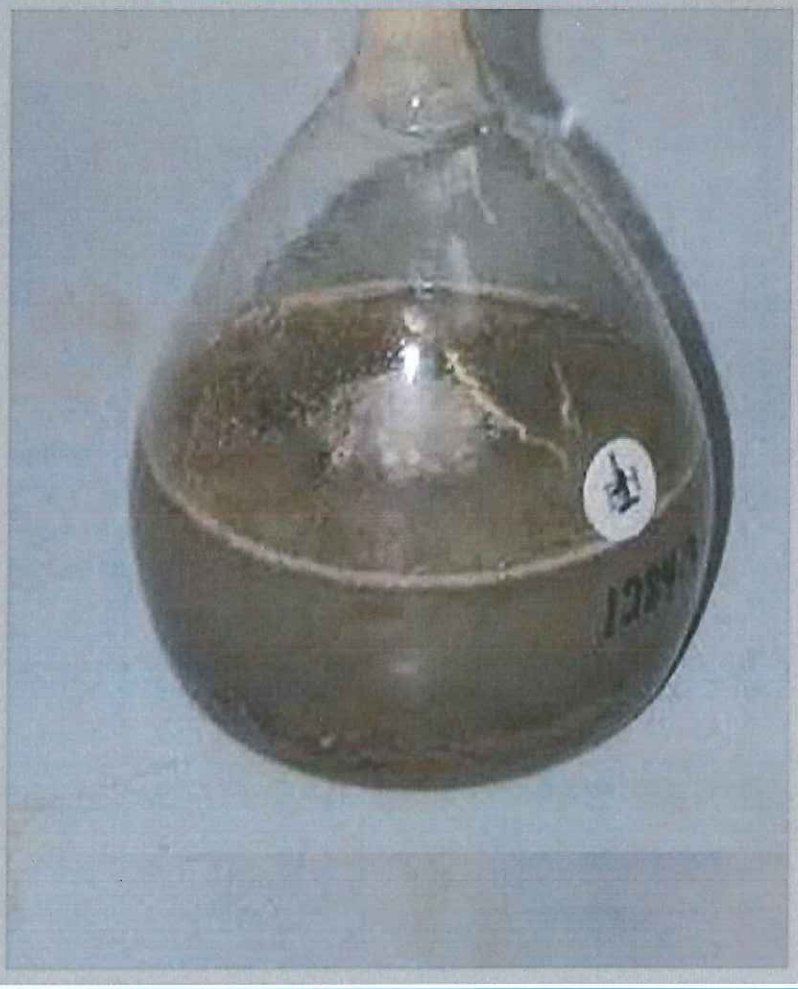
2019 Edition

AGGREGATE SPECIFIC GRAVITY



COURSE CONTENT

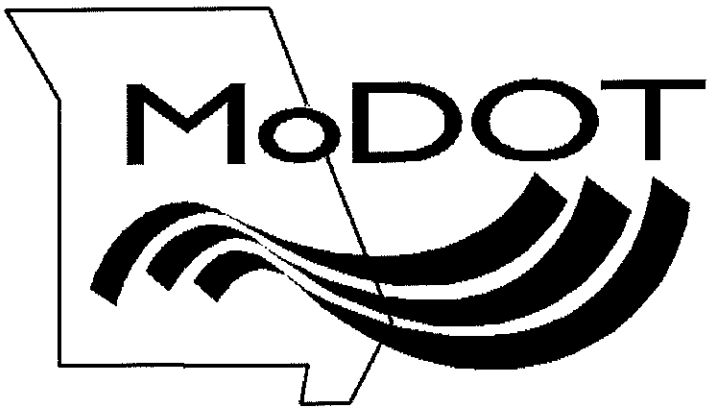
Aggregate Specific Gravity

AASHTO	T 84	Specific Gravity and Absorption of Fine Aggregate
AASHTO	T 85	Specific Gravity and Absorption of Coarse Aggregate
MoDOT	TM 81	Specific Gravity & Absorption of Aggregate Using Automatic Vacuum Sealing Method (Informational Only)
Appendix		
Glossary		Glossary of Terms

AASHTO T84

Specific Gravity and

Absorption
of
Fine Aggregate



AASHTO T 84

Specific Gravity
And
Absorption of Fine Aggregate

Rev 12/11/2018

Scope

- This method covers the determination of bulk, and apparent specific gravity, 74.4°F (23°C), and absorption of fine aggregate.
- This method determines (after 15-19 hour of soaking in water) the bulk specific gravity and the apparent specific gravity, the bulk specific gravity on the basis of mass of saturated surface-dry (SSD) aggregate, and the absorption.

Significance and Use

- Bulk specific gravity is the characteristic generally used for calculation of the volume occupied by the aggregate in various mixtures containing aggregate including Portland cement concrete, bituminous concrete, and other mixtures that are proportioned or analyzed on an absolute volume basis.

Significance and Use

- Bulk specific gravity is also used in the computation of voids in aggregate in AASHTO T19M/T19.
- Bulk specific gravity determined on the SSD (Saturated Surface Dry) basis is used if the aggregate is wet; that is, if its absorption has been satisfied.
- Apparent specific gravity pertains to the relative density of the solid material making up the primary particles not including the pore space within the particles that is accessible to water. This value is not widely used in construction aggregate technology.

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Significance and Use

- Absorption values are used to calculate the change in the mass of an aggregate due to water absorbed in the pore spaces within the particles, compared to the dry condition, when it is deemed that the aggregate has been in contact with water long enough to satisfy most of the absorption potential. The laboratory standard for absorption is that obtained after soaking dry aggregate in water.

5

Test Equipment

- Balance readable to 0.1 grams
- 500 ml Pycnometer (flask)
- Conical mold
- Tamper
- Oven capable of 230 ± 9°F (110 ± 5°C)
- No. 4 Sieve

6

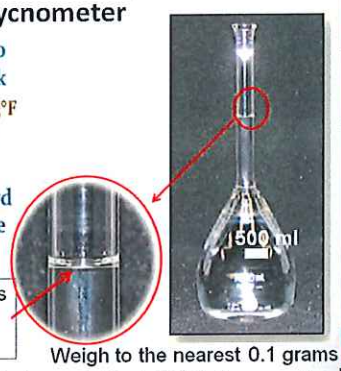
Sample Preparation

- Obtain a representative field sample, using AASHTO R90.
- Mix and reduce, using AASHTO R76.
- Sieve over a **#4 sieve**, collect approximately **1,000 grams of minus #4** material.
- Dry the minus #4 material in a pan to a constant weight at **230 ± 9°F (110 ± 5°C).**
- Allow the sample to cool to comfortable handling temperature.
- Cover with water for **15-19 hours**.
  - (or add at least 6%moisture)

7

Calibrate the Pycnometer

- Fill with water to calibration mark
  - Water @ 73.4 ± 3°F
- Read bottom of meniscus
- Weigh and record the weight of the "Pyc + Water"



Bottom of Meniscus touches the line for full capacity.

Weigh to the nearest 0.1 grams
And record this is "**B**" in the equation.

Sample Preparation

8

After calibrating the pycnometer, Partially fill with water.

Set this aside with a funnel on the counter ready to receive the SSD sample.

Another option is to place the pycnometer with funnel and Water on the scale and zero out the scale.

Sample Preparation

9

Back to the sample:

- After the 15-19 hour soak, decant excess water from the sample with care to avoid loss of fines.
- Spread sample on a flat, nonabsorbent surface.
- Uniformly dry the sample with a gentle current of warm air, stir frequently.

Sample Preparation

10

- It may be necessary to work the sample with the hands in a rubbing motion to break up any lumps that develop.
- Continue this operation until the sample approaches a free-flowing condition.

Sample Preparation

11

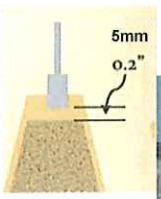
Procedure

- **Cone Test:**
- Place the mold on a flat, nonabsorbent surface, with the large diameter down.
- Fill the mold to overflowing.

12

Procedure

- Tamp 25 times with **5mm** drops (0.2 in).
- Tamper allowed to fall freely under gravitational attraction.



13

Procedure

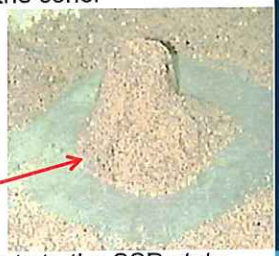
- Remove the material from around the base and mold, then lift cone vertically.

A good first trial = Retains the shape of the cone!

14

Procedure

- The first trial of cone testing must be made with some surface water in the sample and retain the shape of the cone.
- Continue drying and doing cone tests until the sample slumps slightly = SSD condition.



- The closer testing gets to the SSD state, increase the number of cone tests.

15

Procedure

- If the sample slumps on the first cone test this indicates that the sample had been dried past the SSD (saturated surface-dry) condition.

What to do. . .

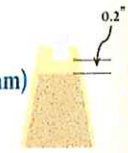
- **Mix in a few milliliters of water**
- **Cover**
- **Let stand for 30 minutes.**

16

Procedure

Cone Test Summary

- Fill cone to overflowing
- Tamp 25 times from a height of 0.2" (5mm)
- Clean aggregate from base of cone
- Lift cone vertically



Wet	Dry	SSD
Aggregate Maintains Shape	NO Shape	Aggregate Slumps Slightly

17

Procedure

After the SSD condition is reached:

- Immediately weigh 500 ± 10 grams of SSD material and add it to the pycnometer.

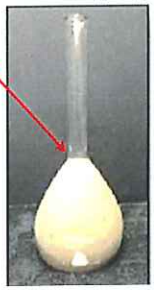
Record the SSD weight to the nearest **0.1g**, this is "**S**" in the equation.

18

Procedure

Fill Pycnometer with additional Water to approximately 90% capacity.

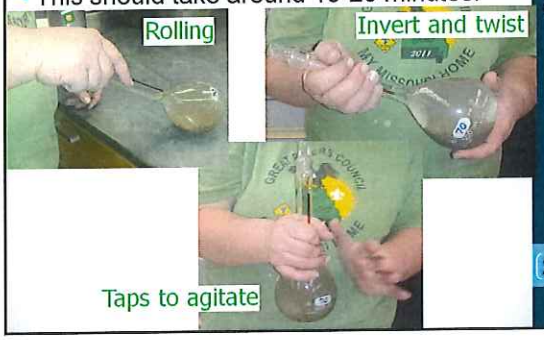
Usually 90% is just into or slightly below the neck of the flask.



