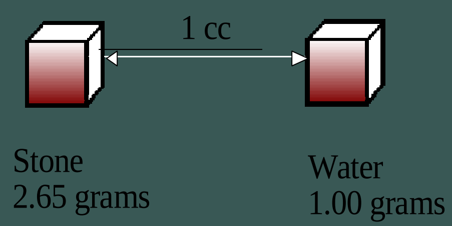
Balancing Binder and Aggregate

Volumetric Analysis

- Air Voids
- Voids in Mineral Aggregate (VMA)
- Voids Filled with Asphalt (VFA)
- Binder Absorption

23

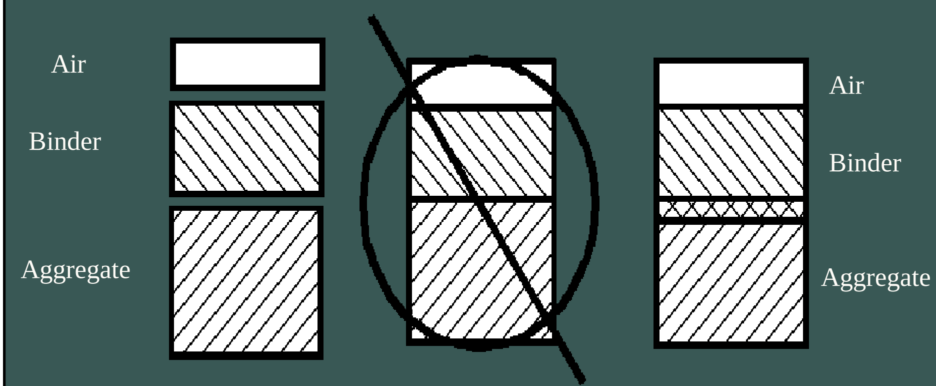
The Key = Specific Gravity



$$\text{Stone Specific Gravity} = \frac{\text{wt of stone/}\cancel{\text{vol of stone}}}{\text{wt of water/}\cancel{\text{vol of water}}} = 2.650$$

24

Adding Material Volumes



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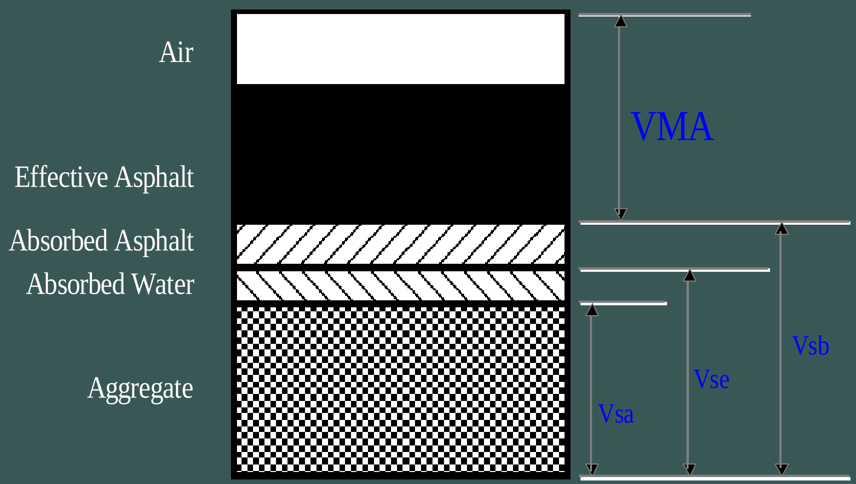
Rocks Have Three Specific Gravities



Which rock specific gravity is used for calculating VMA??

26

Rock Specific Gravities

- The specific gravities of the aggregates used in an asphalt mix have a substantial effect upon the calculated amount of air voids and the VMA in the compacted mixture.
- The actual specific gravity of the aggregates in the mixture depends upon the degree to which the aggregate absorbs asphalt.
- Air voids & VMA are volumetric measurements based on physical tests performed on the aggregates, such as specific gravity & absorption. Therefore, accurate calculations for air voids & VMA depend on knowing the aggregates are remaining reasonably consistent to the mix design values.

