Rocky Mountain Asphalt Education Center

# *Laboratory for the Certification of Asphalt Technicians (LabCAT)*

# *Level E - Aggregates*

## *2024 Presentation Manual*

In cooperation with the Colorado Asphalt Pavement Association, the Colorado Department of Transportation, and the Federal Highway Administration

# Welcome to the the Certification for AggregateTesting TECHNICIANS (LabCAT)

1

Rocky Mountain Asphalt Education Center

## Aggregate Technician Certification Program

2

# Certification Schedule

- Introduction of Staff
- Program Description
- Schedule
- General Information
- Aggregates in general

3

Colorado Asphalt Pavement Association (CAPA)
Rocky Mountain Asphalt Education Center
(RMAEC)

- Tom Peterson, P.E. CAPA Executive Director
- Tom Clayton, SET RMAEC Dir of Training
- Mike Skinner, P. E. CAPA Dir of Pave Eng.
- Cindy Rutkoski Instructor
- Diane Hammond Program Coordinator

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## LabCAT Board of Directors

| | |
|---|---|
| Tom Peterson | CAPA |
| Ed Wells | Connell Resources |
| Craig Wieden | CDOT Staff Materials |
| Jody Pieper | CDOT R-2 |
| Brian Dobling | Co Div –FHWA |
| Craig Vaughn | CMT Technical Services |
| Tim Webb | CDOT R 5 |
| Justin Cupich | Kumar & Associates |
| Ken Coulson | Coulson Excavating |

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## LabCAT Technical Committee

| | |
|---|---|
| Vincent Battista | CDOT Asphalt Pavement Services Manager |
| Jeff Cuypers | Brannon Sand & Gravel |
| David Fife | United Companies |
| Dave Chelgren | Martin Marietta |
| Johnny Lam | CDOT Staff Materials |
| Lisa Wisner | CDOT R-5 |
| Cindy Rutkoski | RMAEC |
| Ethan Wiechert | Earth Engineering |
| Tom Clayton | CAPA |
| Tammy Buck | |
| Mike Gallegos | CDOT R-1 |
| Patrick Kowing | FHWA(Central Federal Lands) |
| Eric Biggers | Martin Marietta |

6

# Aggregate Technician Certification
# LabCAT Level E

- Required by CDOT CP-10 for those performing aggregate properties tests for asphalt mix designs.

7

## Aggregate Technician Program

| | |
|---|---|
| Welcome and Introduction | 8:00am |
| Sampling of Aggregates | CP-30 / T2 |
| Reducing Samples of Aggregate | CP-32 /T 248 |
| Sieve Analysis | T11, T27 / CP-31 |
| SG of Fine Aggregate | CP-L4102 /T84 |
| SG of Coarse Aggregate | CP – L 4103 /T85 |
| Toughness – LA Abrasion | T96 |
| Micro Deval – | CP-L 4211 |
| Liquid Limit, Plastic Limit/Plasticity Index | T89, T90 |

8

## Schedule – (continued)

| | |
|---|---|
| Soundness | T104 |
| Clay Lumps and Friable Particles | T112 |
| Sand Equivalent (Clay Content) | CP 37 |
| Un compacted Void Content | CP- L 5113 |
| Fractured Faces | CP-45 |
| Flat and Elongated | D4791 |
| 0.45 Power Curve | |
| Written Exam | 75 minutes |

9

- Relax
- Don't be Late
- Questions/Comments are welcome
- CEU's are available (See Diane)
- Please Silence Cell Phones

10

- Coffee & Refreshments
- Pop Machine
- Lunch
- Breaks
- Restrooms

11

## Handouts

- Level E Handout Booklet
- CDOT FMM Procedures
  - All electronic– Download from CDOT
- AASHTO Procedures
  - In the LabCAT presentation book
- Evaluation
  - Please remove from your presentation book, to be filled out at the end of the session

12

## LabCAT Policies

- Percent correct to pass 80%
- Failure/Retest Policy
  - Written
    - May not achieve less than 70% on any one section, and 80% overall. If less than 70% in any one section, the section in question will be required to be retested and achieve at minimum of 70%
  - Written and Proficiency
  - Second written exam will be at a cost of $25 . Company will be invoiced with attention to supervisor.
  - Second Written Exam will be administered after the first written exam, if no more than the allotted number of sections is failed per section and the composite score of the first written exam is 70% or better.
  - Allotted number of failed sections per level: Level E including all Level A sections – 4; Level E w/out Level A sections – 3.

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## 2024 LabCAT Policies

- A brief review of failed sections and questions may take place by the technician. The instructor will not give any further instruction. Technician is allowed to ask for clarification of test questions at anytime during the exam and is informed of this before the exam starts.

- If second written exam is failed, the technician will not be allowed to move on to the laboratory proficiency portion of the certification program and will need to re-register for another scheduled full certification session.

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## 2024 LabCAT Program Policies

Written Test:

- Closed book, no personal notes allowed during exam.
- At time of written exam, RMAEC will distribute handout materials from the CDOT FMM & Lab Manual. Provided for quick check of details only.
- Handouts must be returned to instructor when written exam is completed.
- Exams are timed, times stated at top of exams will be adhered to.
- 15 minutes will be allowed for re-test of one section, 30minutes will be allowed for two or more re-test sections.
- These fees and times are being applied to encourage technicians to come prepared for certification testing.

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## Failure/Retest Policy (con't)

- Proficiency
  - To be eligible for Re-test, a technician can not fail more than 2 Level E proficiencies

(If you fail more than 2 proficiency procedures, you will be required to re-take the entire level (classroom, written and lab proficiencies) at full cost)

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# Failure/Retest Policy (con't)

- Lab Proficiency

If at or below the number of failed procedures allowed for a retest an additional proficiency at the same level will be added to the retest to ensure competency at that level.

- Retest fee: $150.00 *per level*

17

# Supplemental Examiners (Proctors)

- Proctors
  - CDOT
  - Local Agency
  - Contractors
  - Consultants
- Testing Stations for Proficiency Tests
  - Based on availability of proctors

18

## Who you are is important too!

### Self Introductions

- Name?
- Organization?
- General responsibilities?
- Years in the industry?

19

## Let's Get Started!

21

Standard Method for

# Sampling of Aggregates

*CDOT CP 30*

AASHTO T 2
ASTM D-75

1

# CP 30

- These methods are intended to apply to the sampling of aggregates used in acceptance and quality control from the points of acceptance as designated for construction materials including aggregate base course and aggregates for asphalt mixtures.

2

# Summary of the procedure

- Sampling is equally as important as the testing of the aggregate material
- Samples must be taken accurately to represent the characteristics of the material
- Always avoid segregation
- Samples must be selected from all the material being produced via CP-75 (Random Sampling)

3

# Securing Samples

- Aggregates used in asphalt shall be sampled by the contractor and witnessed by an authorized state representative
- Samples for preliminary approval or production control may be submitted by the producer but read and consider CP 52 Contractor Asphalt Mix Design Approval Procedures.

4

# Sampling Locations

1. Flowing Aggregate Stream – Belt Discharge using hand tools, automatic belt samplers or power equipment.
2. Stopped conveyor belt.
3. Stockpiles – with power equipment & without power equipment.
4. Roadway – Bases & Subbases
5. Processed Windrows
6. Cover Coat Material Spreader

5

# Belt Discharge using Hand Tools

- If safe and practical to stand within 2' of belt discharge
- Obtain one or more equal increments
- Combine to form field sample that equals or exceeds the minimum recommended in Table 30-1 Size of Field Samples
- Several quick passes from entire cross section of flow
- Container shall be at least 12" diameter with sufficient capacity to hold entire sample

6

# Automatic Belt Sampler

- Must cut the full charge of the belt without any loss of any portion
- Take one or more field samples that combined equals or exceeds the minimum recommended in Table 30-1 Size of Field Samples

7

# Belt Discharge using Power Equipment

- Front-end loader bucket positioned under belt discharge
- Material placed in separate small sampling stock pile using the following procedure

8

# Sampling with Power Equipment should always follow this procedure

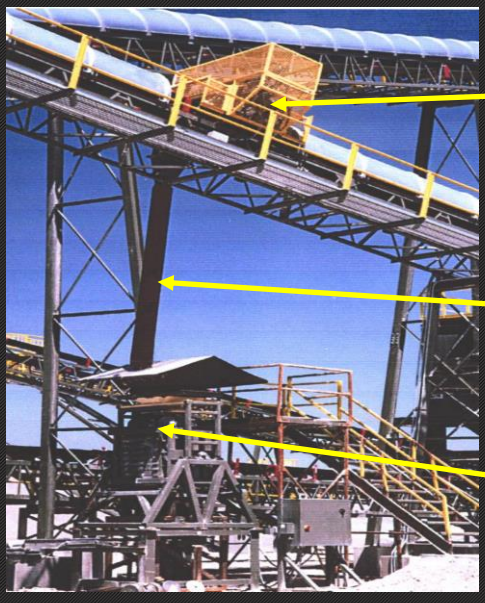
- Combine and mix the material in a separate small pile
- Flatten the pile not thicker than approx. 1 ft.