19

Procedure

- Roll, invert, and agitate the pycnometer to remove all the air bubbles.
- This should take around 15-20 minutes.



20

Procedure

- Adjust the water level in the pycnometer to its calibrated capacity.
- A paper towel or isopropyl alcohol can be used to disperse foam on the water surface.
- Place the pycnometer in a bath 73.4 ± 3°F (23.0 ± 1.7°C).
- After 30-45 minutes check the water inside the pycnometer with a thermometer to verify that the temperature is at 73.4 ± 3°F (23.0 ± 1.7°C). If at temperature move on to the next step. Otherwise give it more time in the bath and check again later.

21

- Determine total mass of the pycnometer, sample, and water. Weigh to 0.1 gram = "**C**" in the equation.
- Remove the sample from pycnometer into a small pre-weighed pan.
- Weigh to the nearest 0.1 grams.
- Dry sample to constant weight at 230 ± 9° (110 ± 5°C).
- Cool sample in air at room temperature for 1.0 ± 0.5 hour(s), weigh the dry sample to the nearest 0.1g. Report as "A" in the equation.
- **All weights determined to 0.1 gram.**

Procedure

22

Calculations

Bulk Specific Gravity

$$Bulk\ Specific\ Gravity = \frac{A}{(B + S - C)}$$

A = mass of oven-dry sample in air (g)
B = mass of pycnometer filled with water (g)
S = mass of saturated surface-dry sample (g)
C = mass of pycnometer with sample and water to calibrated mark (g)

Calculations

23

Bulk Specific Gravity (SSD) -

- **S**aturated **S**urface **D**ry Basis

$$SSD = \frac{S}{(B + S - C)}$$

S = mass of the saturated surface-dry sample (g)
B = mass of pycnometer filled with water (g)
C = mass of pycnometer with sample and water to calibration mark (g)

Calculations

24

Calculations

- **Apparent Specific Gravity**

$$App\ Sp.\ Gr. = \frac{A}{(B + A - C)}$$

A = mass of oven dry sample in air
B = mass of pycnometer filled with water
C = mass of pycnometer with sample and water to the calibration mark

25

Calculations

Absorption percent -

$$Abs.\% = \left[\frac{(S - A)}{A}\right] x100$$

A = mass of oven dry sample in air
B = mass of pycnometer filled with water
S = mass of the saturated surface dry sample
C = mass of pycnometer with sample and water to the calibration mark

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Reporting

- Report the Specific Gravities
  - to the hundredth, **0.01**, for **1005** Concrete
  - to the thousandth, **0.001**, for **1002** Asphalt
- Report the Absorption to the tenth, **0.1**
- Alternative: For, naturally moist condition report the source of the sample and the procedures used to prevent drying prior to testing.

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Reporting for AASHTO M6:

For AASHTO **M6:** Fine aggregate for Hydraulic Cement Concrete.

Report specific gravity results to the nearest 0.01 and absorption to the nearest 0.1%.

Reporting

28

Notes:

T84 for Aggregate Maintained in A Naturally Moist Condition

- As an alternative, where the absorption and specific gravity values are to be used in their naturally moist condition, the requirement for initial drying to constant mass may be eliminated and, if the surfaces of the particles have been kept wet, the required soaking may also be eliminated.

Sample Preparation

29

Notes:

- **Definitions:** Are in the glossary.
- **Tests for materials that do not readily slump:**
  1. Provisional Cone Test
  2. Provisional Surface Test
  3. Colorimetric procedures
  4. SSD on single-size material

See the appendix for more information

Special Notes

30

Practice Calculations

Asphalt (1002) Sample		
499.9 g	Mass of oven-dry sample in air	A
683.7g	Mass of pycnometer filled with water	B
503.3g	Mass of saturated-surface-dry sample	S
990.1g	Mass of pyc., water, and sample	C

Using the information above, Find;

- Bulk Specific Gravity,
- SSD,
- Apparent Specific Gravity,
- Absorption Percent.

Use regular rounding.

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Answers:

This slide is enlarged

ASPHALT SAMPLE

Bulk Sp. Gr. (O.D. basis) = $\frac{A}{B+S-C}$ = $\frac{(\ 499.9\ )}{(\ 683.7\ )+(\ 503.3\ )-(\ 990.1\ )}$ = 2.539 / 2.538552

Bulk Sp. Gr. (SSD basis) = $\frac{S}{B+S-C}$ = $\frac{(\ 503.3\ )}{(\ 683.7\ )+(\ 503.3\ )-(\ 990.1\ )}$ = 2.556 / 2.556120

Apparent Sp. Gr. = $\frac{A}{B+A-C}$ = $\frac{(\ 499.9\ )}{(\ 683.7\ )+(\ 499.9\ )-(\ 990.1\ )}$ = 2.583 / 2.583463

Absorption, percent = $\frac{S-A}{A} \times 100$ = $\frac{(\ 503.3\ )-(\ 499.9\ )}{(\ 499.9\ )} \times 100$ = 0.7 % / 0.680136

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ASG Enlarged slide for T84

EXAMPLE OF CALCULATIONS FOR FINE SPECIFIC GRAVITY

ASPHALT SAMPLE

Bulk Sp. Gr. (O.D. basis) $= \dfrac{A}{B + S - C}$

$\dfrac{(\ 499.9\ )}{(\ 683.7\ ) + (\ 503.3\ ) - (\ 990.1\ )} = \dfrac{2.539}{2.538852}$

Where: **A** = mass of oven-dry sample in air, g.
B = mass of pycnometer filled with water, g.
C = mass of pycnometer with sample and water to calibration mark, g.
S = mass of saturated-surface-dry sample, g.

499.9
683.7
990.1
503.3

Bulk Sp. Gr. (SSD basis) = $= \dfrac{S}{B + S - C}$

$\dfrac{(\ 503.3\ )}{(\ 683.7\ ) + (\ 503.3\ ) - (\ 990.1\ )} = \dfrac{2.556}{2.556120}$

Apparent Sp. Gr. $= \dfrac{A}{B + A - C}$

$\dfrac{(\ 499.9\ )}{(\ 683.7\ ) + (\ 499.9\ ) - (\ 990.1\ )} = \dfrac{2.583}{2.583463}$

Absorption, percent $= \dfrac{S - A}{A} \times 100$

$\dfrac{(\ 503.3\ ) - (\ 499.9\ )}{(\ 499.9\ )} \times 100 = \dfrac{0.7}{0.680136}\ \%$

AASHTO T 84: Specific Gravity for Fine Aggregate (rev 06/04/2018)
PROFICIENCY CHECKLIST

Applicant: _____

Employer: _____

Trial #	1	2
Sample Preparation		
1. Sample obtained by AASHTO R90		
2 Mix and Reduce by using AASHTO R76		
3. Sieved over #4 sieve , keep minus 4 material (approximately 1,000 g)		
4. Dried to constant mass at 230 ± 9°F (110 ± 5°C) **Note:** Oven drying not necessary if naturally moist condition is desired **Note:** See Provisional Tests 1-4 for materials that do not readily slump found in appendix		
5. Sample is covered with water, allowed to stand 15-19 hours		
6. Pycnometer calibrated at 73.4 ± 3°F record this weight to nearest 0.1g (This is "**B**" in the equation)		
7. Pycnometer partially filled with water		
8. After 15-19hrs, decant the excess water off the sample without loss of fines		
STEPS 9-15 is the CONE TEST		
9. Sample spread on a flat nonabsorbent surface		
10. Sample uniformly dried by current of warm air		
11. Mold placed on flat nonabsorbent surface and filled to overflowing		
12. Tamped 25 times with 5 mm drop, and allowed to fall freely		
13. Loose sand removed from around base and mold lifted vertically		
14. Sample should retain the shape of the cone on first trial. If slumps on the first trial, water added, sample covered and allowed to stand for 30min....then back to cone testing.		
15. Drying continued and slump test repeated at frequent intervals until sample slumps slightly = SSD Condition		
16. Immediately weighed 500±10g of the SSD sample to the partially filled pycnometer. (Report the mass to nearest 0.01 this is "**S**" in the equation)		
17. Pycnometer filled to 90% of total capacity and agitated to eliminate air bubbles. **Note:** Paper towel or isopropyl alcohol may be used to disperse foam on the water surface		
18. Pycnometer filled with water to the calibrated capacity line.		
19. When temperature of contents reach 73.4 ± 3°F (23.0 ± 1.7°C), towel dried the outside of the pycnometer and determined the total mass of the pycnometer, sample, and water to the nearest 0.1g (Report this as "**C**" in the equation)		
20. Sample removed from the pycnometer, placed in a pre-weighed pan and dried to constant mass at 230 ± 9°F (110 ± 5°C)		
21. Sample cooled in air at room temperature for 1.0 ± 0.5 hr. and dry mass determined to the nearest 0.1g, this is "**A**" in the equation.		
22. Calculations completed as needed: **Report:** Specific Gravity for Asphalt (1002) to the nearest: **0.001** Specific Gravity for Concrete (1005) and M6 to the nearest: **0.01** And Absorptions Report to the nearest: **0.1%**		
	PASS	PASS
	FAIL	FAIL

Examiner: _____ Date: _____

AASHTO T85

Specific Gravity and

Absorption
of
COARSE Aggregate

AASHTO T85

Specific Gravity and Absorption of Coarse Aggregate

- Types of specific gravities and absorption
  - Apparent (Gsa)
  - Bulk (Gsb)
  - Bulk SSD (Gsb_{ssd})
  - % Absorption (Abs)

Gsb

stone bulk

Rev 12/11/2018

Scope

- This method covers the determination of specific gravity and absorption of coarse aggregate.
- The specific gravity may be expressed as bulk specific gravity, bulk specific gravity (saturated surface-dry (SSD)), or apparent specific gravity.
- The bulk specific gravity (SSD) and absorption are based on aggregate after 15-19 hours of soaking in water.
- This method is not intended to be used with lightweight aggregates.
- NOTE: Definitions are in the glossary.