(Asphalt Institute Handbook MS 4)

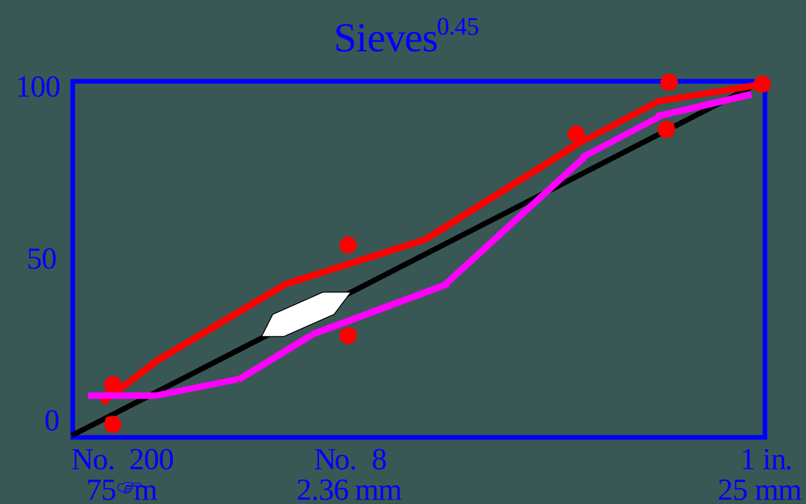
28

VMA and VFA

- Minimum VMA (desirable) can be a difficult mix design property to achieve.
- The goal is to furnish enough space for the binder to provide adequate adhesion to bind the aggregate particles, but without bleeding when the temperatures rise and the binder expands.
- Main effect of VFA criteria is to limit maximum levels of VMA, and subsequently, maximum levels of binder content.

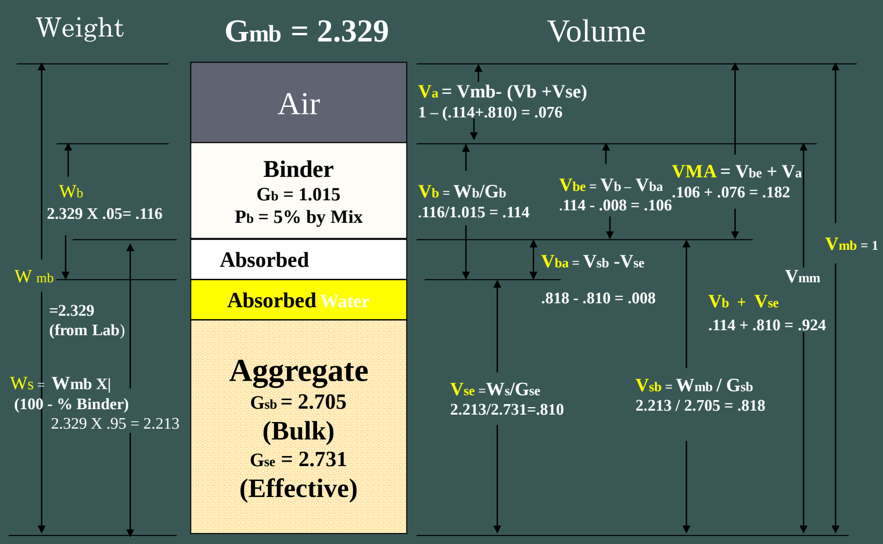
36

The Superpave System



37

Components of Weight and Volume



40

Questions ??????

41

GYRATORY COMPACTION BY THE SUPERPAVE METHOD

CP L 5115

1

OVERVIEW OF CP 5115

- This standard covers the compaction of 100 mm diameter and 150 mm diameter test specimens of an asphalt mixture, using a Superpave gyratory compactor. It also covers the monitoring of specimen density during compaction.

