B

# Verification of Equipment Used to Field Test Bituminous Mixtures

CDOT CP 76

# Verification of Laboratory Equipment Used to Test Bituminous Mixtures

CP-L 5101

1

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## Verification of Equipment Used to Field Test Bituminous Mixtures

CDOT CP 76

- ❑ This procedure provides a **CHECKLIST** for equipment verification at different intervals
  - ❑ Daily
  - ❑ Weekly
  - ❑ Monthly
  - ❑ Annually
- ❑ Some of the types of equipment on the checklist are:
  - ❑ Nuke gauges
  - ❑ Sieves and scales
  - ❑ RICE equipment

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## Verification of Laboratory Equipment Used to Test Bituminous Mixtures

**CP-L 5101**

- This procedure provides a **TABLE** for equipment verification at different intervals
    - Hourly (5 - 1,000)
    - Daily
    - Annually

- Some of the types of equipment on the table are:
    - Gyratory compactors + molds
    - Compression machines
    - Stabilometer
    - Ovens and water baths


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# QUESTIONS?

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# Reducing Field Samples of Soil and Aggregate to Testing Size

## CDOT CP 32

1

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# Splitting

- Samples are obtained using *CP 30 Sampling Aggregates*
- Reducing or "splitting" samples is a critical process in soil and aggregate testing

*"The reduction is done in a manner such that the smaller portion is most likely to be a representation of the field sample, and thus of the total supply."*

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# Methods

- ❑ Method A – Mechanical Splitter
  - ❑ This method should be used whenever possible
  - ❑ Fast, effective, precise
  - ❑ With and without a control hopper
- ❑ Method B – Quartering
  - ❑ Used only when splitter unavailable
  - ❑ Can be done on any hard, flat, clean surface
- ❑ Method C – Selection by Scoop
  - ❑ Only used for fine aggregate

| Test Size | Multi-Lab |
|---|---|
| A | A |
| B | B |
| C | |

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# Method A

## Mechanical Splitter – With Hopper Control

- ❑ Splitter has <u>minimum</u> 8 chutes for coarse aggregate, 12 for fine
- ❑ Openings must be 50% greater than largest particles

PROCEDURE

- ❑ Pour sample into closed hopper and uniformly distribute from edge to edge
- ❑ Open release handle and allow the sample to flow freely through the chutes
- ❑ <u>The first "split" must be reintroduced as a mixing aid before any reduction can begin</u>

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# Method A

## Mechanical Splitter – With Hopper Control

PROCEDURE

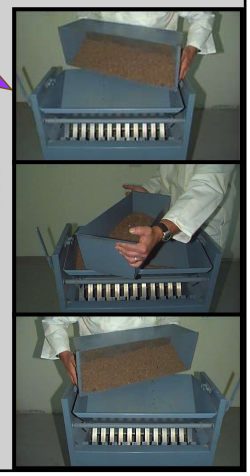
- ❑ Remove both pans from the splitter
- ❑ Pour 1/2 of the first pan into the hopper
- ❑ Reverse ends of pan and pour the remaining ½
- ❑ Repeat on the other side for the second pan

OR

- ❑ Begin reduction by alternating the catch pans to discard or split out material <u>if reintroduction and mixing has been completed</u>

Brush the fines every split

Splitting continues until the desired sample size is obtained



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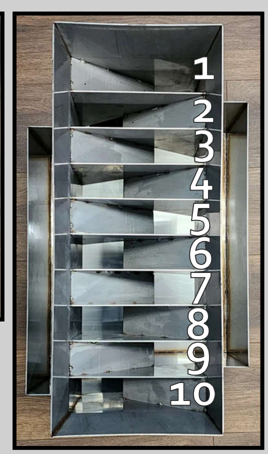
# Method A

## Mechanical Splitter – Without Hopper Control

- ❑ Place the sample in a large flat pan and mix thoroughly 3 times
- ❑ Scoop with the feeder pan and slowly pour into the splitter, ½ of the pan per side, alternating sides
- ❑ Continue until entire sample has been passed through the splitter
- ❑ Begin reduction by alternating the catch pans to discard or split out material


- ❑ Splitter has <u>minimum</u> 8 chutes for coarse aggregate, 12 for fine
- ❑ Openings must be 50% greater than largest particles

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# Method B
## Quartering

- Material is deposited on a minimum 6'x8' canvas tarp, turned over itself 3 times, and formed into a conical pile
- Material is spread out to a diameter that is 4-8x the uniform thickness

EXAMPLE

6" thick material = 24" – 48" diameter

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# Method B
## Quartering

- Divide the flattened mass into 4 equal quarters
- Remove two diagonally opposite quarters, be sure to remove the fines
- Successively mix the remaining quarters and repeat the process until the desired size is obtained

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Quartering is a great "backup" method

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# Method C

## Selection by Scoop

- Sample should be “damp”
- Place the sample in a large flat pan and mix thoroughly 3 times
- Flatten to a uniform depth
- Select a minimum of 3 increments
- Combine portions to form a test specimen

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QUESTIONS?

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# Reducing Field Samples of Hot Mix Asphalt to Testing Size

## CDOT CP 55

1

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# Splitting

- ❑ Samples are obtained using *CP 41 Sampling Hot Mix Asphalt*
- ❑ Reducing or "splitting" samples is a critical process in hot mix asphalt testing.

*"The reduction is done in a manner such that the smaller portion is most likely to be a representation of the field sample, and thus of the total supply."*

2

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# Splitting Hot

- ❑ Samples of HMA need to be heated to allow for easy separation of the particles during the splitting process
- ❑ The timeframe for this is stated as "a minimum of 1 hour but shall not exceed 4 hours at compaction temperature"

Keeping your sample buckets insulated with blankets and in coolers during transport is the key

TABLE 1

| Superpave Binder Grade | Lab Compaction Temp. |
| --- | --- |
| PG 58-28 | 280° F (138° C) |
| PG 58-34 | 280° F (138° C) |
| PG 64-22 | 300° F (149° C) |
| PG 64-28 | 300° F (149° C) |
| PG 70-28 | 300° F (149° C) |
| PG 76-28 | 300° F (149° C) |

Note: The minimum 1-hour timeframe may include the transport of samples in a container that retains heat to the PC/OA Laboratory prior to reheating.