2

Significance and Use

- **Bulk specific gravity** is the characteristic generally used for calculation of the volume occupied by the aggregate in various mixtures containing aggregate, including portland cement concrete, bituminous concrete, and other mixtures that are proportioned or analyzed on an absolute volume basis.

3

Significance and Use

- Apparent specific gravity pertains to the relative density of the solid material making up the constituent particles not including the pore space within the particles that is accessible to water.
- Absorption values are used to calculate the change in the mass of an aggregate due to water absorbed in the pore spaces within the constituent particles, compared to the dry condition, when it is deemed that the aggregate has been in contact with water long enough to satisfy most of the absorption potential.

4

Test Equipment

- Scale M231, Class G5
- Sieves #4 or #8
- Basket mesh [No.6 or (No.10 or smaller)]
- Towels
- Oven capable of maintaining 230 ± 9°F (110 ± 5°C)
- Water Tank - Watertight with an overflow outlet for maintaining a constant water level.
- Suspended Apparatus - A wire of smallest practical size.

5

Sample Size – Chart A

Nominal Maximum Size	Minimum Mass of Sample needed For testing
½" (12.5mm) or less	2000 grams
¾" (19.0mm)	3000 grams
1" (25.0mm)	4000 grams
1 ½" (37.5mm)	5000 grams

6

Sample Preparation

- Obtain a representative field sample using AASHTO R90
- Mix and reduce the sample using AASHTO R76 and Chart A
- Dry sieve over a No. 4 or No.8 sieve as indicated by specification.

NOTE: If the coarse aggregate contains a large quantity of material finer than the #4 sieve use the #8 sieve in place of the #4 sieve.

After separation, test per AASHTO T84 for fine aggregate.

7

- Reject all material passing the #4 sieve.
- Keep all the retained #4 material. (+4)
- Wash the +4 aggregate to remove dust or other coatings
- Dry the +4 material to a constant mass at 230 ± 9°F (110 ± 5°C).
- Cool sample at room temperature for 1-3 hours. (it should be comfortable to handle (~ 50° C).
- Place the sample in a plastic container.

8

- Cover the sample with water for 15-19 hours.

9

Prepare the water bath:

- Overflow the water outlet.

Adjust the temperature to:
73.4 ± °F (23.0 ± 1.7°C)

10

- Remove Sample from water onto a large absorbent cloth.

- Dry the aggregate surfaces with an absorbent towel until all visible surface water is gone.
- Wipe the larger particles individually.

11

- Throughout the procedure, avoid evaporation of water from the aggregate pores
- Tare the scale
- Weigh the sample = Saturated Surface Dry (SSD) mass. (this weight is "**B**" in the calculations)
- Determine weight to the nearest 1gram or 0.1%

12

- Immediately place sample in the wire basket.
- Shake the basket wile immersed to remove entrapped air.
- Weigh the sample in water to the nearest **1g**.

(This weight is "**C**" in the calculations).

13

- Place the sample in a pan for the oven.
  - Remove all particles from the basket
- Dry to a constant weight at 230 ± 9°F (110 ± 5°C).
- Cool sample for 1-3 hours or when comfortably handle (~ 50° C).
- Determine the dry mass
  - Record to the nearest 1g,
  - use this as "**A**" in the calculations.

14

Calculations

$$Bulk\ Specific\ Gravity = \frac{A}{(B-C)}$$

- Mass of Dry Sample (**A**) =_____
- Mass Surface Dry Sample (**B**) =_____
- Mass of Sample in Water (**C**) = _____

15

Calculations

$$Apparent\ Specific\ Gravity = \frac{A}{(A-C)}$$

- Mass of Dry Sample (**A**) =_____
- Mass Surface Dry Sample (**B**) =_____
- Mass of Sample in Water (**C**) = _____

16

Calculations

$$SSD\ Specific\ Gravity = \frac{B}{(B-C)}$$

- Mass of Dry Sample (**A**) =_____
- Mass Surface Dry Sample (**B**) =_____
- Mass of Sample in Water (**C**) = _____

17

Calculations

$$Absorption\ Percent = \frac{(B-A)}{A} x100$$

- Mass of Dry Sample (**A**) =_____
- Mass Surface Dry Sample (**B**) =_____
- Mass of Sample in Water (**C**) = _____

18

Reporting

- Report the Specific Gravities
  - 0.01, for **1005 (Concrete)**
  - 0.01 for **M80 (Hydraulic Cement Concrete)**
  - 0.001, for **1002 (Asphalt).**
- Report the Absorption to the tenth, **0.1**
- ***Use regular rounding***

Note: If the specific gravity and absorption values were tested in an as received condition, note this in the report.

19

- **NOTE:** Where the absorption and specific gravity values are to be used in proportioning concrete mixtures in which the aggregates will be in their **naturally moist condition**, the requirement for initial drying to constant mass may be eliminated, and, if the surfaces of the particles in the sample have been kept continuously wet until test, the required soaking may also be eliminated.

20

AASHTO T 85: Specific Gravity and Absorption
Of
Coarse Aggregate

PROFICIENCY CHECKLIST

Applicant: _____

Employer: _____

Trial#	1	2
Procedure		
1. Sample obtained by ASHTO R90, and Reduced per AASHTO R76		
2. Screened on No. 4 sieve (4.75mm) or No. 8 (2.36mm) sieve		
3. Sample mass as follows: ½ in. or less – 2 kg; ¾ in. – 3 kg; 1 in. – 4 kg; 1 ½ in. – 5kg		
4. Washed to clean surfaces of particles		
5. Dried to constant mass at 230 ± 9°F (110 ± 5°C) and cooled to room temperature for 1 to 3 hours (for up to 1 ½ in. nominal maximum size, longer for larger sizes)		
6. Covered with water for 15 to 19 hours		
7. Prepared bath, overflowed the water for level, and adjusted temperature to 73.4 ± 3°F (23.0 ± 1.7°C)		
8. Rolled in cloth to remove visible films of water		
9. Larger particles wiped individually		
10. Evaporation avoided		
11.Weigh the SSD sample and Record all masses determined to the nearest 1g or 0.1% of sample mass.		
12.Sample immediately placed in the wire basket		
13. Entrapped air removed before weighing by shaking the wire basket while immersed.		
14. Mass determined in water at 73.4 ± 3°F (23.0 ± 1.7°C)		
15.Dried to constant mass at 230 ± 9°F (110 ± 5°C) and cooled to room temperature for 1 to 3 hours [or until aggregate has cooled to comfortable handling temperature, approximately 122°F (50°C)]		
16.Weigh the dry sample and record the mass		
17.Calculated the Bulk Specific Gravity and Absorption **Report:** Specific Gravity for Asphalt (1002) to the nearest: **0.001** Concrete (1005) and M80 to the nearest: **0.01** And Absorption to the nearest: **0.1%**		
	PASS	PASS
	FAIL	FAIL

Examiner: _____ Date: _____

MoDOT TM-81

"Core-Lok"

MoDOT TM – 81
"CoreLok"

Specific Gravity and Absorption of Aggregate Using Automatic Vacuum Sealing Method

1

Summary of Method

- The known volume of the vessel with water only, mass of dry aggregate and mass of sample in vessel with water, are used to calculate the **bulk** specific gravity oven dry (OD)
- The dry mass and submerged mass are used to calculate **apparent** specific gravity

2

Summary of Method

- Dry aggregate to a constant mass
- For each test-
  - Two representative samples of the same material tested (Bulk Specific Gravity)
  - One sample is vacuum saturated and weighed under water (Apparent Specific Gravity)
- The sample is weighed in water in a vessel of known volume

3

Summary of Method

- The results from the two (bulk and apparent) are then used to calculate absorption and bulk specific gravity saturated surface dry (SSD)
- This test can be used for rapid determination of aggregate properties in construction testing laboratories

4

Equipment

- Balance – readable to 0.1%
- Water Bath – 24 x 18 x 18in. Min., capable of maintaining water temperature of 25±1°C (77±2° F)

5

Equipment

- Sample holder for water displacement
- Vacuum Chamber – for placing aggregate in vacuum and sealing in a bag in one operation

6

Equipment

- A Vacuum Measurement Gauge – independent of the vacuum sealing device, capable of reading down to 3mm Hg ± 1 mm Hg
- Plastic bags - two sizes are required with minimums specified for dimensions, opening and thickness

7

Equipment

- Pycnometer – two sizes, the smaller equipped with fixture to hold the lid in place during test

8

Equipment

- Accessories – timer, knife or scissors, spray bottle of isopropyl alcohol, bucket, syringe, small paint brush
- Rubber sheets

9

Verification & Calibration

- Verify the vacuum system annually, when relocated or after major repairs
- Calibrate pycnometer daily – calibration is achieved by repeating the procedure until three masses are within
  - 0.5 gram for fine aggregates (small pyc)
  - 1 gram for course aggregates (large pyc)

10

Verification & Calibration

- Condition the pycnometer by submerging in water maintained at 25 ± 1°C.

11

Verification & Calibration

- Fill pycnometer with water and weigh in the same manner as you will with a sample.
  - Small pycnometer is weighed using the clamping device.

12

Sampling

- Sample in accordance with AASHTO T 2
- For fine aggregate, thoroughly mix sample and reduce it to one sample, 1000 ± 10 grams for the apparent SpGr, and two samples, 500 ± 3 grams for the bulk SpGr.
  - Use AASHTO T 248 to reduce material.

13

Sampling

- For Coarse or Combined aggregates, thoroughly mix sample and reduce it to one sample, 2000 ± 10 grams for the apparent SpGr, and two samples, 1000 ± 10 grams for the bulk SpGr.
  - Use AASHTO T 248 to reduce material.
- When coarse aggregates of large size are encountered, it may be easier to perform the test using two or more sub-samples.

14

Test Procedure
Bulk Specific Gravity

- Dry samples to a constant mass.
- Allow to cool to room temperature.
- Weigh a 1000 ± 10 grams sample and record.