2

SUPERPAVE DESIGN GYRATORY COMPACTIVE EFFORT

Design ESAL's	Compaction Parameters		
	N_{init}	N_{des}	N_{max}
0.3	6	50	75
0.3 to 3	7	75	115
3 to 30	8	100	160
<30	9	125	205

3

COMPACTIVE EFFORT - COLORADO

- Unless otherwise directed, Colorado uses traffic loading (ESAL' s) to determine the level of compactive effort (gyrations) placed on the specimen at N_{des}
- Specimens used for the Lottman test (CP-L 5109) are compacted until the specimen reaches a pre-determined void content.

4

GYRATORY

A SHRP approved electromechanical Superpave compactor that restrains the molds from revolving during compaction, applies & maintains the specified pressure, tilts specimen mold at specified angle and gyrates specimen mold to compact specimen to desired number of gyrations.

Pine AFG1 & AFG2 SUPERPAVE Gyratory.
Troxler 4140 & 4141 SUPERPAVE Gyratory.

5

- As per 3.1, this standard is used to prepare specimens for determining the mechanical properties of asphalt.
- Specimens simulate the density, aggregate orientation, and structural characteristics obtained in the actual roadway when proper construction procedures are used in the placement of the paving mix, including monitoring temperatures.

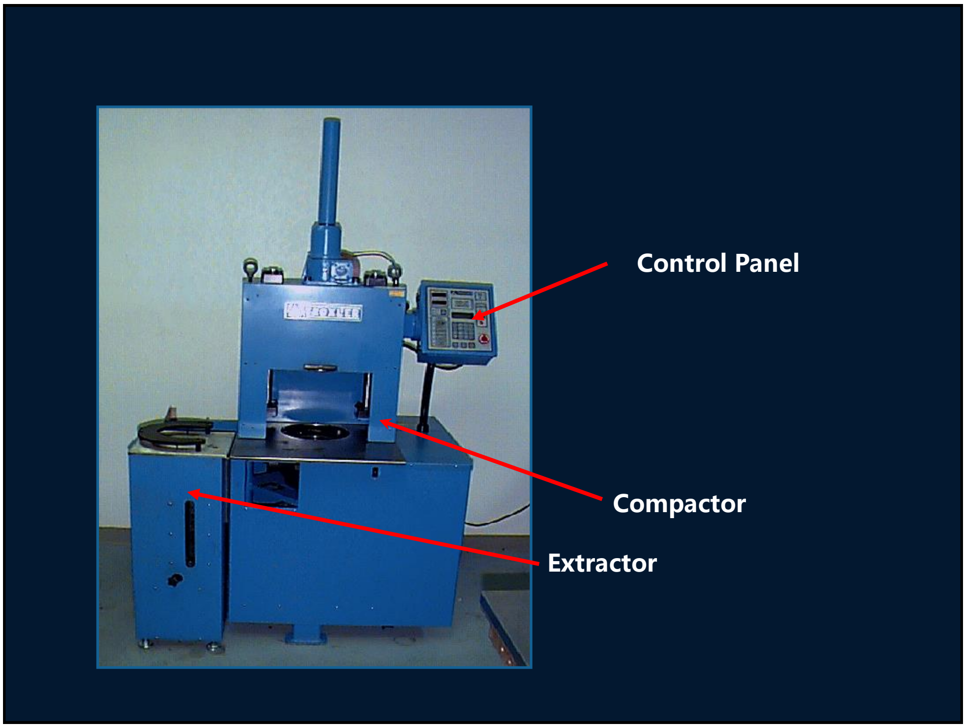
6

PINE AFG2 GYRATORY

8

Pine 100mm Mold

9

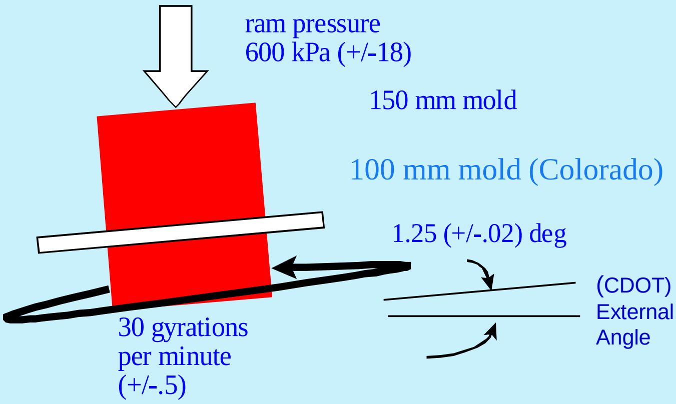

Control Panel
Compactor
Extractor

10


Troxler 150 mm Mold
Troxler 100 mm Mold

11

SPECIMEN MOLDING



12

SPECIMEN MOLDING

FMM now requires that an angle of 1.16 +/- 0.02 degrees for 150mm molds be applied and measured internally to the mold assembly.