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# Sample Preparation

- ❑ Methods A, B, C, and D require the use of a splitting (mixing) pan.
- ❑ There are 2 methods for depositing your sample can into the splitting pan to prepare for splitting – both of which utilize a *"small, flat, square-end scoop with sides"*
  - ❑ Method 1
    - ❑ Deposit the mix into the pan
    - ❑ Mix thoroughly (turn 3 times)
    - ❑ Flatten to uniform depth (scoop height)
  - ❑ Method 2
    - ❑ Flip the can into the pan upside down rapidly
    - ❑ Lift 1" and move in a circular motion
    - ❑ Lift another 1" and repeat until empty
    - ★ ❑ Revert to Method 1 if segregation is present

This method applies to HMA samples with 1.5" maximum NMPS

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# Methods

- ❑Method A - Selection by Scoop
- ❑Method B – Quartering
- ❑Method C – Mechanical Splitter
- ❑Method D – Selection by Cross-Section
- ❑Method E – Quartermaster

Method B is the only spitting method that can be used both to reduce to "test size" and to split samples between laboratories

| Test Size | Multi -Lab |
|---|---|
| A | |
| B | B |
| C | |
| D | |
| | E |

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# Method A

## Selection by Scoop

- ❑Select at least 3 random increments
- ❑Scoop full depth
- ❑Use a putty knife to "trim" samples
- ❑Combine all portions

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# Method B
## Quartering

- Divide into 4 equal quarters using the scoop
- Remove opposite diagonal quarters
- Remix remaining quarters and repeat, as needed to obtain desired sample size

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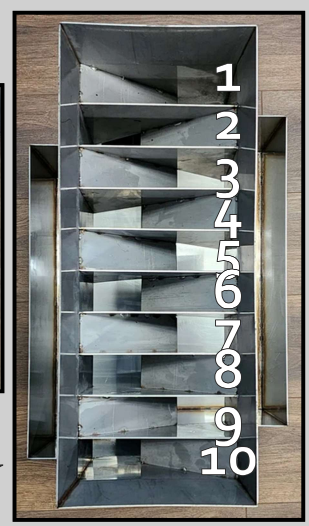
# Method C
## Mechanical Splitter

- Splitter has <u>minimum</u> 8 chutes for coarse aggregate, 12 for fine
- Openings must be 50% greater than largest particles
- Scoop with the feeder pan and slowly pour into the splitter, ½ of the pan per side, alternating sides

OR

- Preload additional splitter pans with the small scoop and use them to feed into the splitter, ½ of each pan per side


Most asphalt mixtures are going to contain coarse aggregate

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# Method D

## Selection by Cross-Section

- ❑ Slats must be at least 1” taller than the pan walls, and must be within 1” of the pan length
- ❑ Insert the two slats and remove ALL material between them
- ❑ Obtain additional portions or samples by then moving one slat and capturing that material

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# Method E

## Quartermaster

- ❑ The Quartermaster is to be level and heated to 230°F (110°C)
- ❑ With the hopper closed, quickly dump multiple cans in the top and level before releasing into the buckets below
- ❑ Rotate clockwise for multiple bucket splits

A spatula or paint scraper will be used to scrape the fines from the quarter master into the buckets below after every split.

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# QUESTIONS?

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# Determining Moisture (Water) or Volatile Distillates Content of HMA

*CDOT CP 43*

1

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## Scope

- This procedure covers 2 methods for determining the percent moisture in HMA samples
- It should be assumed that all samples that comes from the field can and will have a measurable moisture content

Stockpiles receive and hold rainfall intermittently and their moisture contents can vary daily

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# Method A

## Microwave Oven

- ❑ Variable time and power controls
- ❑ Microwave-safe dish large enough to hold entire sample

Every microwave is different, and each must be calibrated

### Microwave Calibration for CP 43

- ❑ 550ml or 550g of tap water in the dish
- ❑ Record starting temperature (T1)
- ❑ Microwave for 5 minutes at 50% power
- ❑ Record the ending temperature (T2)

- ❑ The difference between T1 and T2 should be a 75°F ±10° (42°C ±6°) increase
- ❑ If not, adjust the variable power settings up or down 10% and run trials until the calibration temperature is reached in a 5-minute cycle

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# Method A

## Microwave Oven

### PROCEDURE

- ❑ Place a specimen in a clean, glass, dry, tared container and obtain the sample mass to the nearest 0.1g
  - ❑ 550 ± 50 g for grading S and SX mixes
  - ❑ 2000g minimum for grading SG mixes
- ❑ Run a 5-minute cycle at the calibrated power, record the mass, and continue to run 5-minute cycles until there is no change

Blue Smoke = Overheating

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# Method B

## Convection Oven

Table 43-1

| Superpave Binder Grade | Lab Mixing Temp. | Lab Compaction Temp. |
|---|---|---|
| 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) |

All temperatures in this table have tolerance of ± 5°F (± 2.8°C)

PROCEDURE

- ❑ Place a specimen in a clean, dry, tared container and obtain the sample mass to the nearest 0.1g
  - ❑ 500g minimum for grading S and SX mixes
  - ❑ 2000g minimum for grading SG mixes
- ❑ Dry at binder compaction temperature for a minimum 3 hours and weigh to nearest 0.1g
- ❑ Check the mass every 30±5 minutes
- ❑ Constant miss for this method is ≤ 0.1g change in mass between 2 measurements

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# Calculation

## Either Method

$$\% \text{ Moisture} = \frac{A-B}{A} \times 100$$

A = Wet Wt.

B = Dry Wt.

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# QUESTIONS?