15

Test Procedure
Bulk Specific Gravity

- Fill the conditioned pycnometer half full with water at test temperature (25 ± 1°C)

16

Test Procedure

Bulk Specific Gravity

The following steps shall be completed in less than 2 min.

- Slowly and evenly pour the sample into the pycnometer, ensuring that no material is lost in the process

17

Test Procedure

Bulk Specific Gravity

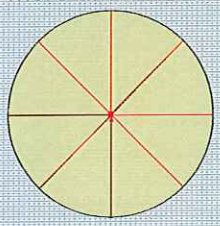
- Insert a metal spatula along the inside of the pycnometer until it reaches the bottom.

18

Test Procedure

Bulk Specific Gravity

- Slowly drag the spatula to the center
- Repeat 7 more times moving 45° along the wall



19

Test Procedure

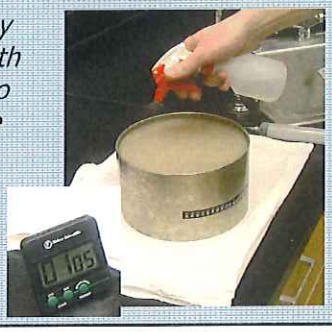
Bulk Specific Gravity

- Top off water level to just below (10mm) the lip.
  - If water spills during lid placement, test is void and must be repeated.

20

Test Procedure
Bulk Specific Gravity

- *Use spray bottle with alcohol to eliminate bubbles*



21

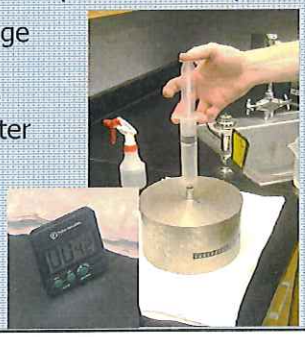
Test Procedure
Bulk Specific Gravity

- *Place lid on pycnometer.*

22

Test Procedure
Bulk Specific Gravity

- Use syringe to finish filling the pycnometer



23

Test Procedure
Bulk Specific Gravity

- For fine aggregates, the clamping device must be installed prior to injection

24

Test Procedure
Bulk Specific Gravity

- Fill pycnometer until water just comes out of hole on the surface of the lid.

25

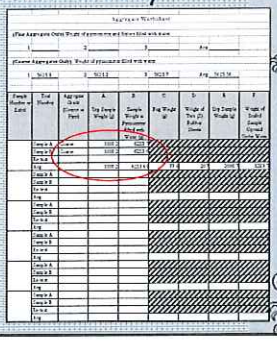
Test Procedure
Bulk Specific Gravity

- Dry water from around hole on surface
- **"Times up!"**
- Place pycnometer on scale
- Record mass

26

Test Procedure
Bulk Specific Gravity

- Repeat procedure for a second sample.
- Record average



Test Procedure
Apparent Specific Gravity

- Set vacuum device according to manufactures recommendation

28

Test Procedure
Apparent Specific Gravity

- Before using, check condition of plastic bags, discard if flaw is discovered
- Weigh both bags and record

29

Test Procedure
Apparent Specific Gravity

- Weigh rubber sheets
- Record

30

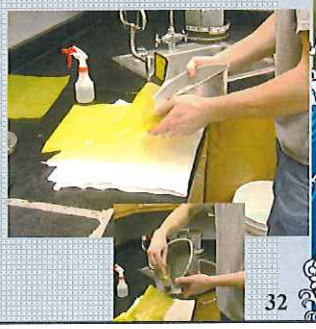
Test Procedure
Apparent Specific Gravity

- Weigh 2000 ± 10 grams of aggregate
- Record

31

Test Procedure
Apparent Specific Gravity

- Place sample in small bag
  - Use caution to prevent damaging the bag



32

Test Procedure
Apparent Specific Gravity

- Place large bag into vacuum chamber

33

Test Procedure
Apparent Specific Gravity

- Place first rubber sheet into large bag
- Push all the way to the back of the large bag

34

Test Procedure
Apparent Specific Gravity

- Place the small bag containing the sample into the large bag
- Center it on top of the rubber sheet

35

Test Procedure
Apparent Specific Gravity

- Manually spread the sample inside the small bag
  - Lightly spray mist samples that contain high amounts of minus No. 200 material

36

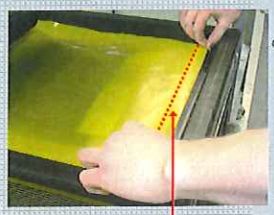
Test Procedure
Apparent Specific Gravity

- Place the second rubber sheet on top of the small bag

37

Test Procedure
Apparent Specific Gravity

- Place the open end of the large external bag over the seal bar
  - Bag should extend over the bar a minimum of ½"



Ensure that rubber pads are *not* over seal bar

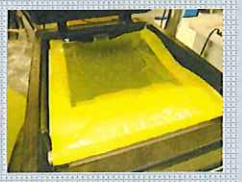
38

Test Procedure
Apparent Specific Gravity

- With bag assembly in the proper position, close lid of vacuum device
- Machine will begin vacuum cycle & bag seal automatically

39

Test Procedure
Apparent Specific Gravity

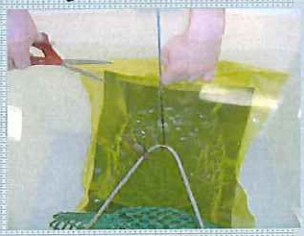


- After vacuum cycle is finished, chamber will open automatically
- Remove sample pack and immediately submerge in water

40

Test Procedure
Apparent Specific Gravity

- While keeping completely submerged, cut one corner of the bag 3-4" to allow water into the bag
  - Note: make slit in bag large enough to get your hand into the bag



41

Test Procedure
Apparent Specific Gravity

- Open the cut portion with your hand to allow water to flow freely into the bag (25 seconds)
- Allow any small air bubbles to escape

42

Test Procedure
Apparent Specific Gravity

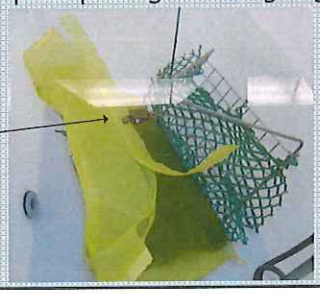
- After water is filled in, cut the other corner similar to the first
- Do not completely remove any cut portion as this needs weighed as a complete package

43

Test Procedure
Apparent Specific Gravity

- Place complete package on weighing device

Clip aids in stability of package on weighing device



44

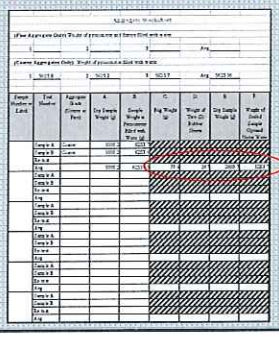
Test Procedure
Apparent Specific Gravity

- Ensure that no part of the package is touching the bottom or sides of the water bath
- Allow sample to remain in the water bath for a minimum of 20 minutes
- Record mass

45

Test Procedure
Apparent Specific Gravity

- Recorded weights



46

Calculations

- Results may be obtained using software developed by the equipment manufacturer, Alternatively, users can develop their own software and correlations for calculation of the results with the equations given in section 10.0 of the test method

47

Aggregate Worksheet

(Fine Aggregate Only) Weight of pycnometer and fixture filled with water.

1. _____ 2. _____ 3. _____ Avg. _____

(Coarse Aggregates Only) Weight of pycnometer filled with water.

1. 5625.8 2. 5625.2 3. 5625.7 Avg. 5625.56

Sample Number or Label	Trial Number	Aggregate Grade (Coarse or Fine)	A. Dry Sample Weight (g)	B. Sample Weight in Pycnometer Filled with Water (g)	C. Bag Weight (g)	D. Weight of Two (2) Rubber Sheets	E. Dry Sample Weight (g)	F. Weight of Sealed Sample Opened Under Water
	Sample A	Coarse	1000.2	6253.7				
	Sample B	Coarse	1000.2	6253.6				
	Re-test							
	Avg		1000.2	6253.65	77.6	207	2000.7	1289.7
	Sample A							
	Sample B							
	Re-test							
	Avg							
	Sample A							
	Sample B							
	Re-test							
	Avg							
	Sample A							
	Sample B							
	Re-test							
	Avg							
	Sample A							
	Sample B							
	Re-test							
	Avg							
	Sample A							
	Sample B							
	Re-test							
	Avg							

Updated 12/15/2006

Enter Rubber Sheet Density 1.305
Enter Plastic Bag Density 0.903

* Use AASHTO T 84 when no coarse fraction is available; blank will produce an approximate value.

Sample ID	Dry Sample 1 Weight (g)	Sample 1 weight in container filled with water (g)	Volumeter Calib. (g)	Bag weight (g)	Rubber sheet weight (g)	Dry Sample 2 weight (g)	Weight of sealed Sample 2 opened in water (g)	P1 **CorGsb** g/cm3	Input initial absorption estimate AASHTO T 85* **ABS**	Preliminary Absorption **CorABS**	Apparent Specific Gravity **CorGsa** (g/cm3)	**Gsapred** CoreLok Apparent	**Gsbpred** CoreLok Bulk	**ABSpred** Corelok Absorption

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Standard Method of Test for

Specific Gravity and Absorption of Aggregate Using Automatic Vacuum Sealing Method

AASHTO Format MoDOT TM-81

1. SCOPE

1.1 This standard covers the determination of specific gravity and absorption of fine aggregates by Method A and coarse and blended aggregates by Method B.

1.2 The values are stated in SI units and are regarded as the standard units.

1.3 A multi-laboratory precision and bias statement for coarse and combined aggregate tests in this standard has not been developed at this time. Therefore, this standard should not be used for acceptance or rejection of coarse and combined aggregate materials for purchasing purposes.