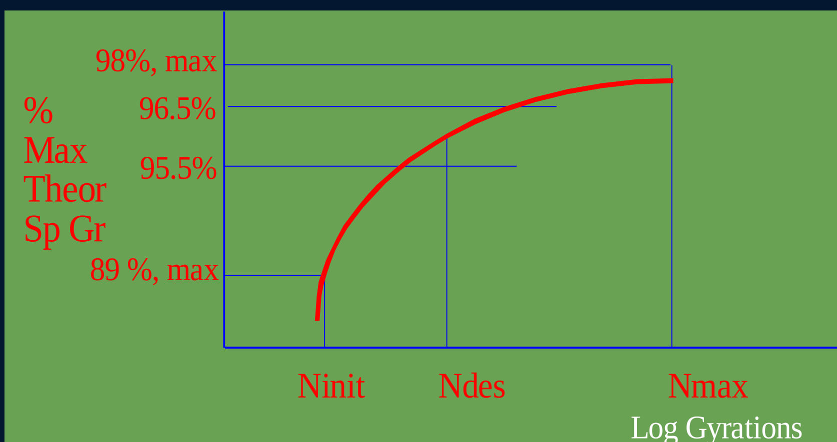
13

PREPARATION OF APPARATUS

- Verify (Per the manufacturer)
  - Angle (Normally 6 months or 480 hrs)
  - Rotation (Not specified)
  - Load (Normally 6 months or 480 hrs)
  - Height (Daily)
- Lubrication
- Height Measurement (LVDT)

14

HOW THE MIX COMPACTS



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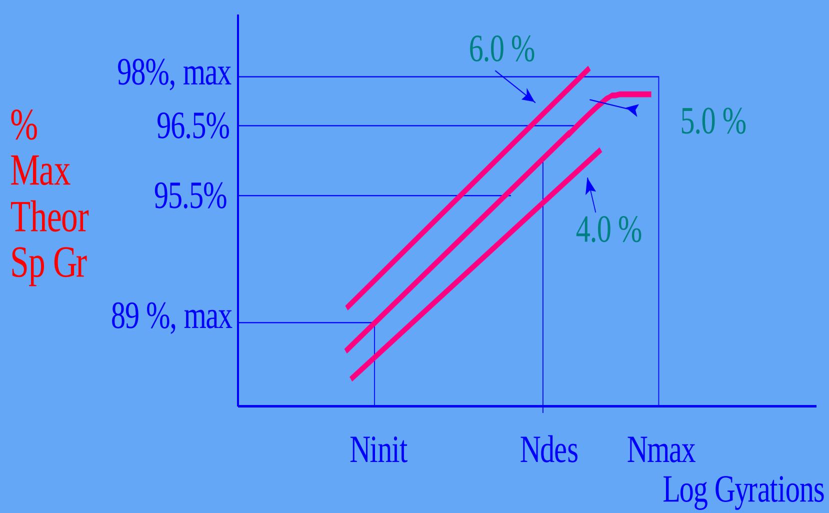
EFFECT OF BINDER ON COMPACTION



16

MIXTURE PREPARATION

- Lab produced mix
  - CDOT-Mix and condition per CP-L 5115
- Proper weight of mixture (CDOT, 100 mm Molds)

Number of Gyrations	Multiplier
50	470 X Gmm
75	474 X Gmm
100	478 X Gmm
125	482 X Gmm
SMA	470 X Gmm

17

MIXTURE PREPARATION (CONTINUED

- 150 mm molds – 1670 X Gmm.
- To make weight adjustments for Lottman see CP-L 5109.
- To make height adjustments for Lottman see CP-L 5109 & CP-L 5115.
- Specimen heights should be 63.5mm +/- 5mm for 100mm diameter specimens and 100+/- 5mm for 150mm diameter specimens.