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# Bulk Specific Gravity and Percent Compaction of Compacted Bituminous Mixtures Using SSD Specimens

***CDOT CP 44***

***Method A***

1

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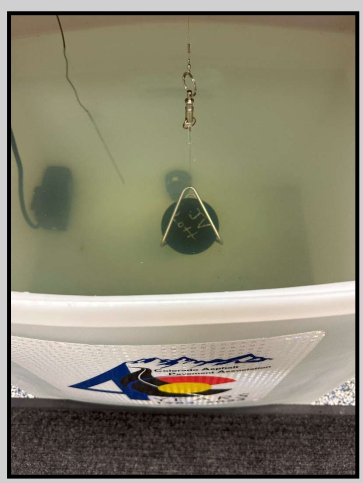
## BsG of Lab Compacted Specimens

- This procedure provides the method for determining **Bulk Specific Gravity** of a laboratory compacted HMA specimen to calculate the percent air voids and relative compaction



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# Method A

- This method applies only to <u>laboratory compacted</u> specimens
- These specimens are dry, and therefore the <u>dry mass</u> is the first weight recorded in Method A
- Obtaining the immersed and SSD masses is the same for all methods
- Zero the scale, and record the <u>dry mass</u>

Lab compacted specimens must be "cooled to room temperature" prior to obtaining the dry mass.

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# Immersed and SSD

- Check water level. (Overflowing)
- Check water temperature 77.0° ± 1.8°F (25 ± 1.0°C)
- Zero the scale, and place specimen on the cradle in the water bath for the <u>immersed mass</u> (4 ± 1 min.) record the mass
- Remove specimen from water, blot with freshly wrung out, damp towel, zero the scale again, and record <u>SSD mass</u>

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## Bulk Specific Gravity

$$Gmb = \frac{A}{(B-C)}$$

A = mass (in grams) of dry sample in air
B = mass (in grams) of SSD sample, in air
C = mass (in grams) of sample in water

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## Percent Relative Compaction

$$\%\ \text{Comp.} = \frac{\text{Bulk Specific Gravity}}{\text{Maximum Specific Gravity (Rice)}} \text{ X100}$$

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# Air Voids

## Air Voids = 100 - % Compaction

- Air voids will always be opposite of percent compaction
- EXAMPLE: *"A lab compacted sample with air voids calculated at 4.0% would be 96.0% relative compaction".*

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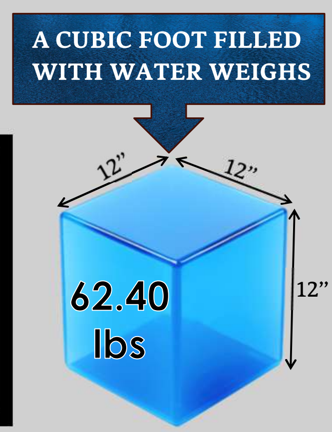
# Specific Gravity Conversion

- Specific Gravity is a ratio expression.
- EXAMPLE: "This core sample weighs 2.397 times the weight of water occupying the same volume"
- Multiplying Specific Gravity by 62.40 provides a value expressed in PCF (pounds per cubic foot)

**Specific Gravity x 62.40**

**Weight of Water**

| | Method of Measuring Weight | | |
|---|---|---|---|
| Dimensions | Pounds | Grams | Kilograms |
| Cubic Centimeter | 0.002205 | 1 | 0.001 |
| Cubic Inch | 0.036127 | 16.387064 | 0.0163871 |
| Liter | 2.204684 | 1000.028 | 1.000028 |
| Gallon | 8.345404 | 3785.4118 | 3.7854118 |
| Cubic Foot | 62.40 | 28316.847 | 28.316847 |

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# QUESTIONS?

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# Determining the Theoretical Maximum Specific Gravity of HMA

*CDOT CP 51*

“RICE”

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## Maximum Specific Gravity of HMA

- This procedure provides the method for determining Theoretical Maximum Specific Gravity of an uncompacted HMA mixture
- Commonly referred to as the “RICE” test, the determined value is used in the calculation for % compaction of HMA cores and % Air Voids (Av) of laboratory compacted samples

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❑Thermometer

# Apparatus

❑Container

❑Scale

❑Vacuum Pump



❑Manometer

❑Water Bath

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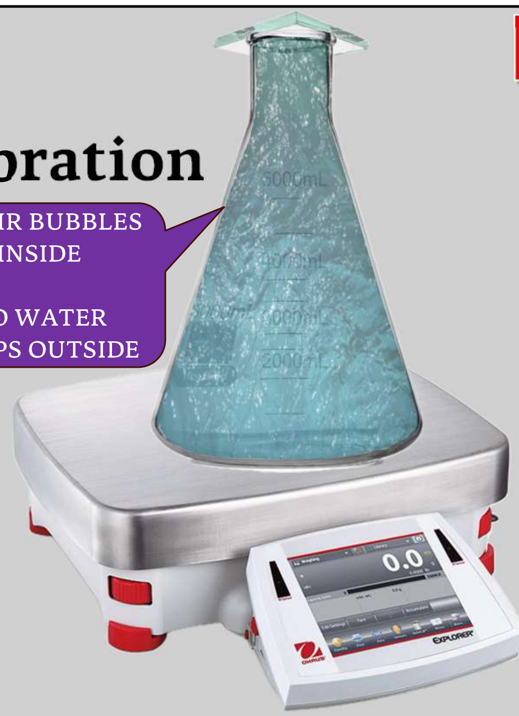
# Flask Calibration

- ❑Performed approximately <u>monthly</u>
- ❑Fill the flask with water at <u>77.0°F ± 1.0°</u> (25.0°c ± 0.5°) and place cover plate on top
- ❑Calibration weight (**D**) = <u>the average of the last 3 weights</u>

NO AIR BUBBLES INSIDE

NO WATER DROPS OUTSIDE





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# Test Samples

TABLE 51-1:
Sample Mass for Various Nominal Maximum Sizes of Aggregate.

| Nominal Maximum Size of Aggregate | | Number and Minimum Mass of Specimens |
|---|---|---|
| In. | mm | specimens x grams |
| 1 ½ | 37.5 | 2 × 3000 g |
| 1 | 25.0 | 2 × 1500 g |
| 3/4 | 19.0 | 2 × 1000 g |
| 1/2 | 12.5 | 2 × 750 g |
| 3/8 | 9.5 | 2 × 500 g |
| No. 4 | 4.75 | 2 × 500 g |


- ❑ Two split samples obtained and <u>not recombined</u> at any time after they have been taken

"<u>Short-Term Aging</u>"
Required on laboratory AND/OR field samples if they have not been held at a temperature of at least 200°F for a minimum of one hour.