1.4 *This standard may involve hazardous materials, operations and equipment. This standard does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this standard to consult and establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. REFERENCED DOCUMENTS

2.1 *AASHTO Standards:*

- M43, Sizes of Aggregate for Road and Bridge Construction
- M 29, Wire-Cloth Sieves for Testing Purposes
- M 132, Terms Relating to Density and Specific Gravity of Solids, Liquids and Gases
- M 231, Weighing Devices Used in the Testing of Materials
- T 2, Standard Practice for Sampling of aggregates
- T 19, Standard Test Method for Bulk Density (Unit Weight) and Voids in Aggregate
- T 27, Test Method for Sieve Analysis of Fine and Coarse Aggregates
- T 85, Standard Test method for Specific Gravity and Absorption of Coarse Aggregate
- T 84, Standard Test Method for Specific Gravity and Absorption of Fine Aggregate
- T 248, Standard Practice for Reducing Samples of Aggregate to Testing Size

2.2 *ASTM Standards:*

- D4753, Standard Specification for Evaluating, Selecting, and Specifying Balances and Scales for Use in Testing Soil, Rock and Related Construction Materials
- C 670, Standard Practice for Preparing Precision and Bias Statements for Test Methods for Construction Materials

- C 691, Standard Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method
- C29/ C29 M, Standard Test Method for Bulk Density (Unit Weight) and Voids in Aggregate
- C 127, Standard Test method for Density, Relative Density (Specific Gravity), and Absorption of Coarse Aggregate
- C128, Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Fine Aggregate
- C 125, Terminology Relating to Concrete and Concrete Aggregates
- C 702, Standard Practice for Reducing Samples of Aggregate to Testing Size
- D 75, Standard Practice for Sampling of Aggregates
- D 136, Test Method for Sieve Analysis of Fine and Coarse Aggregates

2.3 *Other Standards:*

- CoreLok Operational Instructions (InstroTek, Inc.)

3. TERMINOLOGY

3.1 *Definitions*:

3.1.1 *absorption*—the increase in the mass of aggregate due to water in the pores of the material, but not including water adhering to the outside surface of the particles, expressed as a percentage of the dry mass. The aggregate is considered "dry" when it has been maintained at a temperature of 110 ± 5°C for sufficient time to remove all uncombined water.

3.1.2 *specific gravity*—the ratio of the mass (or weight in air) of a unit volume of a material to the mass of the same volume of water at stated temperatures. Values are dimensionless.

3.1.2.1 *apparent specific gravity*—the ratio of the weight in air of a unit volume of the impermeable portion of aggregate at a stated temperature to the weight in air of an equal volume of gas-free distilled water at a stated temperature.

3.1.2.2 *bulk specific gravity*—the ratio of the weight in air of a unit volume of aggregate (including the permeable and impermeable voids in the particles, but not including the voids between particles) at a stated temperature to the weight in air of an equal volume of gas-free distilled water at a stated temperature.

3.1.2.3 *bulk specific gravity (SSD)*—the ratio of the mass in air of a unit volume of aggregate, including the mass of water within the voids filled to the extent achieved by vacuum saturating (but not including the voids between particles) at a stated temperature, compared to the weight in air of an equal volume of gas-free distilled water at a stated temperature.

4. SUMMARY OF METHOD

4.1 Sufficient aggregate sample is dried to constant mass. For each test, two representative dry aggregate samples of the same material are selected for testing. One sample is evacuated in a vacuum chamber inside a plastic bag and opened under water for rapid saturation of the aggregate. The dry mass and submerged mass of the sample is used for calculation of apparent specific gravity. The second sample of the same aggregate is tested in a known volume metal pycnometer. The known mass of the pycnometer with water, mass of the dry aggregate, and mass of the

aggregate and pycnometer filled with water is used for calculation of bulk specific gravity oven dry (OD.) The results from the two samples tested are then used to calculate absorption, and bulk specific gravity saturated-surface-dry (SSD.)

4.2 This test can be completed in less than 30 minutes and can be used for rapid determination of aggregate properties in construction testing laboratories.

4.3 This test can be performed on fine, coarse and blended (combined) aggregates by using appropriate plastic bag and pycnometer sizes.

5. SIGNIFICANCE AND USE

5.1 Bulk specific gravity is the characteristic generally used for calculation of the volume occupied by the aggregate in various mixtures containing aggregate, including Portland cement concrete, hot mix asphalt, and other mixtures that are proportioned or analyzed on an absolute volume basis. Bulk specific gravity is also used in the computation of voids in aggregate in test T 19. Bulk specific gravity SSD is used if the aggregate is wet, that is, if its absorption has been satisfied. Conversely, the bulk specific gravity OD is used for computations when the aggregate is dry or assumed to be dry.

5.2 Apparent specific gravity pertains to the solid material making up the constituent particles not including the pore space within the particles which is accessible to water.

5.3 Absorption values are used to calculate the change in the mass of an aggregate due to water absorbed in the pore spaces within the constituent particles, compared to the dry condition, when it is deemed that the aggregate has been in contact with water long enough to satisfy most of the absorption potential. The laboratory standard for absorption is that obtained after submerging dry aggregate for a prescribed period of time.

6. APPARATUS

6.1 *Balance*—A balance that conforms to M 231. The balance shall be sensitive, readable and accurate to 0.1% of the test sample mass. The balance shall be equipped with suitable apparatus for suspending the sample in water.

6.2 *Water Bath*—A container with minimum dimensions (Length × Width × Depth) of 610 × 460 × 460 mm (24 × 18 × 18 in.) or a large cylindrical container with a minimum diameter of 460 mm and depth of 460 mm (18 × 18 in), for completely submerging the sample in water while suspended, equipped with an overflow outlet for maintaining a constant water level. Temperature controls may be used to maintain the water temperature at 25 ± 1° C (77 ± 2 °F).

Note 1—It is preferable to keep the water temperature constant by using a temperature controlled heater. Also, to reduce the chance for the bag to touch the sides of the water tank, it is preferable to elevate the water tank to a level at which the sample can be placed on the weighing mechanism while the operator is standing up (waist height), and the placement of the sample and the bag in the water tank can easily be inspected.

6.3 Sample *holder* for water displacement of the sample, having no sharp edges.

6.4 *Vacuum Chamber*—with a pump capable of evacuating a sealed and enclosed chamber to a pressure of 6 mm Hg, when at sea level. The device shall automatically seal the plastic bag and

exhaust air back into the chamber in a controlled manner to ensure proper conformance of the plastic to the specimen. The air exhaust and vacuum operation time shall be set at the factory so that the chamber is brought to atmospheric pressure in 80 to 125 seconds, after the completion of the vacuum operations.

6.5 *A Vacuum Measurement Gauge*, independent of the vacuum sealing device, that could be placed directly inside the chamber to verify vacuum performance and the chamber door sealing condition of the unit. The gauge shall be capable of reading down to 3 mm Hg and readable to ± 1 mm Hg.

6.6 *Plastic Bags*, used with the vacuum device, shall be one of the two following sizes: The smaller bags shall have a minimum opening of 235 mm (9.25 in.) and maximum opening of 260 mm (10.25 in.) and the larger bags shall have a minimum opening of 375 mm (14.75 in.) and a maximum opening of 394 mm (15.5 in.). The bags shall be of plastic material, shall be puncture resistant, and shall be impermeable to water. The bags shall have a minimum thickness of 0.127mm (0.005 in.). The manufacturer shall provide the apparent specific gravity for the bags.

6.7 Small metal pycnometer with 137 ± 0.13 mm (5.375 ± 0.005 in.) inside diameter (ID) and 89 ± 0.41 mm (3.5 ± 0.016 in.) height, for testing fine aggregates. The pycnometer shall be machined to be smooth on all surfaces. The inside of the lid shall be machined at a 5° angle to create an inverted conical surface. The pycnometer shall be equipped with a temperature strip to allow the user to monitor temperature during testing.

6.8 Large metal pycnometer with 198 ± 0.13 mm (7.776 ± 0.005 in.) ID and 114 ± 0.8 mm (4.5 ± 0.03 in.) height, for testing coarse and blended aggregate. The pycnometer shall be machined to be smooth on all surfaces. The inside of the lid shall be machined at a 5° angle to create an inverted conical surface. The pycnometer shall be equipped with a temperature strip to allow the user to monitor temperature during testing.

6.9 Fine aggregate fixture to hold and secure the lid on the small metal pycnometer from lifting during fine aggregate tests. The fixture shall be provided with a level indicator.

6.10 *Accessories*— A bag cutting knife or scissors, spray bottle filled with isopropyl alcohol, a bucket large enough to allow the pycnometer to be fully submerged in water, water containers to dispense water into pycnometer during testing, syringe with a needle no larger in diameter than 3 mm (0.125 in.), small paint brush and 25 mm (1 in.) wide aluminum spatula.

6.11 Rubber sheets, for protecting the plastic bags against punctures caused by sharp edges on coarse and blended aggregate samples. The manufacturer shall provide the apparent specific gravity for the rubber sheets.

7. VERIFICATION

7.1 *System Verification:*

7.1.1 The vacuum settings of the vacuum chamber shall be verified once every 12 months and after major repairs and after each shipment or relocation.

7.1.2 Place the gauge inside the vacuum chamber and record the setting, while the vacuum unit is operating. The gauge should indicate a pressure of 6 mm Hg (6 TORR) or less. The unit shall not be used if the gauge reading is above 6 mm Hg (6 TORR).

7.1.3 Vacuum gauge used for verification shall be verified for accuracy once every three years.

Note 2— In line vacuum gauges, while capable of indicating vacuum performance of the pump, are not suitable for use in enclosed vacuum chambers and cannot accurately measure vacuum levels.

7.2 *Calibration of the Small Pycnometer:*

7.2.1 Prior to testing, condition the pycnometer to 25 ± 1°C (77 ± 2°F) by placing it inside a bucket of water that is maintained at 25 ± 1°C (77 ± 2°F). Place the fine aggregate fixture on a level surface. Use a level indicator or the provided level to level the fixture.

7.2.2 Remove the pycnometer from the water bucket and dry it with a towel. Place the pycnometer in the fixture and push it back until it makes contact with the stops.

7.2.3 Fill the pycnometer with 25 ± 1°C (77 ± 2°F) water to approximately 10 mm (0.375 in.) from the top. Using the alcohol spray bottle, spray the surface of the water to remove bubbles.

7.2.4 Gently place the lid on the pycnometer and close the clamps on the fixture.

7.2.5 Using a syringe filled with 25 ± 1°C (77 ± 2°F) water, slowly fill the pycnometer through the large fill hole on the lid post. Make sure the syringe tip is far enough in the pycnometer to be below the water level. Gentle application in this step prevents formation of air bubbles inside the pycnometer.