18

MIXTURE PREPARATION

- **Heat to compaction temperature**
  - **Based on binder type & viscosity**

    -Table 2 from CP-L 5115

SuperPave Binder grade	Lab Mixing Temperature	Lab Compaction Temperature
PG 58-28	310° F (154° C)	280° F (138° C)
PG 58-34	310° F (154° C)	280° F (138° C)
PG 64-22	325° F (163° C)	300° F (149° C)
PG 64-28*	325° F (163° C)	300° F (149° C)
PG 70-28	325 F (163 C)	300 F (149 C)
PG 76-28	325° F (163° C)	300° F (149° C)

□ **>/= 15 min & </= 4 hours at Compaction Temperature**

19

MIXTURE PREPARATION

- Mold and base heated minimum 60 min and 15 min after each use.
- A minimum of three volumetric specimens per field sample shall be compacted. Mixture sample should be at compaction temperature for at least 15 minutes before compaction takes place.

20

COMPACTION PROCEDURE FOR TROXLER AND PINE

- Remove mold from oven.
- <u>(Place on non metallic surface).</u>
- Place paper disk in bottom.
- Place funnel on mold.
- Remove material from oven.
- Mix, no segregation.
- Place in mold in one lift.
- Level mix.
- Place paper disk on top.

21

COMPACTION PROCEDURE THE TROXLER COMPACTOR

- Place mold into compactor.
- Start the gyration process within a maximum of 60 seconds from the time the asphalt mixture was removed from the oven.
- After the required gyrations, remove the mold from compactor.
- Extract the "puck" from the mold, removing the top and bottom papers.
- Allow specimen to cool.

22

Compaction Procedure for the Pine Gyratory

- **Properly seat mold into compaction chamber.**
- **Lock down mold with handles.**
- **Place the top into gyratory and turn to lock into place.**
- **Press start key.**
- **After specified number of gyrations have been applied, remove the gyratory top.**
- **Push the Ram Up key to extrude the specimen with the built-in extruder.**
- **Carefully slide the specimen off the mold base onto cooling surface.**
- **Push Ram Down key to properly PARK the machine in Home position before opening the door.**
- **Remove mold and place base back into mold.**

23

Questions??????

24

Standard Method of Test for
Resistance to Deformation of Asphalt Mixtures by Means of Hveem Apparatus

CDOT CP -L 5106

AASHTO T 246

1

Purpose:

- For the determination of the resistance to deformation of compacted Asphalt mixtures by measuring the lateral pressure developed from applying a vertical load by means of the Hveem Stabilometer

2

Summary

- The Hveem stabilometer is a triaxial testing device which registers the horizontal pressure developed by a compacted test specimen as a vertical load is applied.
- Test specimens shall be 100 mm in diameter.
- Test specimens shall have a height of 63.5 ± 5 mm as per CP L 5115.
- Test specimens shall be compacted with a Superpave Gyratory Compactor .

3

Apparatus

- Hveem Stabilometer.
- Adjustable base.
- Solid wall metal follower (100.30 ± 0.25mm).
- Calibration cylinder (100.00 ± 0.13mm).
- Oven Capable of maintaining 60° ± 3° C (140+/- 5′ F).
- Compression machine minimum capacity of 10,000 lbf.

4

Procedure

- Stabilometer adjustment (calibration).
- Test procedure.

5

New information to perform the Lab Practical for the Stabilometer

- Lab Practical for this procedure will start with performing the calibration (the CDOT Stabilometer Adjustment).
- Technician will have ten minutes to perform the calibration, without verbal assistance from the proctor.
- If not completed correctly within ten minutes, first trial of this practical will be failed.