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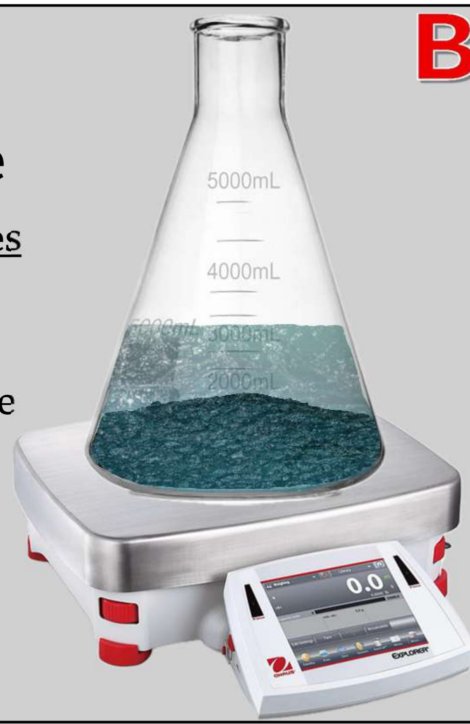
# Procedure

- ❑ Break particle *clusters* into <u>1/4" pieces</u>
- ❑ Tare the empty calibrated flask
- ❑ Place cooled (room temperature) sample into tared flask and record the <u>dry weight</u> (**A**)
- ❑ Cover at least 1" with 77°F (25°C) water.
- ❑ Repeat for second split sample with second calibrated flask

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## Procedure

- ❑ Place flasks in the shaker tables
- ❑ Remove entrapped air with <u>28±2 mm</u> mercury (Hg) for <u>15±2</u> minutes
- ❑ Release the vacuum slowly after 15 minutes

If mechanical agitators are not used, agitate manually for 15±5 seconds every 2 minutes


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## Procedure

- ❑ Fill the flasks completely with water at <u>77ºF ±1º</u> (25ºC ±0.5º )
- ❑ Place flasks in 77ºF ±1º (25ºC ±0.5º ) water bath until the temperature stabilizes, or up to <u>10 minutes</u> – whichever comes first
- ❑ Place calibrated cover plates on each flask


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## Procedure

- ❑ Tare the scale and record the weight of the flask, sample, water, and lid (**E**)
- ❑ Calculate Theoretical Maximum Specific Gravity (Gmm) or (RICE) for each

**[Equation 1]**

$$\text{Specific Gravity} = \frac{A}{(A + D - E)}$$

Where:

A = Mass of the dry specimen in air, g,
D = Mass of the flask filled with water at 77°F (25°C), g,
E = Mass of the flask filled with water and specimen at 77°F (25°C), g.

NO AIR BUBBLES INSIDE

NO WATER DROPS OUTSIDE

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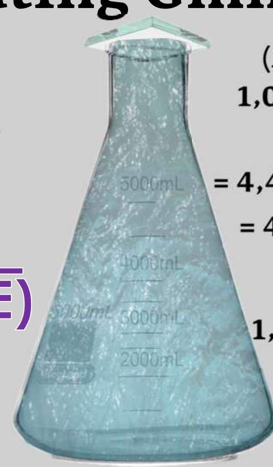
## Calculating Gmm (RICE)

(TARE)

(A) = Dry Weight

(A) = 1090.5g
(D) = 3400.8g
(E) = 4060.5g

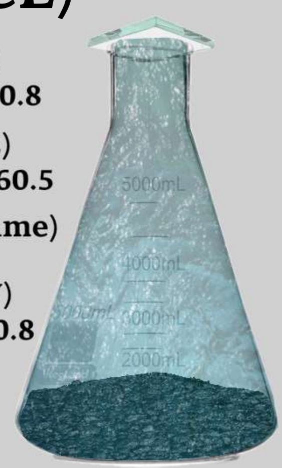
$$\frac{A}{(A+D-E)}$$



(D) = Calibration Weight

(A) (D)
1,090.5 +3,400.8
(E)
= 4,491.3 – 4,060.5
= 430.8 (Volume)

(A) (V)
1,090.5 / 430.8
=
**2.531**
(Gmm)



(E) = Flask, Sample, Water + Lid Weight

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# Reporting Gmm (RICE)

- The two values must be within 0.011 of each other to be valid
- Report the average of the two identical split samples to the nearest thousandth
- Multiply by 62.40 to convert maximum specific gravity (Gmm) into pounds per cubic foot (pcf)


**2.536 x 62.40 = 158.2pcf**

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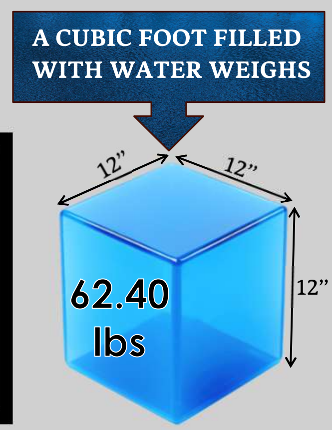
# Specific Gravity Conversion

- Specific Gravity is a ratio expression.
- EXAMPLE: "This core sample weighs 2.397 times the weight of water occupying the same volume"
- Multiplying Specific Gravity by 62.40 provides a value expressed in PCF (pounds per cubic foot)