7.2.6 Fill the pycnometer until water comes out the 3 mm (1/8-in.) hole on the surface of the lid.

7.2.7 Wipe any remaining water from the top of the lid with a towel.

7.2.8 Place the entire fixture with the pycnometer on the scale and record the mass. Record the mass in the top portion of the Aggregate Worksheet. (See Appendix X.1)

7.2.9 Clean the pycnometer and repeat steps 7.2.1 to 7.2.8 two more times and average the calibration masses obtained in 7.2.8.

7.2.10 If the range for the 3 calibration masses is larger than 0.5 grams, then the test is not being run correctly. Check to see if the fixture is level. Make certain the water injection with the syringe is done below the pycnometer water surface and is applied gently. Check the water temperature. Check the pycnometer temperature. Repeat the above procedure until you have three masses that are within ± 0.5 gram.

7.2.11 Re-calibrate the pycnometer daily.

7.3 *Calibration of the Large Pycnometer:*

7.3.1 Prior to testing, condition the pycnometer to 25 ± 1°C (77 ± 2°F) by placing it inside a bucket of water that is maintained at 25 ± 1°C (77 ± 2°F).

7.3.2 Remove the pycnometer from the water bucket and dry it with a towel. Set the pycnometer on a level surface.

7.3.3 Fill the pycnometer with 25 ± 1°C (77 ± 2°F) water to approximately 10 mm (0.375 in.) from the top. Using the alcohol spray bottle, spray the surface of the water to remove any air bubbles.

7.3.4 Gently place the lid on the pycnometer. Using a syringe filled with 25 ± 1°C (77 ± 2°F) water, slowly fill the pycnometer through the large fill hole on the lid post. Make sure the syringe tip is far enough in the pycnometer to be below the water level. Gentle application in this step prevents formation of air bubbles inside the pycnometer. Fill the pycnometer until water comes out the 3 mm (1/8-in.) hole on the surface of the lid.

7.3.5 Wipe any remaining water from the top of the lid and sides with a towel. Place the pycnometer on the scale and record the mass. Record the mass in the top portion of the Aggregate Worksheet.

7.3.6 Clean the pycnometer and repeat steps 7.3.2 to 7.3.5 two more times and average the calibration masses obtained in 7.3.5.

7.3.7 If the range for the 3 calibration masses is larger than 1 gram, then the test is not being run correctly. Check to see if the fixture is level. Make certain the water injection with the syringe is done below the pycnometer water surface and is applied gently. Check the water temperature. Check the pycnometer temperature. Repeat the above procedure until you have three masses that are within 1 gram range.

7.3.8 Re-calibrate the pycnometer daily.

8. SAMPLING

8.1 *Fine aggregate samples (Method A):*

8.1.1 Sampling shall be done in accordance with T 2. For fine aggregate testing thoroughly mix the sample and reduce it to obtain one 1000 ± 10 gram sample for apparent specific gravity and two 500 ± 3 gram samples for bulk specific gravity determination. For aggregate reduction use the appropriate procedures described in T 248.

8.2 *Coarse aggregate samples (Method B):*

8.2.1 Sample the aggregate in accordance with T 2.

8.2.2 Dry the aggregate to constant mass and thoroughly mix the sample of aggregate and reduce it to one 2000 ± 10 gram sample for determination of apparent specific gravity and two 1000 ± 10 gram samples for determination of bulk specific gravity. For reduction of the aggregate samples, use the appropriate procedures in T 248.

8.2.3 If the sample is tested in two or more size fractions, determine the grading of the sample in accordance with test T 27, including the sieves used for separating the size fractions for the determinations in this method.

Note 3— When testing coarse aggregate of large nominal maximum size requiring large test samples, it may be more convenient to perform the test on two or more sub samples, and the values obtained combined for the computations.

9. PROCEDURES

9.1 *Method A, Fine Aggregate Test:*

9.1.1 Make certain water temperature used for this test remains at 25 ± 1°C (77 ± 2°F).

9.1.2 Prior to testing, condition the pycnometer to 25 ± 1°C (77 ± 2°F) by placing it inside a bucket of water that is maintained at 25 ± 1°C (77 ± 2°F).

9.1.3 *Determine Bulk Specific Gravity:*

9.1.3.1 Make certain the samples are dried to constant mass.

9.1.3.2 For a single test select and separate two 500 ± 3 gram samples (samples A and B) for the test in the pycnometer and one 1000 ± 10 gram sample for vacuum saturation test.

9.1.3.3 Allow the sample to cool to room temperature.

9.1.3.4 Place the empty pycnometer in the fixture and push it back until it makes contact with the stops.

9.1.3.5 Weigh a 500 ± 3 gram dry sample that is at 25 ± 1°C (77 ± 2°F) and record in column A of the worksheet.

9.1.3.6 Steps 9.1.3.8 to 9.1.3.15 shall be completed in less than 2 minutes.

9.1.3.7 Place approximately 500 ml (halfway full) of 25 ± 1°C (77 ± 2°F) water in the pycnometer.

9.1.3.8 Slowly and evenly pour the sample into the pycnometer. Make certain aggregate is not lost in the process of filling the pycnometer. Use a brush if necessary to sweep any remaining fines into the pycnometer. If any aggregate is lost during the process of filling the pycnometer, start the test over.

9.1.3.9 Use a metal spatula and push it to the bottom of the pycnometer against the inside circumference. Slowly and gently drag the spatula to the center of the pycnometer, removing the spatula after reaching the center. Repeat this procedure 7 more times so that the entire circumference is covered in 8 equal angles, i.e. every 45 degrees until the starting point is reached. If necessary, use a squeeze water bottle to rinse any sample residue off the spatula into the pycnometer.

9.1.3.10 Fill the pycnometer with 25 ± 1°C (77 ± 2 °F) water to approximately 10 mm (0.375 in.) of the pycnometer rim. It is important that the water level is kept at or below the 10 mm line to avoid spills during lid placement.

9.1.3.11 Use the spray bottle filled with isopropyl alcohol and spray the top of the water to remove air bubbles.

9.1.3.12 Gently place the lid on the pycnometer and lock the clamps. Using the syringe, slowly fill the pycnometer through the center hole on top of the lid post. Make sure the syringe tip is far enough in the pycnometer to be below the water level. Gentle application in this step will prevent formation of air bubbles inside the pycnometer.

9.1.3.13 Fill the pycnometer until water just comes out the 3 mm (1/8-in.) hole on the surface of the lid.

9.1.3.14 Wipe any remaining water from around the 3 mm (1/8-in.) hole with a towel.

9.1.3.15 Weigh the sample, pycnometer and the fixture. Record this mass in column B of the worksheet.

9.1.3.16 Repeat steps 9.1.3.6 to 9.1.4.15 for the second 500 ± 3 gram sample, Sample B.

9.1.3.17 Average the mass in each column of the worksheet for sample A and sample B.

9.1.3.18 Record the average weight of the pycnometer from section 7.2.9 in column C.

9.1.4 *Determine Apparent Specific Gravity:*

9.1.4.1 Set the vacuum device according to manufacturer's recommendation.

9.1.4.2 Use a small plastic bag and inspect the bag to make sure there are no holes, stress points or side seal discontinuities in the bag. If any of the above conditions are noticed, use another bag.

9.1.4.3 Weigh the bag and record in column D of the worksheet.

Note 4—Always handle the bag with care to avoid creating weak points and punctures.

9.1.4.4 Weigh 1000 ± 10 grams of oven dry aggregate and record the mass in column F.

9.1.4.5 Place the sample in the bag. Support the bottom of the bag on a smooth tabletop when pouring the aggregate to protect against punctures and impact points.

9.1.4.6 Place the bag containing the sample inside the vacuum chamber.

9.1.4.7 Grab the two sides of the bag and spread the sample flat by gently shaking the bag side to side. Do not press down or spread the sample from outside the bag. Pressing down on the sample from outside the bag will cause the bag to puncture and will negatively impact the results. Lightly spray mist aggregates with high minus 75-µm (No. 200) sieve material to hold down dust prior to sealing.

9.1.4.8 Place the open end of the bag over the seal bar and close the chamber door. The unit will draw a vacuum and seal the bag, before the chamber door opens.

9.1.4.9 Gently remove the sample from the chamber and immediately submerge the sample in a large water tank equipped with a balance for water displacement analysis. It is extremely important that the bag be removed from the vacuum chamber and immediately placed in the water bath. Leaving the bag in the vacuum chamber or on a bench top after sealing can cause air to slowly enter the bag and can result in low apparent specific gravity results.

9.1.4.10 Cut one corner of the bag, approximately 25 to 50 mm (1 to 2 in.) from the side while the top of the bag is at least 2-inch below the surface of the water. Make sure the bag is completely submerged before cutting. Introducing air into the bag will produce inaccurate results.

9.1.4.11 Open the cut portion of the bag and hold open for 45 seconds. Allow the water to freely flow into the bag. Allow any small residual air bubbles to escape. Do not shake or squeeze the sample, as these actions will cause the fines to escape from the bag.

9.1.4.12 After water has filled in, cut the other corner of the bag approximately 25 to 50 mm (1 to 2 in.). Squeeze any residual air bubbles on top portion of the bag through the cut corners by running your fingers across the top of the bag. Do not completely remove corners from bag nor allow any portion of the bag to reach the surface of the water.

9.1.4.13 Place the bag containing the aggregate on the weighing basket in the water to obtain the under water mass. The bag may be folded before placing it on the basket. However, once on the basket under water, unfold the bag and allow water to freely flow into the bag. Keep the sample and bag under water at all times. Make certain the bag or the sample are not touching the bottom, the sides, or floating out of the water tank. If the bag contacts the tank it will negatively impact the results of this test.

9.1.4.14 Allow the sample to stay in the water bath for a minimum of fifteen (15) minutes.

9.1.4.15 Record the submerged mass in column G of the worksheet.

9.1.4.16 Results may be obtained using software developed by the equipment manufacturer. Alternatively, users can develop their own software and correlations for calculation of the results with equations given in section 10.0.