6

Stabilometer Calibration

- Heat follower, base and calibration cylinder:
  - 140 ± 5°F (60 ± 3° C)
  - 1 hour minimum
- Place stabilometer on base.
- Measure distance, 89 mm (3.5 in) base to bottom of upper tapered ring.
- Insert follower, turn pressure gauge to ~20 psi.
- Allow oil temperature to stabilize.

7

Stabilometer Calibration (continued)

- Remove the follower,
- Immediately insert the calibration cylinder.
- Set pressure gauge to ~100psi.
- Watch the gauge and allow oil temperature to stabilize.

8

Stabilometer Calibration (continued)

- As soon as the oil pressure stabilizes:
  - Set horizontal pressure to 100 (lower just below 100 & back up to 100).
  - Quickly set turns indicator to 3 or 4 (can use 0).
  - Turn the handle slowly to decrease pressure gauge from 100 in exactly 2 turns while observing the displacement gauge.
  - Observe the pressure on the psi gauge.
  - If not at 5 ± 0.5 psi, adjust air, appendix of CP-L 5106 gives suggestions on how to adjust the air.
  - Repeat procedure until you can increase the horizontal pressure from 5 psi to 100 psi by turning the pump handle at the approximate rate of two (2) turns per second.

9

Stabilometer Calibration

Once a week or so check that air bubbles are not present in the bladder. Once again, there are different methods for accomplishing this.

Approximately once per month, once the stabilometer is calibrated, with the calibration cylinder still inserted & the gauge pressure set at 5 PSI, verify that the exposed piston length is 2.8 +/- 0.2 ".

Add or remove oil as necessary

10

Performing the Test

- Test specimens shall be heated in a 140 ± 5 F (60 ± 3 C) oven.
  - 2 to 24 hours for forced draft air ovens.
  - 3 to 24 hours for non-forced draft air ovens.
- Place talcum or for safer alternatives, corn starch or other similar fine, dry powder can be used on the curved portion of the specimen or on the rubber membrane.
- Pre-heated specimen placed into stabilometer.
- Place the heated follower onto specimen.

11

Test Continued

- Turn pump clock wise until the horizontal pressure is ~ 5 psi.
- Place stabilometer onto testing machine.
- Verify the set horizontal pressure (Ph) is at exactly 5 psi, but not over 5psi. (If over 5psi, go below 5 and then back to 5psi).
- Start vertical movement of press at 0.05 in./min. (1.3 mm/min.)
- Record gauge readings (pH) at 5000.
- Immediately reduce load to 1000 lbf.

12

Test (continued)

- Adjust the horizontal pressure to 5psi by lowering pressure below 5 (but not lower than 1) and then back up to exactly 5psi.
- Set turns indicator to 2 or 3 (Zero).
- Turn handle at a rate of two (2) turns per second to increase the pressure from 5 to 100 psi.
- Record the number of turns (D) required to reach 100 psi.
- Calculate the stability.

13

Stability Calculations

$$S = \frac{22.2}{\frac{Ph * D}{Pv - Ph} + 0.222}$$

14

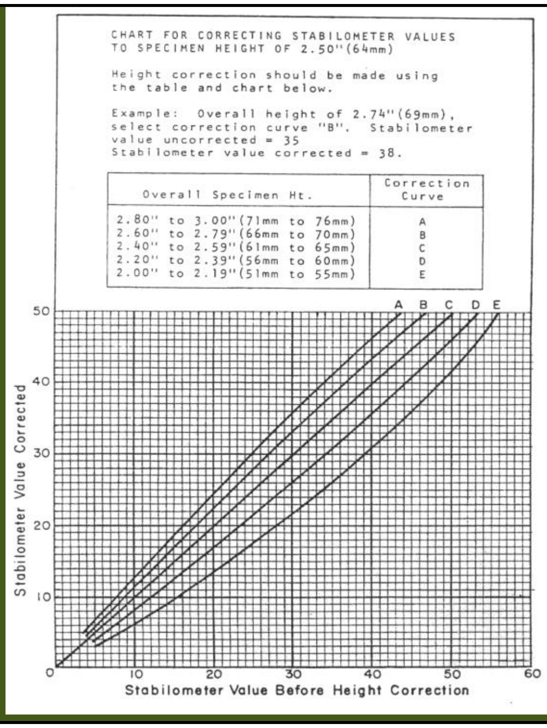


CHART FOR CORRECTING STABILOMETER VALUES TO SPECIMEN HEIGHT OF 2.50"(64mm)