9

# Sampling with Power Equipment (continued)

- Sample from at least 3 locations through full depth of the pile created using a flat, square end shovel.
- Combine all portions

10



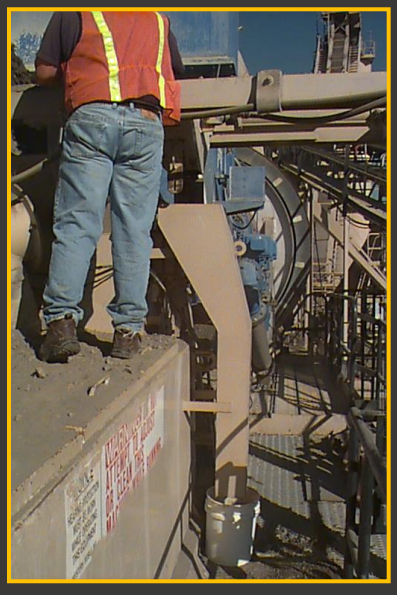
Automatic belt sampling device

Tube transfer device

Automatic gradation unit

11

12



13

# Storage Bin Discharge

- Bin discharge – is not for acceptance testing

14

# Dry Batch

- When sampling a dry batch an initial dry batch must be wasted
- For the second batch position a frontend loader bucket, truck or similar equipment under the pugmill to obtain a large sample in one increment
- Use extreme care to avoid segregation and loss of dust sized particles
- Use procedure for power equipment

15

# Stopped Conveyor Belt

- Obtain at least 3 [one or more CDOT] increments selected at random
- Stop the conveyor belt
- Insert two templates contoured to fit the belt

16

# Stopped Conveyor Belt

- Distance between templates to yield an increment of the required weight
- Remove all material between the templates

17

# Stopped Conveyor Belt

- Include all of the finer aggregates
- Use a brush and dustpan
- Combine all portions

18

# Stockpiles

- Stockpile sampling should be avoided if possible (MSHA/OSHA)
- Sampling should only be done by or under the direction of experienced personnel
- Mechanical equipment should be used if stockpiles are to be sampled

19

# Power Equipment

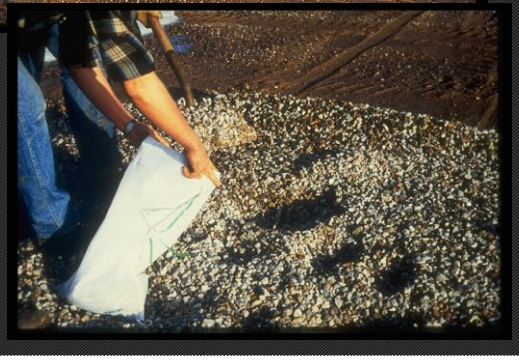
- Remove segregated material from the stockpile sides.
- Expose a representative face.
- Channel the face from bottom to top

20

# Power Equipment

- Combine and mix to form a small sampling pile

21



# Power Equipment

- Flatten the pile to a depth not thicker than approximately 1ft
- Sample from at least three (3) locations, to full depth of pile if possible
- Combine all portions

22

# Stockpiles (Manually)

- Obtain portions of the sample from the top third, mid-point and bottom third of the stockpile
- Take two sets of three samples 180° apart

23

# Stockpiles – Coarse & Mixed Size Aggregate

- Place shelf up slope from the sampling point
- Remove top six (6) inches outer layer of material
- Use a flat square end shovel or a scoop with sides
- Sample to full depth of shovel
- If possible use front end loader or backhoe

24

25

# Stockpiles – Fine Aggregate (– 3/ 8 in.)

- Same as coarse and mixed sized aggregate
  or
- Sampling tube

26

# Stockpiles – Fine Aggregate (– 3/ 8 in.) using a sampling tube

- Sampling tube approximately 1.25 in. minimum diameter by 6 ft. long inserted horizontally at a minimum of 5 locations to form the sample

27

# Roadway

- Sample from random location
- Minimum of 3 approximately equal increments
- Use flat square end shovel or scoop

28

# Roadway

- Sample full depth of lift

29

# Roadway

- Take care to exclude any underlying material
- Combine all portions

30

# Processed Windrows

- Material should contain sufficient moisture to maintain a near vertical face
- Remove material from one side toward the center to the full depth until a representative face is exposed
- Channel the exposed face from bottom to top and obtain a sample of required weight

31

# Processed Windrows

- Sample from at least three equally spaced locations on the exposed face
- Use a flat, square end shovel
- Do not lose particles off the shovel

32

# Cover Coat Material Spreader

- Last possible location prior to placement on the pavement
- Spreader must be stopped
- Samples will be taken from minimum of three individual gates as it is falling from the spreader
- Combine all samples to equal or exceed minimum requirement

33

# Cover Coat Material Spreader

- If there is a belt transfer device, samples may be taken from the stopped belt as per the Sampling from the Stopped Conveyor Belt method.
- Under the engineers approval, material may be sampled from the stockpile as per 4.3.3

34

# Definition: (Aggregate for Item 403)

- Nominal Maximum Particle Size is one sieve size larger than the first sieve that retains more than 10% of the aggregate sample (SHRP/Superpave)

35

# Example

| Sieve Size mm (in.) | Aggregate –% Passing | | |
|---|---|---|---|
| | A | B | C |
| % | % | % | |
| 19 (3/4) | *100* | 100 | 100 |
| 12 (1/2) | 88 | *93* | *90* |
| 9.5 (3/8) | 78 | 88 | 79 |

36

Sample Size Requirements are based on the

Nominal Maximum Particle Size and can be found in Table 30-1 Size of Field Samples

37

Questions?

38

# TABLE 30-1: SIZE OF FIELD SAMPLES

| Nominal Maximum Size of Aggregates | Approximate Minimum Mass of Field Samples |
|---|---|

| Fine Aggregate | lbs | kg |
|---|---|---|
| No. 8 (2.36 mm) | 10 | 5 |
| No. 4 (4.75 mm) | 10 | 5 |

| Coarse Aggregate | lbs | kg |
|---|---|---|
| 3/8 inch (9.5 mm) | 15 | 7 |
| ½ inch (12.5 mm) | 20 | 10 |
| ¾ inch (19.0 mm) | 25 | 12 |
| 1 inch (25.0 mm) | 30 | 15 |
| 1 ½ inch (37.5 mm) | 40 | 20 |
| 2 inch (50.0 mm) | 45 | 22 |
| 2 ½ inch (63.0 mm) | 50 | 25 |
| 3 inch (75.0 mm) | 55 | 27 |
| 3 ½ inch (90.0 mm) | 60 | 30 |

# *STANDARD METHOD OF TEST FOR* REDUCING FIELD

SAMPLES OF AGGREGATE
TO TESTING SIZE
CDOT CP 32

1

## PURPOSE OF SPLITTING

These methods provide for reducing large samples of aggregate to measure characteristics in a manner that the smaller test portion is most likely to be a representation of the larger sample, and thus of the total supply.

2

- Aggregates must be sampled in accordance with

- Samples must be split properly to obtain representative test specimens.

3

# METHODS

- Method A – riffle type splitter
- Method B – quartering
- Method C –
  - Selection by scoop (CDOT)
  - Miniature stockpile method (AASHTO)

4

# RIFFLE APPARATUS

- Riffle type splitter with variable size openings.
- Hopper to retain sample or flat scoop (feeder pan) equal in length to the overall assembly of chutes.
- Collection pans, minimum of two (2), equal in length to the overall assembly of chutes.
- Splitter brush to clean chutes of adhering fines.

5

# QUARTERING APPARATUS

- 6’ x 8’ quartering canvas or
- Clean, hard, level surface (AASHTO)
- Flat, square end shovel

6

# SCOOP & MINIATURE STOCKPILE APPARATUS (FINE AGGREGATE ONLY)

- Large flat bottomed mixing pan (CDOT) or a clean, hard, level surface.
- Small, flat, square end scoop.

7

# BY RIFFLE SPLITTER

- Riffle splitting is always preferable to hand quartering.
- Proper size openings required.
- Opening shall permit easy passage of the largest particles in the sample.
- For variable splitters the openings should be 1.5 times the size of the largest particles

8

# METHOD A – RIFFLE SPLITTER

- An even number of equal width chutes, but not less than 8 for coarse, or 12 for fine aggregates
- The splitter shall be equipped with a hopper or straight-edged pan which has a width equal or slightly less the overall width of the assembly of chutes.
- Sample at SSD or drier.
- Two procedures to split sample:
  - Hopper
  - Scoop (feeder pan)

9

# RIFFLE SPLITTER CONTROL FLOW HOPPER (CDOT)

- Sample poured into the closed hopper from the sample container.
- Use all material.
- Uniformly distribute from edge to edge.
- Open release handle and allow the sample to flow freely through the chutes.
- The first split that is then reintroduced to the splitter assists in mixing the sample.