**Specific Gravity x 62.40**

Weight of Water

| | Method of Measuring Weight | | |
|---|---|---|---|
| Dimensions | Pounds | Grams | Kilograms |
| Cubic Centimeter | 0.002205 | 1 | 0.001 |
| Cubic Inch | 0.036127 | 16.387064 | 0.0163871 |
| Liter | 2.204684 | 1000.028 | 1.000028 |
| Gallon | 8.345404 | 3785.4118 | 3.7854118 |
| Cubic Foot | 62.40 | 28316.847 | 28.316847 |

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# Other Things To Know

- Phenolphthalein can be added to the sample in water before the application of the vacuum to check for the presence of lime (**fuchsia** reaction)
- A temperature correction formula is provided in section 7.2 to be used if a 77°F ±1° (25°C ±0.5°) water bath is not used
- Section 8 details a "dry back" method for samples with uncoated aggregate

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# Determination of the Asphalt Binder Content of Bituminous Mixtures by the Ignition Method

*CDOT CP –L 5120*

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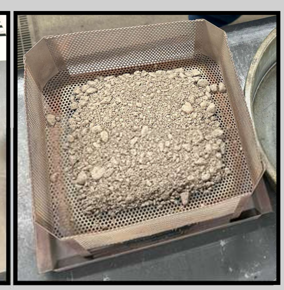
## Scope & Summary

- This procedure provides for the determination of the percent asphalt binder of a sample by burning away (removing) the binder and comparing the masses of the sample before and after the ignition process
- The residual aggregate gradation is then analyzed using CP 31 *Sieve Analysis of Aggregates*
- Correction factors must be developed for both the ignition process and the residual aggregate gradation



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# Apparatus

## Ignition Furnace (Oven)

- ❑ Can maintain required temperature
- ❑ Internal scale within 0.1g with weight displayed during test
- ❑ Internal computer and data collection system
- ❑ Audible alarm when mass loss does not exceed 0.01g for 3 consecutive minutes

Sample Baskets

- ❑ Steel mesh or similar with catch pan
- ❑ Must allow for sample to be thinly spread and airflow all around

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# Safety

- ❑ Extreme Heat
- ❑ Face shield
- ❑ Long sleeves and gloves
- ❑ Always use the basket retrieval forks
- ❑ Designated basket cooling area


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# Correction Factors

- ❑ Correction factors will be determined for both asphalt binder content and aggregate degradation
- ❑ Must be completed prior to performing any acceptance testing
- ❑ Each mix design will require its own correction factors
- ❑ New correction factors will be required if the ingredients in the mix are changed

**ASHPHALT BINDER CORRECTION FACTOR** + **AGGREGATE DEGRADATION CORRECTION FACTOR**

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# Correction Factors

- ❑ Prepare 2 laboratory mixed samples at optimum binder content according to the mix design or JMF

**ASHPHALT BINDER CORRECTION FACTOR**

**TABLE 2**

| Superpave Binder Grade | Lab Mixing Temp. | Lab Compaction Temp. |
|---|---|---|
| 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) |

All temperatures in this table have tolerance of ± 2.8°C (± 5°F)

**Heat all bowls, tools, aggregate, and binder to the LAB MIXING TEMP. provided in CP-L 5115.**

- ❑ Prepare 1 additional "blank sample" (no binder added) – perform CP 31 *Sieve Analysis of Aggregates* on this sample to establish the "gradation control" values

**AGGREGATE DEGRADATION CORRECTION FACTOR**

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# Correction Factors

- Burn both of the optimum binder content samples and record their displayed binder percentages
- Average the two percentages and report to the nearest 0.01%
- Calculate the difference between the actual and measured asphalt content
- The correction factor is the difference between the actual and measured asphalt content.

The 2 measured values must be within 0.15 of each other

ASHPHALT BINDER CORRECTION FACTOR

#1 #2

5.50 ACTUAL binder content (mixed) 5.50

BURN

5.59 MEASURED binder content (burned) 5.66

AVG.

5.50 − 5.63 = -0.13

7

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# Correction Factors

- If RAP is part of the JMF or mix design, 2 RAP samples will be split out and burned
- The average binder content of the 2 samples will be used for the calculation of a correction factor with RAP
- The average results of the 2 RAP residual aggregate gradations will also be factored in

The 2 measured values must be within 0.15 of each other

See section 9 for all calculations

ASHPHALT BINDER CORRECTION FACTOR

#1 #2

RAP RAP

BURN

4.89 MEASURED binder content (burned) 4.85

AVG.

4.87 = % Binder RAP

8

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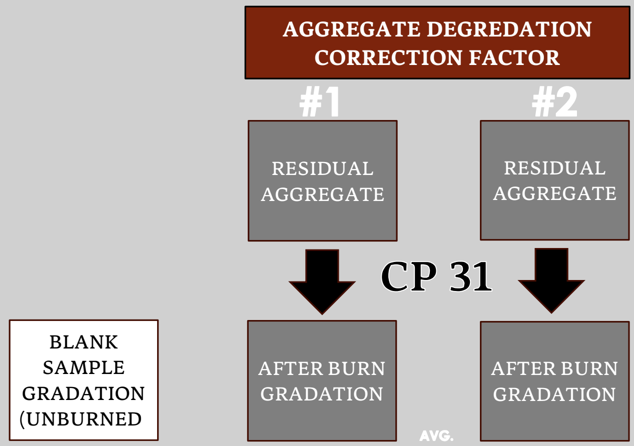
B

# Correction Factors

- Empty the residual aggregate into a wash pan and record the weight
- Perform a wash and gradation per CP 31 Sieve Analysis of Aggregates
- Compare the BLANK SAMPLE gradation to the RESIDUAL AGGREGATE gradation