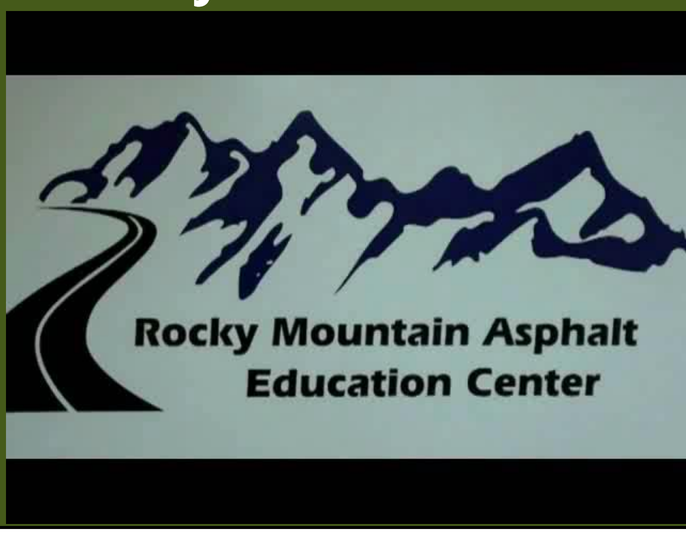
Height correction should be made using the table and chart below.

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

This chart can be found in the CP-L 5106 procedure

Video of Stabilometer/CDOT Air Adjustment Procedure



Questions???

17

Standard Method of Test for
Resistance of Compacted Asphalt Mixture to Moisture Induced Damage

CDOT CP-L 5109

1

Summary

- Evaluate the effects of saturation and accelerated water conditioning of compacted Asphalt mixtures in the laboratory
  - Mixture design
  - Plant produced material

  - This procedure measures the resistance of asphalt mixtures to the detrimental effects of water.

2

Apparatus

- Compactor
- Vacuum container
- Bulk Sp G Equipment – CP 44 (T 166)
- Freezer
- Plastic Film and Bags
- Mix Design purposes - Aluminum Pans (CDOT 40-100 sq. in.)
- Forced Draft Ovens
- Testing Machine Rate (0.2 in/min)
- Steel Loading Strips (0.5" wide)

3

Mixture Design Specimen Prep

- Mix heated aggregate and binder together
- Place in steel or aluminum pan, 40-100 sq in & approx. 1 -3" deep.
- Cool at room temp for 2 ± 0.5 h
- Cured in oven @ 140 ± 5F (60 ± 1C) for 16 - 24 hrs air must circulate under pans
- Placed in oven set at compaction temperature for the binder for 2.5 +/- 0.5 hrs. (new)
- This short term aging procedure is used for laboratory mixed samples only

4

Specimen Molding

- Heat at compaction temperature according to CP- L5115 (Prep. of samples by SGC)
    - Compact specimens to 7 ± 1.0% air voids
- Do not begin testing until specimens have cooled to room temperature (after compaction).

5

Specimen Molding

Height or Weight Adjustments

- Height
    - Using the same sample mass as the volumetric specimens adjust the height per the formula in CP-L 5109, Section 6.3.1 to acquire more air voids.
    - (Ave. Bulk SpG @ N(des) x Ave. Ht. @ N(des)
    - (0.925 x Rice)
- Weight
    - Using the formula in CP-L 5109, 6.4, adjust the weight of the material used and compact to the same height as the volumetric specimens to acquire more air voids

6

Evaluation and Grouping

- Determine Max. SG of mixture (Gmm)
- Determine specimen heights CP-L 5115 & average of three
- Determine Bulk SG CP 44 of compacted specimens & average of three (Gmb)
- Determine air voids of each specimen (Va)
- Va=100 x (1-(Gmb/Gmm))