10

## Riffle Splitter Control Flow Hopper (CDOT)

- Then remove both pans from the splitter.
- Save material in one pan for other tests.
- Pour half of the remaining pan into the hopper
- Reverse ends of pan.
- Pour the remaining sample into the hopper.

11

## RIFFLE SPLITTER CONTROL FLOW HOPPER (CDOT)

- Uniformly distribute material in hopper.
- Open release handle and allow the sample to flow freely through the chutes.
- Use alternate pans for further reduction.
- Splitting is continued until the sample is reduced to the required specimen size.

12

# RIFFLE SPLITTER (AASHTO)

- Splitting continued from one side until sample reduced to required specimen size

13

# RIFFLE SPLITTER WITHOUT CONTROL HOPPER (CDOT)

- Place entire sample in a large mixing pan and mix thoroughly.
- Scoop the material from the pan with the feeder pan.
- Uniformly distribute in feeder pan.
- First, slowly pour half the sample from one side.

14

# RIFFLE SPLITTER WITHOUT CONTROL FLOW HOPPER (CDOT)

- Pour the other half from the other side.
- Continue until entire sample has been passed through the chutes.
- Use alternate pans for further reduction to desired specimen size.

15

# METHOD B –QUARTERING

- Sample deposited on clean, hard, level surface or canvas (6’ X 8’ canvas).
- Mix material thoroughly by turning the entire sample over onto itself 3 times.

16

# METHOD B -QUARTERING

- Material shoveled into cone.
- Cone flattened at apex into in circular layer.
- Diameter equals approx. 4-8 times the thickness.

17

# METHOD B -QUARTERING

- Uniform thickness.
- Sample divided into two equal parts using a square shovel, pipe or stick under canvas if surface is uneven.

18

# METHOD B –QUARTERING

- Procedure repeated at 90 degrees.
- Diagonal opposite quarters removed [include all fines].
- Remaining two quarters re-mixed.
- Procedure repeated until sample is reduced to required size.

19

# METHOD C – MINIATURE STOCKPILE (CDOT SCOOP)

- Only for fine grained materials (minus 3/8 inches (9.5mm).
- Sample should be damp.
- Sample deposited into large pan and mixed 3 times.
- Form into conical pile. Flatten pile (as in quartering).
- Scoop to full depth of material.

20

# METHOD C – MINIATURE STOCKPILE
(CDOT SCOOP)

- Mix and sample to minimize the loss of particles.
- Portions selected from five (three) locations.
- Portions combined for required weight.

21

# METHODS FOR REDUCING SAMPLES WHEN USING A MECHANICAL SPLITTER CONTAINING FREE MOISTURE

- Dry to at least SSD condition, using temps that do not exceed those specified for any tests.
- Then split to specified size.

OR

- Preliminary split with mechanical splitter having chute openings 1½" or more to reduce large sample to not less than 5000 gr.
- Then dried as above and further reduced to desired size.

22

# QUESTIONS?

23

*Standard Method of Test*
*for* Materials Finer Than 0.075-mm (No. 200) Sieve in Mineral Aggregates by Washing and the Sieve Analysis of Fine and Coarse Aggregate.

- CDOT uses both:

CDOT CP 31

AASHTO T 11 / T 27

1

# Summary

- The weight required (after drying) for this procedure, is based on the nominal maximum particle size.
- The -200 wash is performed to remove the finer material from the coarser particles for a more efficient result.
- The aggregate gradation is the distribution of particle sizes expressed as a percent of the total weight of the sample.
- The gradation is determined by passing the material through a series of sieves stacked with progressively smaller openings and weighing the material retained on each sieve

2

## Apparatus Required

- Balance, with ample capacity and sensitivity (0.1 g)
- Sieves
  - For the −200 wash, a nest of two sieves, the lower a No. 200 and the upper with openings in the range of No. 8 and No. 16
- For the Sieve Analysis, additional sieves, conforming to AASHTO M92 and ASTM E11

- Container, sufficient in size to contain the sample covered with water and to permit vigorous agitation without any loss of the sample or water
- Oven or hot plate.

3

## Test Samples

- Aggregates must be sampled in accordance with CP 30.
- Aggregates must be mixed and reduced to test specimen size in accordance with CP 32

4

## CP 31
## Sieve Analysis & Materials Finer than the No, 200 by washing

- AASHTO T 11 & T 27 (found in AASHTO portion of handout) shall be used to determine the sieve analysis of fine & coarse aggregates with the following exceptions:
- Table 31-1 still used for minimum sample mass.
- Moisture Correction process can still be used, according to following procedure.

5

## CP 31

- Split material into two approximately equal samples.
- Dry one sample to constant mass in oven at 230° F ± 9° oven or use a hotplate to determine % moisture.
- Determine dry weight of second sample:

Wet weight/100 + %moisture X 100 = Corrected Dry Weight

6

# Test Samples–Coarse Aggregate Table 31–1

| Aggregate Nominal Maximum Size square openings, | Minimum Mass of Test Sample (AASHTO) (kg) | Minimum Mass of Test Sample Lb (kg) |
|---|---|---|
| 3/8” | 2 | 2.2 (1.0) |
| ½” | 4 | 3.3 (1.5) |
| ¾” | 11 | 4.4 (2.0) |
| 1” | 22 | 5.5 (2.5) |
| 1.5” | 33 | 11.0 (5.0) |
| 2” | 44 | 16.0 (7.5) |

7

# Procedure

- Dry the sample to constant mass @ 110 ± 5° C (230 ± 9° F) and determine the mass of the test sample.

or

- Use moisture correction method.

8

# Procedure for the −200 wash

- Place the sample into container and cover with water.
- Add wetting agent if desired.
- Agitate the test sample with sufficient vigor to separate the particles finer than the No. 200 sieve and to bring the material into suspension.

9

# Procedure, −200 wash (cont.)

- Immediately pour the wash water over the nested sieves avoiding the decantation of coarser particles of the sample.

10

# Procedure, −200 wash
(continued)

- The entire sample may be placed into the upper sieve and washed until the coarser fraction is clean, however all water must pass through the No. 200 sieve.
- Add a second charge of water (no wetting agent).
- Agitate and decant.
- Repeat this operation until the wash water is clear.

11

# Procedure, −200 wash (continued)

- Return all material retained on the sieves to the container.
- Dry the washed aggregate to a constant mass at 230 ± 9°F (110 ± 5° C)
- Cool to room temperature, determine and record the dry mass of the material.

12

## Before/After Sieve Weight Check

- Weigh & record weight of washed sample after drying prior to placing in the stack.
- Weigh & record weight of material from each sieve either individually or accumulatively.
- Final total weight should not differ by more than 0.3% of the original dry mass of the washed and dried sample.

$$\left(Difference \div OriginalDryMass\right) \times 100 =\leq 0.3\%$$

13

## Sieving Procedure

- Separate the specimen over a series of suitable.
- Size sieves, including those required by the specifications, manually or mechanically.
- Do not overload sieves:
  - 12 inch = Approx. 500g
  - 8 inch = Approx. 200g

14

# Sieving Adequacy

- Annual calibration of shaker.
- Test using different material types.
  - Hand shake each individual sieve for additional 1 minute.
  - Pan on bottom and lid on top.
  - Hold at slightly inclined angle and tap sharply with heel of hand.
  - 25 taps at each of 6 locations around the sieve = 150 taps.
  - Not more than 0.5% by weight of the total sample can pass.

**Loss / original dry mass x 100= ≤ 0.5%**

15

# Procedure, Sieve (cont)

- Determine and record the mass of material retained on each sieve to 0.1g
  - individually
  - cumulatively

16

# Procedure

- Calculate the Moisture content

  **M/C = (Wet – Dry)/Dry x 100**

- Calculate the original dry mass from the percent moisture when using moisture correction methods.