9.2 *Method B, Coarse and Combined Aggregate Test:*

9.2.1 Make certain water temperature used for this test remains at 25 ± 1°C (77 ± 2°F)

9.2.2 Prior to testing, condition the pycnometer to 25 ± 1°C (77 ± 2°F) by placing it inside a bucket of water that is maintained at 25 ± 1°C (77 ± 2°F).

9.2.3 *Determine Bulk Specific Gravity:*

9.2.3.1 Make certain the samples are dried to constant mass.

9.2.3.2 Allow the sample to cool to room temperature.

9.2.3.3 For a single test select and separate two 1000 ± 10 gram samples (samples A and B) for the test in the pycnometer and one 2000 ± 10 gram sample for vacuum saturation test.

9.2.3.4 Make certain the pycnometer is set on a level surface.

9.2.3.5 Weigh a 1000 ± 10 gram dry sample (sample A) that is at 25 ± 1°C (77 ± 2°F) and record in column A of the worksheet.

9.2.3.6 Steps 9.2.3.8 to 9.2.3.15 shall be completed in less than 2 minutes.

9.2.3.7 Place approximately 1000 ml (halfway full) of 25 ± 1°C (77 ± 2°F) water in the pycnometer.

9.2.3.8 Slowly and evenly pour the sample into the pycnometer. Make certain aggregate is not lost in the process of filling the pycnometer. Use appropriate pouring techniques to help in transferring the aggregate into the pycnometer. If any aggregate is lost during the process of filling the pycnometer, start the test over.

9.2.3.9 Use a metal spatula and push it to the bottom of the pycnometer against the inside circumference. Slowly and gently drag the spatula to the center of the pycnometer, removing the spatula after reaching the center. Repeat this procedure 7 more times so that the entire circumference is covered in 8 equal angles, i.e. every 45 degrees until the starting point is reached. If necessary, use a squeeze water bottle to rinse any sample residue off the spatula into the pycnometer.

9.2.3.10 Fill the pycnometer with 25 ± 1°C (77 ± 2°F) water to approximately 10 mm (0.375 in.) of the pycnometer rim. It is important that the water level is kept at or below the 10 mm line in order to avoid spills during lid placement

9.2.3.11 Use the spray bottle filled with isopropyl alcohol and spray the top of the water to remove air bubbles.

9.2.3.12 Gently place the lid on the pycnometer. Using the syringe, slowly fill the pycnometer through the center hole on top of the lid post. Make sure the syringe tip is far enough in the pycnometer to be below the water level. Gentle application in this step will prevent formation of air bubbles inside the pycnometer.

9.2.3.13 Fill the pycnometer until you see water coming out the 3 mm (1/8-in.) hole on the surface of the lid.

9.2.3.14 Wipe any remaining water from around the 3 mm (1/8-in.) hole with a towel.

9.2.3.15 Weigh the pycnometer and the fixture. Record this mass in column B of the worksheet.

9.2.3.16 Repeat steps 9.2.3.6 to 9.2.3.15 for the second 1000 ± 10 gram sample, Sample B.

9.2.3.17 Average the mass in each column of the worksheet, for Sample A and Sample B.

9.2.3.18 Record the average weight of the pycnometer from section 7.3.6 in column C.

9.2.4 *Determine Apparent Specific Gravity:*

9.2.4.1 Set the vacuum device according to manufacturers recommendation.

9.2.4.2 Use one small and one large plastic bag. Inspect both bags to make sure there are no holes, stress points or side seal discontinuities in the bag. If any of the above conditions are noticed, use another bag.

9.2.4.3 Weigh both bags and record the mass in column D of the worksheet.

Note 5—Always handle the bag with care to avoid creating weak points and punctures.

9.2.4.4 Weigh the two rubber sheets and record the mass in column E.

9.2.4.5 Weigh 2000 ± 10 grams of aggregate and record the mass in column F.

9.2.4.6 Place the sample in the small bag. When filling, support the bottom of the bag on a smooth tabletop to protect against puncture and impact points.

9.2.4.7 Place the large bag into the vacuum chamber, then place one of the rubber sheets inside the large bag. The rubber sheet should be flat, centered, and pushed all the way to the back of the large bag.

9.2.4.8 Place the small bag containing the sample into the large bag centered on top of the rubber sheet. Manually spread the sample inside the small bag. Be sure the area taken up by the sample inside the small bag remains completely contained within the area of the rubber sheets. Lightly spray mist aggregates with high minus 75-µm (No. 200) sieve material to hold down dust prior to sealing.

9.2.4.9 Place the other rubber sheet on top of the small bag, inside the large bag. The small bag should be between the two rubber sheets.

9.2.4.10 Place the open end of the large external bag over the seal bar and close the chamber door. Make certain the rubber sheets are not over the seal bar.

9.2.4.11 After the chamber door opens, gently remove the sample from the chamber. Immediately place the sample in the water, for water displacement analysis.

9.2.4.12 Cut one corner of the bag, approximately 70 to 100 mm (3 to 4 in.) from the side. Make sure the bag is completely submerged before cutting. Introducing air into the bag will produce inaccurate results.

9.2.4.13 Open the cut portion of the large bag and the small bag with your fingers and hold open for 25 seconds. Allow water to freely flow into the bags. Allow any small residual air bubbles to escape from the bags.

9.2.4.14 After water has filled in, cut the other corner of the bag approximately 70 to 100 mm (3 to 4 in.). Squeeze any residual air bubbles out of the cut corners by running your fingers across the top of the bag. Do not completely remove corners from bag nor allow any portion of the bag to reach the surface of the water.

9.2.4.15 Place the bags containing the rubber sheets and the aggregate on the provided weighing basket under water. You may fold the bag to place it on the basket. However, once on the basket under water, unfold the bag and allow water to freely flow into the bag.

9.2.4.16 Make certain the bag or the sample are not touching the bottom, the sides, or floating out of the water tank. If the bag contacts the tank during mass measurement, it will negatively impact the results of this test. Allow the sample to stay in the water bath for a minimum of twenty (20) minutes.

9.2.4.17 Record the submerged mass in column G of the worksheet.

9.2.4.18 Results may be obtained using software developed by the equipment manufacturer. Alternatively, users can develop their own software and correlations for calculation of the results with equations given in section 10.0.

10. CALCULATIONS

10.1 *Initial Specific Gravity:*

10.1.1 *Initial Bulk Specific Gravity*—Calculate the bulk specific gravity, 25°C (77°F) as follows:

$$\text{Cor G}_{sb} = \frac{A}{C-(B-A)} \qquad (1)$$

where:

A = Mass of oven-dry sample 1 in air, g
B = Mass of pycnometer and oven-dry sample in water, g
C = Mass of plastic bag(s), g
D = Mass of 2 rubber sheets, g
E = Mass of oven-dry sample 2 in air, g
F = Mass of saturated sample 2 in water, g
ρ_{bag} = Density of plastic bag(s)
ρ_{rbr} = Density of rubber sheets

10.1.2 *Initial Apparent Specific Gravity*—Calculate the bulk specific gravity, 25°C (77°F) as follows:

$$\text{Cor G}_{sa} = \frac{F}{(D+E+F-G)-(D/\rho_{bag}-E/\rho_{rbr})} \qquad (2)$$

10.1.3 *Initial Absorption*—Calculate the absorption, percent, as follows:

$$\text{Cor Abs} = \frac{CorG_{sa}-CorG_{sb}}{CorG_{sa}\times CorG_{sb}}\times 100 \qquad (3)$$

10.1.4 *Initial Bulk Specific Gravity (Saturated-Surface-Dry)*—Calculate the bulk specific gravity, 25°C (77°F) on the basis of saturated-surface-dry aggregate as follows:

$$\text{Cor G}_{sb}\,(\text{SSD}) = (1+CorAbs/100)\times CorGsb \qquad (4)$$

10.2 Predicted properties account for the effects of absorption during the measurement of the dry aggregate volume by correlating the results to those obtained by T 85 using absorption. When an aggregate does not contain a coarse fraction, e.g. natural sand, T 84 absorption may be used. The result of equations 1 and 2 are used to calculate the following:

Note 6—Development of regression equations for correlation of properties may be found in Missouri Department of Transportation Report OR06.016. These equations may be substituted for correlation to local aggregates.

10.2.1 *Predicted Bulk Specific Gravity—*

$$G_{sb} = 0.342355 + 0.8751137 CorG_{sb} - 0.051843 Abs_{T85} \quad (5)$$

where:

Abs_{T85} = Absorption from T 85

10.2.2 *Predicted Apparent Specific Gravity—*

$$G_{sa} = 0.24680896 + 0.90993947 CorG_{sa} - 0.02031058 Abs_{T85} \quad (6)$$

10.2.3 *Predicted Absorption—*

$$Abs = \frac{G_{sa} - G_{sb}}{G_{sa} \times G_{sb}} \times 100 \quad (7)$$

10.2.4 *Predicted Bulk Specific Gravity (Saturated-Surface-Dry)—*

$$G_{sb}(SSD) = (1 + Abs/100) \times G_{sb} \quad (8)$$

10.3 *Average Specific Gravity Values*—When the sample is tested in separate size fractions, the average value for bulk specific gravity, bulk specific gravity (SSD), or apparent specific gravity can be computed as the weighted average of the values as computed in accordance with Section 9.1 using the following equation:

$$G = \frac{1}{\frac{P_1}{100\,G_1} + \frac{P_2}{100\,G_2} + \cdots \frac{P_n}{100\,G_n}} \quad (9)$$

where:

G = average specific gravity (All forms of expression of specific gravity can be averaged in this manner.);

$G_1, G_2 \ldots G_n$ = appropriate specific gravity values for each size fraction depending on the type of specific gravity being averaged; and

$P_1, P_2 \ldots P_n$ = mass percentages of each size fraction present in the original sample.

Note 7—Some users of this method may wish to express the results in terms of density. Density may be determined by multiplying the bulk specific gravity, bulk specific gravity (SSD), or apparent specific gravity by the density of water (997.5 kg/m^3 or 0.9975 Mg/m^3 or 62.27 lb/ft^3 at 23°C). Some authorities recommend using the density of water at 4°C (1000 kg/m^3 or 1.000 Mg/m^3 or 62.43 lb/ft^3) as being sufficiently accurate. Results should be expressed to three significant figures. The density terminology corresponding to bulk specific gravity, bulk specific gravity (SSD), and apparent specific gravity has not been standardized.