7

Grouping

- Determine Dry Subset and Wet Subset (3 Specimens each group)
- The two subsets should be grouped so that the average air voids between the two subsets are approximately equal.
- Use developed programs or
- Dry set - use highest & lowest air voids plus one mid range air void specimen
- Wet set – mid range

8

Preconditioning - Dry Subset

- Store in incubator (77+/- 1F) or at room temp until testing then bring to 77' F.
- A 25 ± .5 C (77 ± 1F) water bath, may be used providing a method for keeping the specimens DRY is used.
- Another method is placing the specimen in a 77 degree oven until testing.
- Specimens must be at 77 +/- 1F for 3.5 +/- 0.5 hrs until testing
- Determine indirect tensile strength (PEAK or Max Load) of each specimen at 77 degrees +/- 1 degree at a constant rate of 0.2 inches per minute

9

Conditioning – Wet Subset CDOT

- Place specimen in vacuum container in such a way that water flows under specimen and is covered with at least 1" of water. (can set specimen on side with 1" water covering).
- Vacuum at 28 ± 2mm Hg for 5 ± 0.25 min (begin time when applied vacuum reaches the specified level)
  let the sample remain in the water for a short time after the vacuum is released (greater than 5 seconds)
- Remove specimen and place in bulk tank to determine the weight in water (saturated state) and then the SSD weight (saturated state) (saturate weights are used for calculations for the % swell & the level of saturation)

10

Conditioning - Wet Subset CDOT

- Submerge for 1 sec. back in bulk tank
- Wrap in plastic wrap
- Place in plastic bag and seal
- Place in freezer @ -2.5F +/- 7.5 F for minimum for 16 hrs.

11

Conditioning - Wet Subset

- Place into 140 ± ± 1.0 bath for 24 ± 1h. Remove the bag/plastic film ASAP after the sample has been place into the 140° water bath
- Place into 77 ± 1F (25.0 ± 0.5C) for 3.5 +/- 0.5 hrs.
- 15 minutes to get water back to 25 ± 0.5 C

12

Testing

- At time of testing remove each specimen from 77 degree water bath and…
- Place specimen between two ½" steel loading strips in frame, so that load is applied along the diameter of specimen.
- Apply constant loading rate of <u>0.2 in./min</u>
- Record maximum compressive strength
- Calculate tensile strength (PEAK or MAX Load)

13

Calculate Tensile Strength (St) and Tensile Strength Ratio (TSR)

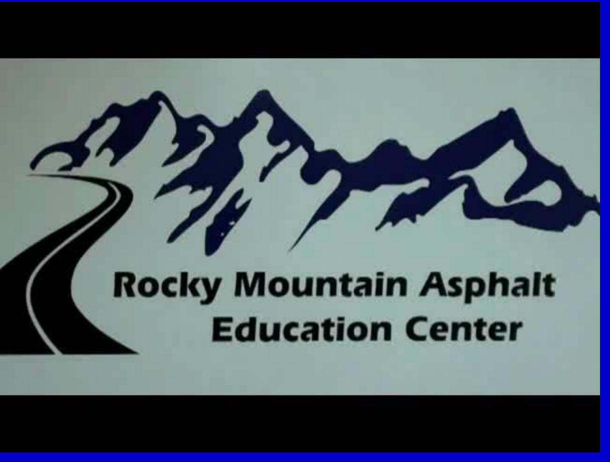
$$St = \frac{2P}{\pi tD} \text{ (psi)}$$

$$TSR = \frac{S_2 \text{(Wet)}}{S_1 \text{(Dry)}} \times 100$$

St1 = average tensile strength (dry)
St2 = average tensile strength (wet)
TSR = Tensile Strength Retained 3.1416
t = thickness 2.5 "
D = diameter 3.937 in. (100mm)
D = diameter 5.906 in. (150mm)

16

Video of Lottman Procedure



17

Questions????

THE END

THANK YOU

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You have not completed LabCAT Level C Certification until you complete check out with the Instructor!

Items needed to complete Check out:

- ☐ Completed Proficiency Tracking Form
- ☐ Completed Program Critique Form

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