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# Correction Factors

- If the results between the blank sample and the average of the residual aggregate samples exceeds the tolerances in Table 2, correction factors will be applied to those individual sieves
- The correction factors shall be calculated to the nearest 0.1% on all sieves except for the <u>#200 sieve, which is 0.01%</u>

Section 12.3 for full details

**AGGREGATE DEGRADATION CORRECTION FACTOR**

**Table 2 -** Permitted Sieving Difference

| Sieve | Allowable Difference |
|---|---|
| Sizes larger than or equal to 2.36 mm (No.8) | +/- 5.0 percent |
| Sizes larger than 0.075 mm (No. 200) and smaller than 2.36 mm (No. 8) | +/- 3.0 percent |
| Sizes 0.075 mm (No. 200) and smaller | +/- 0.5 percent |

10

B

# Procedure

- ❑ Preheat ignition furnace to 1,000°F (538 °C) or per manufacturer's directions
- ❑ Record sample basket weight
- ❑ Load the sample in the basket
- ❑ Record loaded sample basket weight, calculate sample weight
- ❑ Input sample weight into computer on ignition furnace

CP 43 Moisture of HMA required!

| | |
|---|---|
| Basket | **3010.6g** |
| Basket + Sample | **5043.5g** |
| Sample | **2032.9g** |

**Table 1: Size of Specimen**

| Nominal Maximum Aggregate Size (mm) | Sieve Size | Specimen Weight Range (g) |
|---|---|---|
| 4.75 | No. 4 | 1200 - 1300 |
| 9.5 | 3/8 in. | 1200 - 1300 |
| 12.5 | ½ in. | 1800 - 1900 |
| 19.0 | ¾ in. | 2200 - 2300 |
| 25.0 | 1 in. | 3000 – 3100* |
| 37.5 | 1 ½ in. | 4000 – 4100* |

* Specimens shall either be divided in half or thirds, each individual part Will be tested, and then the results averaged.

11

B

# Procedure

- ❑ Open the furnace door, place the loaded sample basket inside the chamber and close the door
- ❑ Verify that the loaded sample basket total weight on the furnace internal scale display is <u>±5 grams</u> of the lab scale you took your initial weights on
- ❑ Press the START button, the chamber will lock and the test will begin

**If the scale weights are not within ±5 grams, check to make sure your basket isn't touching the chamber walls**

12

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# Procedure

- The sample will continue to burn until there is no loss greater than 0.01% over 3 consecutive minutes
- The audible alarm will beep, press STOP, and the chamber will unlock
- Remove the sample basket with the forks and set in the designated cooling area
- Weigh basket and burned sample at 40 ±5 minutes


13

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# Procedure

- Calculate the residual aggregate weight and the uncorrected % binder content
- Apply the binder correction factor
- Subtract any moisture from CP 43 *Determining Moisture Content of HMA*
- Report corrected % binder content to 0.01%

$$P_{b(uncorr)} = \frac{W_{m(initial)} - W_{m(final)}}{W_{m(initial)}} \times 100$$

Where:

$P_{b(uncorr)}$ = Percent uncorrected asphalt binder determined by the mass loss measured on an external scale,

$W_{m(initial)}$ = External scale weight of the hot mix specimen before ignition

$W_{m(final)}$ = External scale weight of the hot mix specimen after ignition.

14

B

# Gradation

- Empty the residual aggregate into a pan – remove all fines using a wire brush
- Record the weight of the residual aggregate
- Perform a gradation using CP 31 *Sieve Analysis of Aggregates*

If the presence of lime in the sample needs to be determined, wet the sample and add 2-4 drops of phenolphthalein – a positive result will have a fuchsia-colored reaction

15

B


16

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B

# Asphalt Cement Content of Asphalt Mixtures by the Nuclear Method

***CDOT CP 85***

1

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B

## Scope & Summary

- This procedure provides for the rapid determination of the asphalt cement content (percent binder) of asphalt mixtures using a nuclear asphalt content gauge
- With a percent binder determined within a matter of minutes, adjustments can be made at the asphalt plant (if needed) to better stay on target with the JMF or mix design
- A mix correlation must be developed for each mix tested, created from pans filled with known binder percentages


2

B

# Apparatus

- ❑ Nuclear Asphalt Content Gauge
- ❑ Minimum 3 sample pans
- ❑ Scale, warm up oven (up to 350°F)
- ❑ Straight edge, compaction plate
- ❑ Thermometer (50°-500°F)
- ❑ Mixing bowls and tools


3

B

# Successful Operation

- ❑ Other radioactive sources must be at least 33 feet away
- ❑ Keep 3 feet around the gauge clear of hydrogenous materials, liquids, and personnel
- ❑ New background measurements and possibly correlations will be required each time the gauge is moved

Ideally, the gauge will be used in the same location every time.

This metal lock-box provides a secure and consistent location for use


4

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# Standardization

- ❑ Long-term aging of the radioactive source takes place in all nuclear gauges
- ❑ Changes in the surroundings of the gauge can alter the relationship between the count rate and the asphalt content (percent binder)
- ❑ To offset these effects, standard counts must be taken at least once daily

- ❑ Warm up <u>20 minutes</u>
- ❑ <u>Minimum 8 minutes</u> standard count
- ❑ Count must be <u>within 1% of previous count</u>
- ❑ Statistical stability <u>monthly</u>


5

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# Correlation

*"This method is sensitive to the type of aggregate, percentage and source of asphalt cement, aggregate gradation, and all additives, including hydrated lime"*

*RAP, if used, must be mixed in per the JMF

- ❑ <u>Minimum 3 points</u> (correlation pans)
- ❑ A <u>dry aggregate count</u> must also be taken to establish a baseline, to be used to determine whether changes in the aggregate properties are affecting the AC content results

**1 pan**

**3+ pans**

6

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# Dry Aggregate Count

- Aggregate is oven-dried at <u>300ºF ±15º</u> (149ºC ±8º)
- Aggregate is either a cold-feed sample or combined in the lab to match the <u>JMF or mix design</u>
- Run this test "<u>approximately once per week</u>" to detect changes in the aggregate
- A new correlation should be run if the count is greater than <u>±0.5%</u>