  **Wet Weight ÷ (100 + %M) X 100 = Corrected Dry Weight**

- Calculate percent retained to 0.1%

  **Sieve Weight ÷ Corrected Dry Weight X 100 = % Retained**

- Calculate the percent passing and report to nearest whole number except No. 200 to 0.1%

  **100 -% retained = % Passing**

17

**Calculated by cumulative weights**

COLORADO DEPARTMENT OF TRANSPORTATION
SIEVE ANALYSIS FOR AGGREGATES
NOT SPLIT ON THE No. 4 SIEVE

| Project no. | Project code (SA#) |
|---|---|
| Proj. location | |
| Pit name | |
| Item | Class |

| Station | | | Test # | | Station | | | Test # | |
|---|---|---|---|---|---|---|---|---|---|
| Specimen wt (dry) B 2383.7 | | | Date | | Specimen wt (dry) B 2383.7 | | | Date | |
| Sieve | Weight | Percent retained | Percent passing | Specs | Sieve | Weight | Percent retained | Percent passing | Specs |
| | | | | | | | | | |
| | | | | | | | | | |
| 1" | 0.0 | | 100 | | 1" | 0.0 | 0.0 | 100 | |
| ¾" | 23.0 | 1.0 | 99 | | ¾" | 23.0 | 1.0 | 99 | |
| ⅜" | 253.7 | 10.6 | 89 | | ⅜" | 230.7 | 10.6 | 89 | |
| 3/8" | 452.1 | 19.0 | 81 | | 3/8" | 198.4 | 19.0 | 81 | |
| #4 | 832.1 | 34.9 | 65 | | #4 | 380.0 | 34.9 | 65 | |
| #8 | 1052.1 | 44.1 | 56 | | #8 | 220.0 | 44.1 | 56 | |
| #16 | 1246.7 | 52.4 | 48 | | #16 | 196.6 | 52.4 | 48 | |
| #30 | 1489.5 | 62.5 | 37 | | #30 | 241.0 | 62.5 | 37 | |
| #50 | 1892.1 | 79.4 | 21 | | #50 | 402.6 | 79.4 | 21 | |
| #100 | 2015.3 | 84.5 | 15 | | #100 | 123.2 | 84.5 | 15 | |
| #200 | 2259.4 | 94.8 | 5.2 | | #200 | 244.1 | 94.8 | 5.2 | |
| -#200 | 63.1 | | | | -#200 | 63.1 | | | |
| TOTAL | 2322.5 | | Within 0.3% of dry washed weight? Y or N | | TOTAL | 2322.5 | | Within 0.3% of washed dry weight? Y or N | |

| | Gradation Sample | Moisture Sample | | Gradation Sample | Moisture Sample |
|---|---|---|---|---|---|
| Pan ID | | | Pan ID | | |
| Pan weight | | | Pan weight | | |
| Wet weight + Pan | | | Wet weight + Pan | | |
| Wet weight | A | 550.2 | Wet weight | A | 550.2 |
| Dry weight + Pan | | | Dry weight + Pan | | |
| Dry weight | B | 525.1 | Dry weight | B | 525.1 |
| Dry wash weight / H2O Loss | | 25.1 | Dry wash weight / H2O Loss | | 25.1 |
| 2323.1 / % H2O | | 4.8 | 2323.1 / % H2O | | 4.8 |
| Wet weight = (100 + % H2O) x 100 = Dry weight | | | Wet weight = (100 + % H2O) x 100 = Dry weight | | |
| A 2500.5 = (100 + 4.8) x 100 = B 2383.7 | | | A 2500.5 = (100 + 4.8) x 100 = B 2383.7 | | |

**Calculated by individual weights**

18

# Questions?

19

# *STANDARD METHOD OF TEST FOR* SPECIFIC GRAVITY AND ABSORPTION OF FINE AGGREGATE

CP-L 4102
AASHTO T - 84

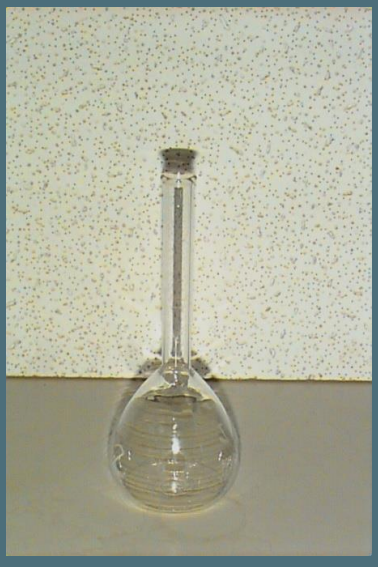
1

## SPECIFIC GRAVITY AND ABSORPTION OF FINE AGGREGATE

- This test method covers the determination of bulk specific gravity, apparent specific gravity, saturated surface dry (SSD) specific gravity and absorption of fine aggregates.
- Effective specific gravity is calculated using the maximum specific gravity (Rice) of the HMA mixture.

2

# APPARATUS



Balance
-with a sensitivity of 0.1g or better

Pycnometer or Volumetric Flask
-volume repeatable to 0.1 $cm^3$

3

# APPARATUS


4

## PROCEDURE

- Material Sampled by T 2 (CP-30)
- Obtain ~ 1000 g of fine aggregate by T 248 (CP-32)

5

## PROCEDURE

- Dry test specimen to constant mass at 230 ± 9 °F (110 ± 5°C).
- Cool to room temperature
- Obtain approximately 1000 g of fine aggregate. (1500 if doing moisture correction)
- Cover with water

  or add 6% water & cover.
- Let stand for 15 -19 hours.

6

## SSD CONDITION

- Decant water carefully.
- Spread sample on flat nonabsorbent surface

- Expose to current of warm air

- Frequently mix to ensure uniform drying the sample

7

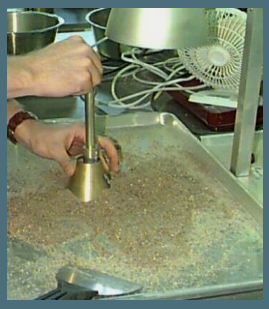
## DETERMINING SSD…?

- First trial should be when some surface moisture is still present.
- Test at frequent intervals until test indicates specimen has reached SSD condition.
- If first trial or any subsequent trials indicate sample has dried past SSD condition, mix a few mL of water with fine aggregate, thoroughly and let stand covered for 30 min.

8

## CONE TEST FOR SSD

- Fill mold to overflowing while firmly pressing down on the mold.
- Lightly tamp the fine aggregate into the mold with 25 light drops of the tamper about 5 mm above the top surface of the aggregate.
- Permit the tamper to fall freely under gravitational attraction



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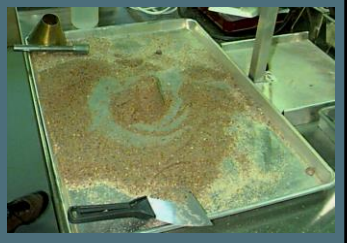
## CONE TEST FOR SSD

- Remove loose sand from the base and lift the mold vertically.
- If surface moisture is present the sample will retain the molded shape.
- When the sample slumps slightly, it has reached an SSD condition



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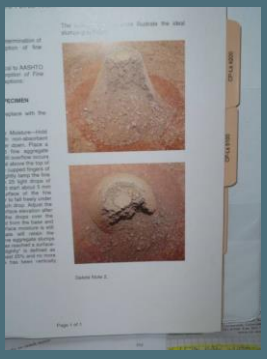
## CP-L 4102 DETERMINING SSD

- As per CP-L 4102 7.2.1
- "Slumps slightly" is defined as when the face slumps at least 25% and no more than 50% after the cone has been vertically lifted.



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- Some angular fine aggregate or material with a high proportion of fines may not slump in the cone test @ SSD condition.
- If fines become airborne upon dropping a handful of sand from 100 to 150mm above surface, this may indicate this type of material.
- For these materials, the SSD condition should be considered as the point that one side of the fine aggregate slumps slightly upon removing the cone.

12

# PROCEDURE

- Once SSD condition has been determined, immediately obtain and record sample weight of a sample that weighs 500 ± 10 g and place into a partially filled flask.
- If performing a moisture correction, also immediately obtain an equal portion of fine aggregate at the same time, for a moisture content within ± 0.2 g of first sample.
- Dry moisture sample to constant weight at 230 ± 9 ºF

13

# PROCEDURE

- Fill flask to approx. 90 % of capacity.
- Roll, invert and agitate flask to eliminate all air bubbles (may take app. 20min) or use mechanical agitation

14

# PROCEDURE

- Adjust flask temperature to 73.4 ± 3 °F (23.0 ± 1.7 °C)
- Bring water level to the flask calibration capacity.
- Determine the mass of the flask, material and water.

15

# PROCEDURE

- Remove the fine aggregate from the flask.
- If moisture correction has not been done, dry to constant mass at 230±9°C (110 ± 5 ° C).
- Determine the mass of the dry aggregate.

16

## CALIBRATION OF VOLUMETRIC FLASK

- Determine the mass of the flask filled to its calibration.
- Water temperature 73.4 ±3.0 °F (23.0±1.7 °C).

17

## CALCULATIONS

$$G_{sb} = \frac{A}{(S+B-C)} \qquad G_{sb}(SSD) = \frac{S}{(S+B-C)}$$

$$G_{sa} = \frac{A}{(A+B-C)} \qquad \%Abs. = \frac{(S-A)}{A} x100$$

Where:

A = mass of oven dry specimen
B = mass of flask filled with water
C = mass of flask filled with specimen and water
S = mass of saturated surface-dry specimen

18

# QUESTIONS ?

19

# *STANDARD METHOD OF TEST FOR* SPECIFIC GRAVITY AND ABSORPTION OF COARSE AGGREGATES AASHTO T – 85

1

## PURPOSE

- This test method covers the determination of the specific gravity and absorption of coarse aggregates

2

# TEST SPECIMENS

- Aggregate sampled by CP- 30 (T- 2)
- Material mixed and reduced by CP-32 (T248)

3

# TEST SPECIMENS

- Material split on 4.75-mm sieve (No. 4).
- Plus 4.75-mm washed.

and dried at 110 ± 5 °C (230 ± 9 °F)

- Test sample cooled at room temperature for 1-3 hours.

4

# TEST SPECIMENS

- Test specimen size is a minimum mass based on nominal maximum particle size.

5

# TEST SPECIMEN SIZE

| Nominal Maximum Size mm (in.) | Minimum Test Sample Size kg (lb) |
|---|---|
| 12.5 (1/2) or less | 2 (4.4) |
| 19.0 (3/4) | 3 (6.6) |
| 25.0 (1.0) | 4 (8.8) |
| 37.5 (1.5) | 5 (11) |
| 50.0 (2.0) | 8 (18) |

6

# PROCEDURE

- Immerse aggregate in water for 15 – 19 hours.
- Check water bath temperature, 23.0 ± 1.7 °C (73.4 ± 3 °F).
- Check and adjust water bath level

7

# PROCEDURE

- Remove aggregate from water, surface dry the material.
- Wipe larger particles individually.
- Avoid evaporation of water.

8

# PROCEDURE

- Determine the SSD mass of the test sample.
- Sample immediately placed into immersion container.

9

# PROCEDURE

- Immerse container in water bath.
- Shake container while immersed to remove entrapped air.
- Determine mass of immersed material.

10

# PROCEDURE

- Dry test specimen to constant mass at 110 ± 5 °C (230 ± 9 °F).
- Cool sample to room temperature.
- Determine the dry mass.
- Specific gravity and absorption calculated.

11

# CALCULATIONS

$$G_{sb} = \frac{A}{(B-C)} \qquad G_{sa} = \frac{A}{(A-C)}$$

$$G_{sb}(SSD) = \frac{B}{(B-C)} \qquad Abs\% = \frac{(B-A)}{A} x100$$

Where:
A = mass of oven-dry test sample in air, g
B = mass of saturated-surface dry test sample in air
C = mass of saturated test sample in water, g

12

- Questions?

13

# *STANDARD METHOD OF TEST FOR* RESISTANCE TO DEGRADATION OF SMALL-SIZE COARSE AGGREGATE BY ABRASION AND IMPACT IN THE LOS ANGELES MACHINE AASHTO T-96

1

## PURPOSE

- Testing different size coarse aggregates smaller than 1-1/2 inch (37.5 mm) for resistance to degradation using the L.A Abrasion Machine

2

## SUMMARY

- This test is a measure of the break down of mineral aggregates in a rotating drum containing a specified number of steel spheres from a combination of actions, including:
  - attrition
  - impact
  - grinding

3

## APPARATUS

- Los Angeles Machine

- Sieves

4

## APPARATUS

- Balance
- Charges, twelve total, each with a mass of 390 to 445 g and an average approximate diameter of 46.8 mm (1-27/32 inch)

5

## TEST SPECIMENS

- Obtain sample in accordance with T 2 (CP -30)
- Reduce sample in accordance with T 248 (CP - 32)
- Test sample washed, then dried at 230±9 °F (110±5 °C)

6

# TEST SPECIMENS

- Aggregate separated into individual sized fractions
- Combine aggregates according to the specified grading

7

# GRADING OF TEST SAMPLES

| Sieve Size | | Mass of Indicated Sizes, g | | | |
|---|---|---|---|---|---|
| Passing | Retained on | Grading | | | |
| | | A | B | C | D |
| 1 ½ in. | 1.0 in. | 1250 ± 25 | ….. | ….. | ….. |
| 1.0 in. | ¾ in. | 1250 ± 25 | ….. | ….. | ….. |
| ¾ in. | ½ in. | 1250 ± 10 | 2500 ± 10 | ….. | ….. |
| ½ in. | 3/8 in. | 1250 ± 10 | 2500 ± 10 | ….. | ….. |
| 3/8 in. | ¼ in. | ….. | ….. | 2500 ± 10 | ….. |
| ¼ in. | No. 4 | ….. | ….. | 2500 ± 10 | ….. |
| No. 4 | No.8 | ….. | ….. | ….. | 5000 ± 10 |
| Total | | 5000 ± 10 | 5000 ± 10 | 5000 ± 10 | 5000 ± 10 |

8

## CHARGE OF STEEL SPHERES

| Grading | Number of Spheres | Mass of Charge g |
|---|---|---|
| A | 12 | 5000 ± 25 |
| B | 11 | 4584 ± 25 |
| C | 8 | 3330 ± 20 |
| D | 6 | 2500 ± 15 |

9

## PROCEDURE

- Test sample and correct charge (and mass) of spheres placed into LA Machine
- 500 revolutions are impacted on the test sample, at 30 to 33 rpm

10

## PROCEDURE

- Contents of drum removed and a preliminary separation made on a sieve coarser than No. 12 (1.70 mm)
- Finer material separated on No. 12 sieve

11

## PROCEDURE

- Wash sample over No. 12 sieve
- Dry to constant mass and weigh

12

# CALCULATIONS

- Percentage of wear correctly calculated

$$Loss,\% = \left\langle \frac{A - B}{A} \right\rangle x100$$

**Where:**
**A = original test sample weight**
**B = final test sample weight**

Colorado = 45%
Maximum Loss

13

# QUESTIONS ?

14

*STANDARD METHOD OF TEST FOR*
# RESISTANCE OF COARSE AGGREGATE TO DEGRADATION BY ABRASION IN THE MICRO- DEVAL APPARATUS
CP-L 4211

1

## Summary of Method:

- A measure of abrasion resistance and durability of mineral aggregates.
- A sample with standard grading is initially soaked in water for 15 to 19 hours.
- It is then placed in a jar mill with 2.0 liters of water.
- An abrasive charge consisting of 5000 grams of 9.5 mm diameter steel balls.

2

## Significance and Use

- The Micro-Deval Test is a test of coarse aggregates to determine abrasion loss in the presence of water. This test measures the reduction in resistance to degradation.

3

- The Micro-Deval test is a useful test for detecting changes in properties of aggregate produced from a source as part of a quality control or quality assurance process.

Significance and Use

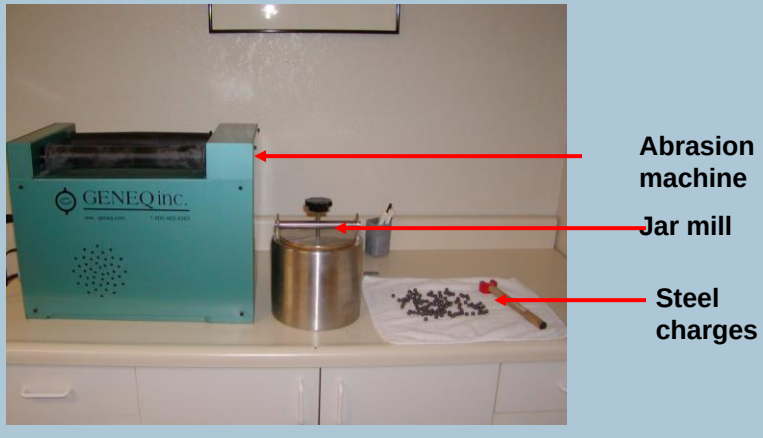
4

# Apparatus

- Micro-Deval Abrasion Machine – A jar rolling mill capable of running at 100 ± 5 rpm.
- Containers – Stainless steel Micro- Deval abrasion jars having a 5-liter capacity with a rubber ring in the rotary locking cover.
- Abrasion Charge – Magnetic stainless steel balls are required. These shall have a diameter of 9.5 ± 0.5 mm. Each jar requires a charge of 5000 ± 5 g of balls.
- Sieves – Sieves with square openings and of the following sizes conforming to AASHTO M 92 specifications: ¾" (19.0 mm) 5/8" (16.0 mm), ½" (12.5 mm), 3/8" ( 9.5 mm), 3/5" (9.0 mm), ¼" (6.7 mm), #4 (4.75 mm), and #16 (1.18 mm).
- Oven – The oven shall be capable of maintaining a temperature of 110 ± 5° C.
- Balance – A balance or scale accurate to 1.0 g.

6

# Apparatus

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## TEST SAMPLE STOCKPILES

- The test sample shall be washed and oven-dried at 110 ± 5° C to constant mass.
- separated into individual size fractions.
- recombined to meet the grading specified.

8

## Gradation A

- This gradation is to be used when the nominal maximum aggregate size is 16.0 mm or greater. An oven-dried sample of 1500 ± 5 g shall be prepared as follows:

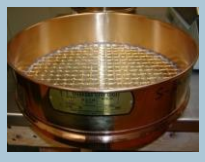
| Passing | Retained | Mass |
|---|---|---|
| 19.0 mm | 16.0 mm | 375 g |
| 16.0 mm | 12.5 mm | 375 g |
| 12.5 mm | 9.5 mm | 750 g |

9

## Gradation B

- This gradation is to be used when the nominal maximum aggregate size is 12.5 mm or greater, but less than 16.0 mm. An oven-dried sample of 1500 ± 5 g shall be prepared as follows:

| Passing | Retained | Mass |
|---|---|---|
| 12.5 mm | 9.5 mm | 750 g |
| 9.5 mm | 6.3 mm | 375 g |
| 6.3 mm | 4.75 mm | 375 g |



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## Gradation C

- This gradation is to be used when the nominal maximum aggregate size is less than 12.5 mm. An oven-dried sample of 1500 ± 5 g shall be prepared as follows:

| Passing | Retained | Mass |
|---|---|---|
| 9.5 mm | 6.3 mm | 750 g |
| 6.3 mm | 4.75 mm | 750 g |

11

## Gradation D

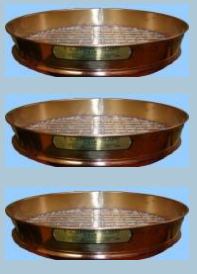
- This Gradation D is to be used when a combined gradation is to be tested.
- The test sample shall be washed and oven-dried at 110 ± 5° C to constant mass.
- Sample shall then be separated into individual size fractions and recombined to meet the grading as specified.