**Hydrated lime, if required by the mix design, shall be added in the laboratory, regardless of the sample origin**

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# Dry Aggregate Count

PROCEDURE

- Fill the (tared) pan ½ way with heated aggregate and level
- Drop from 1", 4 times to consolidate the aggregate
- Fill the pan above the rim slightly
- Drop from 1", 4 times to consolidate the aggregate
- Using a sawing motion, strike off the aggregate level with the pan – filling voids in the surface with fines

8

B

# Dry Aggregate Count


PROCEDURE

- ❑ Record the <u>weight</u>
- ❑ Record the <u>temperature</u>
- ❑ Perform a 16-minute count (<u>BASELINE</u>)

*New correlations will need to be performed if the weekly aggregate counts exceed <u>±0.5%</u>*

9

B

# Correction Factor

- ❑ Prepare a <u>minimum of 3</u> correlation sample pans using all materials listed in the JMF, at "Mixing Temp." per CP-L 5115
- ❑ <u>Optimum, -1.0%, and +1.0%</u>
- ❑ Following the gauge manufacturer's instructions, perform and record a <u>16-minute</u> count on each sample to develop a correlation factor

**HMA Correlation**

**EXAMPLE*

| #2 | #1 | #3 |
|---|---|---|
| *4.50% AC | OPTIMUM<br>*5.50% AC<br>BASE WEIGHT | *6.50% AC |

**Correlation Factor**

**<u>≥0.9990</u>**

*At the conclusion of the correlation, an additional background count (STANDARDIZATION) must be taken (within 1.0% of previous)*

10

B

# Correction Factor

- This formula can be found on **CDOT Form #599**
- This formula can also be used for the ignition oven (CP-L 5120) when building correction factor samples

**% Binder to Add Calculation**

$$\frac{\mathbf{C \times D}}{\mathbf{100 - D}}$$

C = Weight of dry aggregate

D = Percent asphalt (binder) required

***EXAMPLE**

$$\frac{(\mathbf{C})\ 8{,}000.0 \times (\mathbf{D})\ 5.00 = 40{,}000}{100 - (\mathbf{D})\ 5.00 = 95}$$

40,000 / 95 = **421.1 grams**

11

B

# Determining AC of HMA

PROCEDURE

- Fill the (tared) pan ½ way with mix and level
- Fill the pan the to within <u>±5 grams</u> of the base weight (correlation) and record the weight
- Temp. <u>250°F - 300°F</u> (121°C - 149°C)
- Record temperature (Must be <u>±10°F</u> (±6°C) of correlation samples)
- Fill the corners, and compact using a metal plate or similar


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# Determining AC of HMA

- ❑ Perform a 16-minute count on the sample
- ❑ Correct gauge's displayed AC content for moisture (CP-43)
- ❑ Report the

Corrected % AC


CP 43 MOISTURE REQUIRED

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# QUESTIONS?

14

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B

# Sieve Analysis of Aggregates

## *CDOT CP 31*


AASHTO
**T 11-24**
(2024)

AASHTO
**T 27-24**
(2024)


1

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# Scope

These procedures provide the methods for determining the particle size distribution of **FINE** and **COARSE** aggregate

AASHTO
**T 11-24**
(2024)

AASHTO
**T 27-24**
(2024)

CP 31 says to follow *these* 2 AASHTO procedures, with *these* exceptions:

**Samples will be obtained using CP 30 Sampling of Aggregates and split using CP 32 Reducing Aggregates**

\+

**Sample weights will be obtained from Table 31-1, and moisture content per 3.1.3 of CP 31**

2

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# Procedure CP 31

## Sample Size

Table 31-1

| Aggregate Nominal Maximum Size Square Opening, inches | Minimum Weight (Mass) of Test Sample, Pounds (kg) |
|---|---|
| < 3/8 | 0.66 (0.30) |
| 3/8 | 2.2 (1.0) |
| 1/2 | 3.3 (1.5) |
| 3/4 | 4.4 (2.0) |
| 1 | 5.5 (2.5) |
| 1-1/2 | 11.0 (5.0) |
| 2 | 16.0 (7.5) |
| 2-1/2 | 22.0 (10.0) |
| 3 | 27.5 (12.5) |
| 3-1/2 | 33.0 (15.0) |

## Moisture

$$W_{Dry} = \frac{W_{wet}}{100 + MC} \times 100$$

Where:
$W_{Dry}$ = Dry weight (mass) of 2nd sample
$W_{Wet}$ = Wet weight of 2nd sample
MC = Moisture content of 1st sample

**The dry weight for the wash sample is back calculated!**

- ❑ Split out 2 samples and record **WET WEIGHTS**
- ❑ Sample 1 – In oven (or **hot plate**) at 230°F ±9° (110°C ±5°) to constant mass, cool, record **DRY WEIGHT**
- ❑ Sample 2 – Goes right into the wash

3

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B

# Apparatus

AASHTO
**T 11-24**
(2024)

❑Wash Pan

❑Auto Washer (Optional)

❑Sieves

❑Scale

❑Oven

4

AASHTO
T 11-24
(2024)

B

# Procedure T 11 (Wash)

- Place the sample into a wash pan or bowl and cover with water
- Agitate by hand or using tools to bring the fine material into a suspension
- Decant the water over the nest of 2 sieves
- Repeat until the water is reasonably clear


5

AASHTO
T 11-24
(2024)

B

# Procedure T 11 (Wash)

- If a mechanical washer is being used, limit the wash time to <u>10 minutes</u>

DON'T ALLOW THE #200 SIEVE TO CLOG AND OVERFLOW DURING ANY METHOD – BUT THIS CAN BE COMMON USING THE AUTO WASHER


6

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AASHTO T 11-24 (2024)

B

# Procedure T 11 (Wash)

- ❑ Remove the top sieve and spray the material retained on the #200 sieve until it runs clear