12

## Gradation D

- An oven-dried sample of 1500 ± 5 g shall be prepared as follows:

| Passing | Retained | Mass |
|---|---|---|
| 19.0 mm | 16.0 mm* | 250 g |
| 16.0 mm | 12.5 mm | 250 g |
| 12.5 mm | 9.5 mm | 500 g |
| 9.5 mm | 6.3 mm | 250 g |
| 6.3 mm | 4.75 mm | 250 g |



* If the top size isn't a part of the mix gradation, add the mass to the 16.0 mm to 12.5 mm mass.

13

# TEST PROCEDURE

- Prepare a representative 1500 ± 5 g sample. Record the Mass 'A' to the nearest 1.0 g.
- Saturate the sample in 2.0 ± 0.05 liters of tap water (temperature 20 ± 5° C) for 15 to 19 hours. This may be done in the Micro-Deval container or some other suitable container.
- Place the sample in the Micro-Deval abrasion container with 5000 ± 5 g of steel balls and the water to saturate the sample. Place the Micro- Deval container on the machine.



14

# TEST PROCEDURE


- For Gradation A run the machine for 2 hours ± 1 min. or 12,000+/-100 revolutions.
- For Gradation B run the machine for 105 ± 1 min. or 10,500+/-100 revolutions.
- For Gradation C run the machine for 95 ± 1 min. or 9,500+/-100 revolutions.
- For Gradation D run the machine for 105 ± 1 min. 10,500+/-100 revolutions.

All Gradations are run at 100 +/- 5 rpms

15

# TEST PROCEDURE

- Carefully pour the sample over two superimposed sieves: 4.75 mm and 1.18 mm. Take care to remove the entire sample from the stainless steel jar.
- Wash and manipulate the retained material with water, using a hand held water hose, and the hand until the washings are clear and all material smaller than 1.18 mm passes the sieve.
- Remove the stainless steel balls using a magnet or other suitable means.
- Discard material smaller than 1.18 mm.

16

# TEST PROCEDURE

- Combine the material retained on the #4 (4.75 mm) and #16 (1.18 mm) sieves, being careful not to lose any material.
- Oven dry the sample to constant mass at 110 ± 5° C.
- Weigh the sample to the nearest 1.0 g. Record the Mass 'B'.

17

## CALCULATIONS

- Calculate the Micro-Deval abrasion loss as follows, to the nearest 0.1%.

A (Original Mass)

B (Final Mass)

$$\frac{A-B}{A} X 100$$

18

## REPORT

- The report shall include the following:
  - *The nominal maximum aggregate size of the aggregate tested and the gradation (A, B, C, or D) used.*
  - *The percent loss of the test sample to one decimal place. (0.1%)*

19

# CONTROL OF ABRASION CHARGE

- Every 10 samples, but at least every week in which a sample is tested, the abrasion charge must be placed on a 9 mm screen to check for loss of size due to wear.

- Any charges that fall through the screen are out of specification and must be discarded.

20

# Questions ??

21

*Standard Specification for*
Determining Liquid Limit,
Plastic Limit and Plasticity Index of Soils

AASHTO T 90

1

## AASHTO T 90 Plastic Limit and Plasticity Index

The Plastic Limit is the lowest water content at which the soil remains plastic.

The Plasticity Index is the range in water content, expressed as a percentage, that the soil remains in a plastic state.

13

## Apparatus

- Mixing Dish (~115 mm diameter)
- Spatula (~75-100 mm in length, ~20 mm in width)
- Ground glass plate or smooth unglazed paper
- Rolling device (optional)
- Oven
- Balance (Sensitive to 0.01 g)

14

## Sampling

- ~10 g from liquid limit test

  or

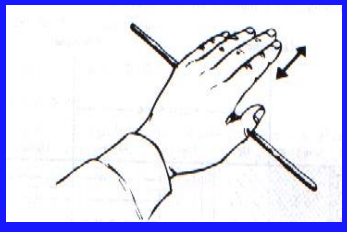
- ~20 grams of minus No.40 materially mix with distilled or de-mineralized water until mass can be shaped into a ball.

- Use ~ 10 g for test sample

15

## Procedure

Take 1.5 to 2 g from the mass and form into an ellipsoidal mass

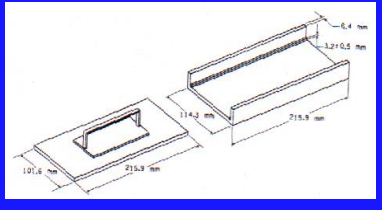


- Hand Rolling
  - Roll with palm or fingers
  - 80–90 strokes per minute
  - 3 mm in diameter
  - No more than 2 minutes

16

## Procedure

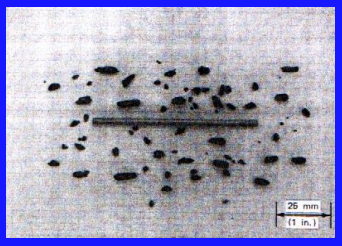
- Plastic Limit Device with paper
- Place soil mass on bottom plate
- Place top plate
- Slight downward pressure
- Back and forth motion
- Contact with side rails–2 min. max



17

## Procedure

- Roll to 3 mm (1/8 in)
- Break thread
- Remold into mass
- Roll again
- Continue until further attempts cause the soil to crumble under slight pressure




18

## Procedure

- At least once to 3 mm (1/8 in.)
- Delicate soil
- Immediately place in tarred container and cover
- Continue until entire sample is complete
- Determine moisture content per AASHTO T 265

19

## Calculations

- % Moisture=Plastic Limit (PL)

$$\%M = \frac{(Wet - Dry)}{Dry} x100$$

- Plasticity Index (PI)

  PI=LL−PL

20

## Questions ??

21

# *STANDARD METHOD OF TEST FOR* SOUNDNESS OF AGGREGATES BY USE OF SODIUM SULFATE OR MAGNESIUM SULFATE

# AASHTO T 104

1

## PURPOSE

- This method is used to determine the resistance of aggregates to disintegration by saturated solutions of sodium sulfate or magnesium sulfate.

2

# SUMMARY

- Aggregates are repeatedly immersed (usually 5 cycles) in a sodium sulfate or magnesium sulfate solution
- Followed by oven drying to dehydrate the salt in the pores of the aggregate.

The internal expansive force of the salt upon re-hydration simulates the expansive force of water during freezing.

3

# APPARATUS

- Sieves, conforming to M 92 (ASTM E 11)
- Containers for sample (out of spec sieves)
- Immersion container
- Balance (0.1% sample mass)

4

# APPARATUS

- Thermometer
- Temperature Recorder
- Oven, 230 /– 9 F (110 ± 5 °C), 25 g/hr for 4 hr (evap. rate)
- Sodium sulfate or magnesium sulfate solution

5

# SODIUM SULFATE

- Prepare solution
  - Dissolve salt of the anhydrous ($Na_2SO_4$) form in water (distilled for referee or comparison)
  - Stir as adding and frequently during storage
  - Cover
  - Allow to cool to 68.5 – 71.5 °F
  - Let stand for 48 hours before use
  - Specific Gravity of solution should be between 1.154 to 1.171

6

# MAGNESIUM SULFATE

- Prepare solution

  - Dissolve salt of the anhydrous ($MgSO_4$) in distilled water.
  - Stir while adding and frequently during storage.
  - Cover to prevent evaporation.
  - Allow solution to cool to between 68.5 – 71.5 °F
  - Let stand for 48 hours before use.
  - Specific Gravity when used should be 1.297 to 1.306

7

# TEST SPECIMENS

- Fine aggregate
  - Minus 3/8 in.
- Yield not less than 100 g of each of the following sizes

| Passing Sieve | Retained on Sieve |
|---|---|
| 9.5-mm (3/8 in.) | 4.75-mm (No. 4) |
| 4.75-mm (No. 4) | 2.36-mm (No. 8) |
| 2.36-mm (No. 8) | 1.18-mm (No. 16) |
| 1.18-mm (No. 16) | 600-mm (No. 30) |
| 600-mm (No. 30) | 300-mm (No. 50) |

8

# FINE AGGREGATE

9

- Coarse Aggregate
- Plus No. 4

# TEST SPECIMENS

| Sieve Size | Mass, g |
|---|---|
| 63 mm to 37.5 mm (2 1/2 in. to 1 1/2 in.) | 5000 +/- 300 |
| Consisting of: | |
| 50 mm to 37.5 mm (2 in. to 1 1/2 in. ) material | 2000 +/- 200 |
| 63 mm to 50 mm ( 2 1/2 in. to 2 in.) material | 3000 +/- 300 |

10

# SAMPLE COMPOSITION

- Should the sample contain less than 5 % of any of the sizes specified, that size shall not be tested.
- Reduce the test portion by the mass required of the missing size.

11

# SAMPLE PREPARATION

- Thoroughly wash fine aggregate (on No. 50 sieve) and coarse aggregate (on the #4).
- Dry to constant mass at 110 ± 5 ° C.
- Sieve & weigh out sample as per 6.1 for Fine Aggregate and 6.2 for Coarse Aggregate.

12

# PROCEDURE

- Immerse test sample in solution that is temperature controlled, with at least 1/2in cover of water, cover container.
- Volume of solution shall be at least 5 times the solid volume of sample.
- Sample immersed 17 ± 1 hours
- Temperature shall remain between 68.5 to 71.5 F
- Remove sample from solution and let drain for 15 ± 5 min.
- Temperature recorder should be used to verify that solution temperature limits were not exceeded. Temperature should be recorded temperature every 10 minutes.

13

# PROCEDURE

- Dry sample to constant weight at 110 ± 5 °C
- Cool sample to 20-25 °C (Solution Temp)

14

# PROCEDURE

- Repeat cycle (5 times) to complete test.
- If testing is interrupted, leave the sample in oven.
- After the final cycle and cooling, wash sample by circulating water at 43 ± 6 °C (110 ± 10 °F) through the sample in their containers from the bottom.
- Check for solution present in wash water with Barium Chloride Solution.

15

# PROCEDURE

- Care should be taken to not cause abrasion to the sample during washing
- Dry fraction to constant weight at 110 ± 5 °C

16

# QUANTITATIVE EXAMINATION

- Aggregate sieved over appropriate sieves
  - Fine–same method as preparation–same sieves used
  - Coarse–by hand–sieves per table, section 8.1.2

17

# QUANTITATIVE EXAMINATION

- Material retained on each sieve recorded
- Loss calculated on each sieve
- Total loss calculated by weighted average for fine & coarse

18

# QUALITATIVE EXAMINATION

- Separate particles into groups by action produced (+ 3/4 inch only)
- Record number of particles showing each type of distress
  - Disintegration, Splitting, Crumbling, Cracking, Flaking, Etc.

19

# QUESTIONS ??

20

# *STANDARD METHOD OF TEST FOR* CLAY LUMPS AND FRIABLE PARTICLES IN AGGREGATE

# AASHTO T – 112

1

## PURPOSE

- This method determines the approximate amount of clay lumps and friable particles in natural aggregates.
- This method is of primary significance in determining the acceptability of aggregate

2

# APPARATUS

- Balance, readable to 0.1% of sample mass
- Rust resistant containers
- Sieves, conforming to AASHTO M 92
- Oven

3

# TEST SPECIMENS

- Samples are obtained from material remaining from T11
- Dry sample to constant mass at 110 ± 5 °C (230 ± 9 °F)
- Test samples of fine aggregate shall consist of −4 and + 16 material and not weigh less than 25 g

4

# TEST SAMPLE

- Coarse aggregates are separated into different sizes using the following sieves
  - 4.75 mm (No. 4)
  - 9.5 mm (3/8 in.)
  - 19.0 mm (3/4 in.)
  - 37.5 mm (1-1/2 in.)

5

# TEST SAMPLE SIZE

| Size of Particles Making Up Test Sample | Test Sample Weight Minimum, g |
|---|---|
| 4.75 to 9.5-mm (No. 4 to 3/8 in.) | 1000 |
| 9.5 to 19.0-mm (3/8 to ¾ in.) | 2000 |
| 19.0 to 37.5-mm (3/4 to 1-1/2 in.) | 3000 |
| Over 37.5 mm (1-1/2 in.) | 5000 |

Note: If the original sample provides less than 5% of any of these sizes, do not test that size

6

# PROCEDURE

- Determine the mass of the test sample
- Spread the sample in a thin layer on bottom of container
- Cover with distilled water and soak for 24 ± 4 hours

7

# PROCEDURE

- Roll and squeeze particles individually.
- Fingernails not used to break up particles.

8

# PROCEDURE

- Break all discernable lumps and friable particles.
- Separate the undersized material by wet sieving.
  - pass water over the sample through the sieve
  - manually agitate the sieve

9

# SIZES OF SIEVES USED FOR WET SIEVING

| Size of Particles Making Up Test Sample | Size of Sieve |
|---|---|
| Fine Aggregate (retained on No. 16) | 850-mm (No. 20) |
| 4.75 to 9.5-mm (No. 4 to 3/8 in.) | 2.36-mm (No. 8) |
| 9.5 to 19.0-mm (3/8 to ¾ in.) | 4.75-mm (No. 4) |
| 19.0 to 37.5-mm (3/4 to 1-1/2 in.) | 4.75-mm (No. 4) |
| Over 37.5 mm (1-1/2 in.) | 4.75-mm (No. 4) |

10

## PROCEDURE

- Remove retained particles from sieve.
- Dry to constant weight at 110 ± 5 °C (230 ± 9 °F).
- Cool to room temperature and determine the retained material mass.

11

## CALCULATIONS

$$P = \frac{(W - R)}{W} x100$$

- Percent of clay lumps or friable particles correctly calculated

Where:
P = percent of clay lumps and friable particles
W = mass of test sample
R = mass of particles retained on sieve

12

QUESTIONS ??

13

# CP 37

PLASTIC FINES IN GRADED AGGREGATES
AND SOILS BY SAND EQUIVALENT TEST
(REPLACES AASHTO T – 176)

1

# Purpose

- To indicate the relative proportions in soil or graded aggregates of
  - *clay like materials*
  - *fine dust*

2

# Apparatus

- Mechanical Shaker
- Plastic graduated cylinders
- Weighted foot
- Siphon assembly
- 85 mL tin

3

# Apparatus

- 4.75-mm (No. 4) sieve
- Stock solution (22 ± 3° C/72 ± 5°F)
- Timer
- 4 inch Funnel

4

# Test Specimen Preparation

- T 2 (CP-30)
- T 248 (CP-32)
- Split on 4.75-mm sieve, use minus 4.75-mm material
- 1500 g truly representative sample of original sample.

5

# Procedure

- Dry sample to constant mass @ temp not to exceed 140 F.
- Weigh dried sample to the 0.1 g & mix with 3 +/- 1% moisture, cover for 45 +/- 15 min.
- Mix thoroughly & form into a conical pile.
- Fill three 85 ml tins by pushing them through the base of the pile while compacting with palm of the hand.
- Strike off excess material with spatula.
- Fill graduated cylinder to the 4.0 in. line with working stock solution

6

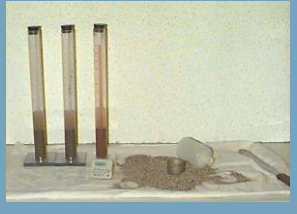
# Procedure

- Pour sample through a funnel into the cylinder.
- Strike the bottom of cylinder with the heel of hand to release air in material.


7

# Procedure

- Let stand undisturbed for 10 ± 1 min
  - [Note: three test samples are usually tested at the same time. See operator qualifications section]



8

# Procedure

- Place rubber stopper in top of cylinder
- Rotate the cylinder to horizontal position and shake vigorously
- Place cylinder into the mechanical shaker and set the timer for 45 +/- 1 sec.
- Set cylinder on work surface and remove stopper and irrigate with stock solution

9

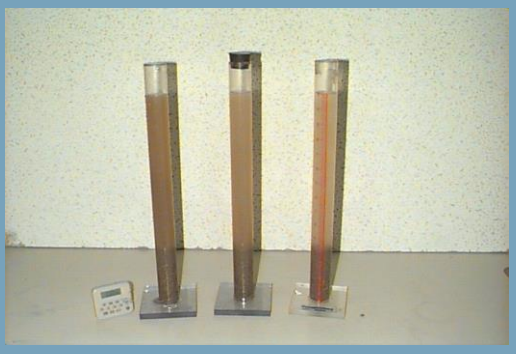
# Procedure

- Working solution should be placed on shelf 36 +/- 1" above working space.
- Working solution should be discarded if organic growth is present or 30 days after it has been prepared.
- Force the irrigator through the material to the bottom of the cylinder. Irrigate the sample until the stock solution reaches the 15 inch mark.
- Bottom of meniscus between the top two gradations, but not above the 15 in mark.