7

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AASHTO T 11-24 (2024)

B

# Procedure T 11 (Wash)

- ❑ Return the material retained on the #200 sieve to the wash pan


NO FURTHER DECANTING OF THE WASH PAN SHOULD TAKE PLACE AT THE COMPLETION OF THE WASH

8

AASHTO
**T 11-24**
(2024)

B

# Procedure T 11 (Wash)


- Dry the washed aggregate at 230°F ±9° (110°C ±5°) to a constant mass
- Cool to room temperature before recording after wash weight to the nearest 0.1g

9

AASHTO
**T 11-24**
(2024)

B

# % Passing #200

## Calculation

$$A = [(B-C)/B] \times 100$$

A = % passing #200 by washing

B = Original dry weight

C = Dry weight after washing

REPORT TO THE NEAREST **0.1%**, UNLESS THE RESULTS ARE 10% OR GREATER

10

# Apparatus

B

AASHTO
**T 27-24**
(2024)

❑Mechanical Sieve Shaker

❑Sieves

❑Scale


❑Oven

11

# Procedure T27 (Sieve Analysis)

B

- ❑Utilize a nest of sieves which conform to the specifications of the material to be tested
- ❑ANNEX A1 and 7.3 – provide weight requirements and troubleshooting methods for the prevention of overloading sieves


THIS INFORMATION WILL BE IN THE MIX DESIGN OR JMF

| Sieve Size | |
|---|---|
| mm | in. |
| 50 | 2 |
| 37.5 | 1.5 |
| 25 | 1 |
| 19 | 3/4 |
| 12.5 | 1/2 |
| 9.5 | 3/8 |
| 4.75 | No. 4 |
| 2.36 | No. 8 |
| 1.18 | No. 16 |
| 0.6 | No. 30 |
| 0.3 | No. 50 |
| 0.15 | No. 100 |
| 0.075 | No. 200 |

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# Procedure T27 (Sieve Analysis)

- ❑Sample has been washed, dried, and cooled to room temperature per T11
- ❑The recorded "dry weight after washing" is the <u>**starting weight**</u> for the sieve analysis (gradation)
- ❑Place the sample into the top of the nest of sieves and agitate for a *"sufficient period"*

"Sufficient Period" is defined by the <u>**Sieving Adequacy**</u> process found in ANNEX A2.


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# Procedure T27 (Sieve Analysis)

- ❑Weigh and record the material on each sieve individually or accumulatively to the nearest <u>0.1g</u>

THE TOTAL MUST BE WITHIN <u>**0.3%**</u> OF THE BEGINNING WEIGHT

CUMULATIVE

| Specimen wt (dry) **B** 2383.7 | | | | |
|---|---|---|---|---|
| Sieve | Weight | Percent retained | Percent passing | Specs |
| | | | | |
| | | | | |
| 1" | 0.0 | | 100 | |
| ¾" | 23.0 | 1.0 | 99 | |
| ½" | 253.7 | 10.6 | 89 | |
| 3/8" | 452.1 | 19.0 | 81 | |
| #4 | 832.1 | 34.9 | 65 | |
| #8 | 1052.1 | 44.1 | 56 | |
| #16 | 1248.7 | 52.4 | 48 | |
| #30 | 1489.5 | 62.5 | 37 | |
| #50 | 1892.1 | 79.4 | 21 | |
| #100 | 2015.3 | 84.5 | 15 | |
| #200 | 2259.4 | 94.8 | 5.2 | |
| -#200 | 63.1 | | | |
| TOTAL | **2322.5** | | Within 0.3% of dry washed weight? Y or N | |

INDIVIDUAL

| Specimen wt (dry) **B** 2383.7 | | | | |
|---|---|---|---|---|
| Sieve | Weight | Percent retained | Percent passing | Specs |
| | | | | |
| | | | | |
| 1" | 0.0 | 0.0 | 100 | |
| ¾" | 23.0 | 1.0 | 99 | |
| ½" | 230.7 | 10.6 | 89 | |
| 3/8" | 198.4 | 19.0 | 81 | |
| #4 | 380.0 | 34.9 | 65 | |
| #8 | 220.0 | 44.1 | 56 | |
| #16 | 196.6 | 52.4 | 48 | |
| #30 | 241.0 | 62.5 | 37 | |
| #50 | 402.6 | 79.4 | 21 | |
| #100 | 123.2 | 84.5 | 15 | |
| #200 | 244.1 | 94.8 | 5.2 | |
| -#200 | 63.1 | | | |
| TOTAL | 2322.5 | | Within 0.3% of washed dry weight? Y or N | |


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# Sieving Adequacy (A2)


- ❑Performed at least annually
- ❑Shake sample in the nest of sieves for 10 minutes
- ❑Take each sieve and cover with a lid and catch pan
- ❑Holding at a slight incline (for 60 seconds) and shake the sieve by striking 150 times while rotating (approximately 25 strikes over 6 locations around the sieve)
- ❑Not more than <u>0.5%</u> of the total sample can move through any/all sieves

INCREASE SHAKER TIME AND REPEAT IF FIRST TRIAL FAILS

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IT IS RECOMMENDED TO USE LARGER DIAMETER SIEVES FOR COARSE AGGREGATE

B

# Other Things To Know

- ❑ For sieves <u>#4 and smaller</u>, the maximum weight per sieve is:
  - ❑ 200g for 8” diameter
  - ❑ 450g for 12” diameter
- ❑ Large samples can be broken into multiple increments and recombined
- ❑ Intermediate sieves can be introduced to the nest to prevent sieve overloading

16

B

# Calculation T27 (Sieve Analysis)

**% RETAINED =**

SIEVE WEIGHT / DRY WEIGHT x 100

**% PASSING =**

100 - % RETAINED

REPORT % PASSING TO THE NEAREST WHOLE NUMBER

REPORT THE ONLY
THE #200 TO THE **0.1%**

17

B

# QUESTIONS?

18