10

# Procedure

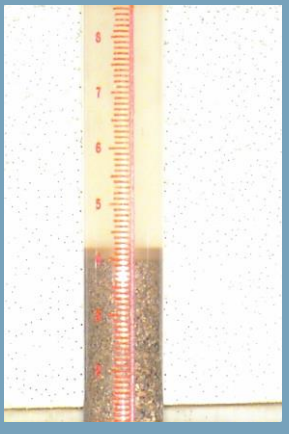
- Place the sample on a flat, level surface and let stand for 20 minutes ± 15 seconds



11

# Procedure

- Record the level at the top of the clay suspension (clay reading)



12

# Procedure

- If there is no clear line, allow the sample to stand undisturbed and record the total sedimentation time.
- If sedimentation time exceeds 30 min., rerun the test using 3 samples and record the sample reading with the shortest time only.

13

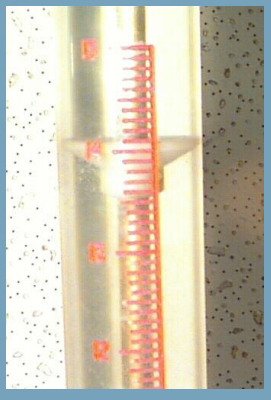
# Procedure

- Carefully lower the weighted foot assembly into the cylinder without hitting the sides
- Foot assembly = 1000 +/- 5g.

14

# Procedure

- When the foot rests on the top of the sample, tip the indicator to the side and the record the level (top edge of indicator)
- Subtract 10 from the reading to obtain the sand reading



15

# Calculations

- Always round up calculated values

$$SE = \left\langle \frac{sand}{clay} \right\rangle x100$$

Where:
SE = sand equivalency
sand = reading of sand level
clay = reading of clay level

16

# Results

- Average three readings (whole numbers)
- Round up the average
- All three results cannot vary by more than ± 4 points from the average

  (See Operator Qualifications section)

17

# Questions ??

18

# *STANDARD METHOD OF TEST FOR* UNCOMPACTED VOID CONTENT OF FINE AGGREGATE

# AASHTO T – 304

1

## PURPOSE

- To determine the un-compacted void content of a sample of fine aggregate.
- The un -compacted voids is an indication of the particle shape and texture of fine aggregates

2

## SUMMARY

- A sample of fine aggregate is poured through a funnel into a cylindrical measure and weighed.
- The bulk dry specific gravity of the aggregate is used to determine the volume of the fine aggregate.
- The void content is calculated from the difference between the cylindrical measure volume and the fine aggregate volume.

3

## APPARATUS

- Cylindrical measure, approximately 100 mL
- Funnel
- Funnel stand
- Balance, 0.1 g

4

## TEST SPECIMENS

- Aggregate sampled by CP-30 (T – 2).
- Material mixed and reduced by CP-32 (T-248).
- Material taken from that sieved by T-27.
- Determine the bulk dry specific gravity of the minus No. 4 material.

5

## CALIBRATION OF CYLINDRICAL MEASURE

- Apply a light coat of grease to the top of cylindrical measure.
- Determine the mass of the cylindrical measure, cover plate and grease.

6

# CALIBRATION OF CYLINDRICAL MEASURE

- Fill measure with freshly boiled deionized water at 21 ± 3 °C.
- Cover with cover plate, and completely dry the outside.
- Determine the mass of the plate, water, grease and cylindrical measure.

7

# CALCULATE THE VOLUME OF CYLINDRICAL MEASURE

$$V = 1000\left\langle \frac{M}{D} \right\rangle$$

- Where:
  V = volume of cylindrical measure, mL
  M = net mass of water, g
  D = density of water, g/mL (at 21.1 °C = 997.97 kg/m$^3$)

8

## PROCEDURE - METHOD A

- Dry sample to constant mass at 110 ± 5 °C.
- Separate the sample over a 4.75-mm sieve (No. 4)
- Wash the minus 4.75-mm material (No. 100 or No. 200).
- Dry sample to constant mass at 110 ± 5 °C

9

## PROCEDURE

- Sieve sample in accordance with T-27.
- Weigh out and combine the portions of fine aggregate from each of the following screens to produce a test specimen of **190 g**

10

## PROCEDURE

- Method A – Standard Graded Sample
- Method B – Individual Size Fractions
- Method C – As-Received Grading

11

## METHOD A
## STANDARD GRADED SAMPLE

| Individual Size Fraction | | Mass, g (±0.2) |
|---|---|---|
| Minus No 8 | Plus No. 16 | 44 |
| Minus No. 16 | Plus No. 30 | 57 |
| Minus No. 30 | Plus No. 50 | 72 |
| Minus No. 50 | Plus No. 100 | 17 |

12

# PROCEDURE

- Combine portions and mix with spatula until material is uniform

13

# PROCEDURE

- Place tared cylindrical measure under funnel
- Use a finger to block the funnel opening
- Pour the test sample into the funnel and level the material

14

# PROCEDURE

- Remove the finger and allow the sample to fall freely into the measure

15

# PROCEDURE

- After the funnel has emptied, strike off excess heaped fine aggregate by a single pass of the spatula, holding the spatula at a 90 degree angle.

16

# PROCEDURE

- Exercise care to avoid vibration or any disturbance that could cause compaction of the fine aggregate in the cylindrical measure.
- Brush adhering fines from the outside of the container.

17

# PROCEDURE

- Determine the mass of the cylindrical measure and contents to the nearest 0.1 g

18

## PROCEDURE

- Retain all fine aggregate particles for a second test run.
- Recombine the sample from the retaining pan and cylindrical measure and repeat the procedure.
- Average the results of the two runs.

19

## PROCEDURE

- The results of two properly conducted tests by the same operator on similar samples should not differ by more than 0.37 percent (~0.5 g)
- Colorado = Minimum 45%

20

# CALCULATIONS

$$U = \left\langle \frac{V - \frac{F}{G}}{V} \right\rangle x100$$

- Where:

V = volume of cylindrical measure (mL)

F = mass of fine aggregate

G = $G_{sb}$ of fine aggregate

U = percent of un-compacted voids

21

# *Standard Method of Test for* Determining Percent of Particles with Two or More Fractured Faces

## CDOT CP – 45

1

## Purpose

- This method describes the procedure for determining the percentage of crushed particles in a sample of aggregate by fractured face count.
- *Grading S & SX Minimum 60% (70% over 10 million ESALs)
- *Grading SG Minimum 90%
- *SMA Minimum 100%

2

# Apparatus

- Balance
- 4.75-mm (No. 4) sieve
- Splitter
- Drying equipment

3

# Test Specimens

- Sample shall be obtained in accordance with CP-30 and CP-32.
- Split material on 4.75-mm sieve.
- Discard minus 4.75-mm material.
- Wash plus 4.75-mm material, dry to constant mass at 110 ± 5 °C (230 ± 9 °F).

4

# Test Specimens

- Sieve material on 4.75-mm sieve.
- Determine mass of plus 4.75-mm material.

5

# Procedure

- Particles separated into piles with two or more fractured faces.
- A particle is counted if it appears to have at least 25 % of the maximum cross sectional area of the rock particle fractured.
- Determine the mass of particles with two or more fractured faces.

7

# Calculations

- Calculate percent of particles with two or more fractured faces

$$A\% = \left\langle \frac{B}{C} \right\rangle x100$$

Where:
A = particles with two or more fractured faces, %
B = weight of fractured aggregate, g
C = total weight of test specimen, g

8

# Questions ??

9

# *Standard Method of Test* for Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate

ASTM 4791

1

## Purpose

- This method covers the determination of the percent of flat particles, elongated particles, or flat and elongated particles in coarse aggregate

2

# Apparatus

- Proportional Caliper Device
- Balance

3

# Test Specimens

- Test samples taken in accordance with CP-30
- Test samples reduced in accordance with CP 32
- Sample dried to constant mass at 110 ± 5 °C (only for determination by weight, not count)

4

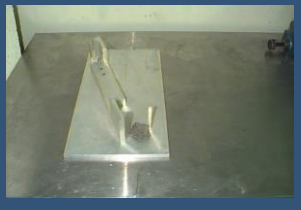
# Procedure

- Test each particle in each size fraction, and place into one of three piles
- Flat
- Elongated
- Neither flat or elongated
- Use the proportional device positioned at the proper ratio (3:1 or 5:1)

6

# Procedure – Flat

- Set the larger opening equal to the particle *width.*
- The particle is flat if the *thickness* can be placed in the smaller opening



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# Procedure – Elongated

- Set the larger opening equal to the particle *length.*
- The particle is elongated if the *width* can be placed in the smaller opening

8

# Calculations

- After the particles have been separated into one of the three piles, determine the proportion of the sample in each group by count or mass.

9

# Procedure – Flat and Elongated

- Test each of the particles in each size fraction and place into one of two groups.
- Flat and elongated.
- Not flat and elongated.

10

# Procedure – F and E

- Use the proportional caliper device set at the desired ratio
- Set the larger opening to the particle *length*

11

# Procedure – F and E

- The particle is flat and elongated if the *thickness* can be placed in the smaller opening.
- After the particles have been separated, determine the proportion of the sample in each group by count or by mass

12

# Questions ???

13