10.4 *Average Absorption*—Calculate the percentage of absorption, as follows:

$$\text{Absorption, percent} = [(B - A)/A] \times 100 \quad (10)$$

10.5 *Average Absorption Value*—When the sample is tested in separate size fractions, the average absorption value is the average of the values as computed in Section 9.3, weighted in proportion to the mass percentages of the size fractions in the original sample as follows:

$$A = (P_1 A_1/100) + (P_2 A_2/100) + \cdots (P_n A_n/100) \qquad (11)$$

where:

A = average absorption, percent;
$A_1, A_2 \ldots A_n$ = absorption percentages for each size fraction; and
$P_1, P_2 \ldots P_n$ = mass percentages of each size fraction present in the original sample.

11. REPORT

11.1 Report predicted specific gravity results to the nearest 0.001, and indicate the type of specific gravity, whether bulk, bulk (SSD), or apparent.

11.2 Report the predicted absorption result to the nearest 0.1 percent.

X1. WORKSHEET

(Fine Aggregate Only) Mass of pycnometer and fixture filled with water.

1._____ 2._____ 3._____ Avg._____

(Coarse Aggregates Only) Mass of pycnometer filled with water.

1._____ 2._____ 3._____ Avg._____

Sample Number or Label	Trial Number	Aggregate Grade (Coarse or Fine)	A Dry Sample Mass (g)	B Sample Mass in Pycnometer Filled with Water (g)	C Mass of Pycnometer Filled with Water-Avg. (g)	D Bag Mass (g)	E Mass of Two (2) Rubber Sheets (g)	F Dry Sample Mass (g)	G Mass of Sealed Sample Opened Under Water
	Sample A								
	Sample B								
	Re-test								
	Avg								
	Sample A								
	Sample B								
	Re-test								
	Avg								
	Sample A								
	Sample B								
	Re-test								
	Avg								
	Sample A								
	Sample B								
	Re-test								
	Avg								

TM-81 CoreLok
Step by Step Procedure

EQUIPMENT:

CoreLok machine

Bags (Large and Small)

Rubber sheets (2)

Sieves: #4 and #8

Water bath and heater (capable of maintaining water at 77 +/- 2 deg. F, 25 +/- 1 deg C)

Stand for water bath (Capable of supporting a scale above the water bath and a hole to allow for the bottom loading of the scale)

Scale: Electronic- 0.1 gram readability- 5000 gram capacity- Bottom loading capability

Basket and means to attach to the bottom of the scale

Large Pycnometer

Small Pycnometer and Apparatus

CoreLok Software

Oven: Capable of maintaining 110 +/- 5 deg. C. (230 +/- 9 deg F)

Absorptive towels

Weight Pan

Thermometer (to check water temperature)

Misc. Equipment: Brush – Spray Bottle – Timer – Scissors – Alcohol – Spatula – Syringe – Scoop

TM-81 CoreLok
Step by Step Procedure

SAMPLE SIZE

Minus #4 material: 2 – (500+ gram samples) 1 – (1000+ gram sample) (after drying)

Plus #4 or #8 material: 2 – (1000+ gram samples) 1 – (2000+ gram sample) (after washing and drying)

TM-81 CoreLok
Step by Step Procedure

Procedure minus #4 material

1. Obtain sample by AASHTO T248 (Sample preparation)
2. Dry material to a constant mass (Oven 110 +/- 5 deg. C)
3. Start CoreLok, making sure that it is in the correct program.
4. Make sure that the Spacer plates are in the proper position
5. Check that the water temperature in the bath is correct (77 +/ 2 deg. F)
6. Submerge the Small Pycnometer and Lid in water (77 +/- 2 deg. F)
7. Place the basket in the water bath and attach to the scale
8. Tare the scale
9. Remove Pycnometer and Lid from the water and remove all water
10. Place Pycnometer into Apparatus on a level surface
11. Fill with water (77 +/- 2 deg. F) to the line inside the Pycnometer
12. Spray alcohol on the surface to eliminate air bubbles
13. Place lid on Pycnometer, vent hole in front
14. Clamp Pycnometer and lid in Apparatus
15. Insert syringe into the top hole and add water until water comes out of the vent hole.
16. Wipe off all excess water (check the Apparatus carefully)
17. Make sure that the scale is zeroed
18. Place Apparatus on the scale
19. Record weight (0.1 gm)

TM-81 CoreLok
Step by Step Procedure

20. Place Apparatus back on the level surface

21. Empty the Pycnometer and dry.

22. Repeat steps 11 – 21 two more times (or until you have 3 masses that are within +/_ 0.5 gram)

23. Average the three readings and record (0.1 gm) (do this daily)

24. Place weight pan on the scale (with basket attached below) ***(if only one scale)***

25. Tare the scale

26. Weigh out 500 +/- 3 gm of the sample

27. Record the weight (nearest 0.1 gm)

28. With the Pycnometer in the Apparatus, fill with water (77 +/- 2 deg. F), approximately ½ full

29. Start the timer

30. Carefully pour the sample into the Pycnometer (use the brush to remove all the fines from the weight pan)

31. Using the spatula, gently stir the sample (pull from the edge to the center 8 times) to remove any entrapped air.

32. Fill the Pycnometer to the line

33. Spray Alcohol on the surface to eliminate any air bubbles

34. Place the lid on the Pycnometer, vent hole forward, and clamp down.

35. Insert the syringe into the top hole

36. Slowly add water (77 +/- deg. F) until some water comes out of the vent hole (make sure you do not lose any of the sample)

37. Wipe off all excess water (check the side and bottom edge)

38. Tare scale

TM-81 CoreLok
Step by Step Procedure

39. Place Apparatus on the scale

40. Record the weight (0.1 gm)

41. Place Apparatus back on level surface

42. Empty and clean Pycnometer **(Steps 29 – 40 must be completed in less than 2 minutes)**

43. Repeat steps 24 – 42 one more time

44. Place weight pan on scale

45. Tare scale

46. Tear off one small bag and examine for holes or deformities (if any discard)

47. Weigh the bag

48. Record the weight (0.1 gm)

49. Weigh out 1000 +/- 10 gm of sample

50. Record the weight (0.1 gm)

51. Carefully pour the sample into the bag, use the brush to make sure that all the fines are removed from the weight pan.

52. Place one hand under the bag, move the bag to the spacer plates in the CoreLok machine

53. Grab the sides of the bag and gently move it from side to side to level the material in the bag (lightly spray mist aggregates with a high minus #200 to hold down dust prior to sealing).

54. Pull the bag forward until approximately ½ inch of the bag is past the sealer wire (make sure that the sample is completely on the spacer plates)

55. Make sure that the bag is open

56. Slowly close the lid on the CoreLok

57. Tare the scale (basket in the bath and attached to the scale) ***(if only one scale)***

TM-81 CoreLok
Step by Step Procedure

58. When the CoreLok lid opens, quickly and carefully move the bag to the water bath

59. Completely submerge the bag in the bath

60. Using the scissors, cut along and just below the seal for approximately 1 to 2 inches

61. Hold the bag open for 45 seconds to allow the water to enter

62. When the bag is full, cut along and just below the seal on the other side of the bag. (This is to help remove the air.)

63. Carefully remove all the air bubbles (be sure to avoid the loss of any material)

64. Place the bag on the basket (make sure that the bag stays submerged)

65. Start the timer

66. After 15 minutes, record the weight

IMPORTANT: Once the bag has been submerged in the water bath make sure that it stays submerged until the final weight has been recorded.

TM-81 CoreLok
Step by Step Procedure

Procedure for plus #4, plus #8 or combined

1. Obtain sample by AASHTO T 248 (sample preparation)
2. Dry material to a constant mass (Oven 110 +/- 5 degrees C)
3. Start CoreLok, making sure that it is in the correct program.
4. Make sure that the Spacer plates are in the proper position
5. Check that the water temperature in the water bath is correct (77 +/- 2 deg. F)
6. Submerge the Large Pycnometer and Lid in water (77 +/- 2 deg. F)
7. Place the basket in the water bath and attach to the scale
8. Tare the scale
9. Remove the Pycnometer and Lid from the water and remove all water
10. Place Pycnometer on a level surface (over a sink or pan)
11. Pycnometer with water (77 +/- 2 deg. F) to the line inside the Pycnometer
12. Spray the surface of the water with alcohol to remove the air bubbles
13. Place the lid on the Pycnometer (water should flow out of at least the vent hole)
14. Rotate the lid until the vent hole is in front
15. Insert the syringe into the large hole and add water (77 +/- 2 deg. F) until water comes out of the vent hole.
16. Dry off all excess water, make sure that there is no water on the bottom of the Pycnometer.
17. Place Pycnometer on the scale
18. Record weight (0.1 gm.)
19. Empty Pycnometer
20. Repeat steps 10 – 18 (2 more times) (or until you have 3 masses within 1 gram)

TM-81 CoreLok
Step by Step Procedure

21. Average the 3 weights and record (0.1 gm.)
22. Place weight pan on scale
23. Tare scale with basket in the bath and attached to the scale (if only one scale)
24. Weigh out 1000 +/- 10 grams of sample
25. Record weight (0.1 gm)
26. Place Pycnometer back on level surface
27. Fill until approximately ½ full with water (77 +/- 2 deg. F)
28. Start Timer
29. Carefully pour sample into Pycnometer, use the brush for any fines
30. Using the spatula, stir the sample to remove any entrapped air
31. Fill the Pycnometer with water to the line
32. Spray alcohol on the surface of the water to eliminate air bubbles
33. Gently place the lid on the Pycnometer
34. Rotate the lid until the vent hole is in front
35. Using the syringe, fill Pycnometer until water comes out of the vent hole
36. Dry off all excess water from the outside of the Pycnometer
37. Tare the scale without the weight pan
38. Place Pycnometer on the scale
39. Record weight (0.1 gm)
40. Empty and clean the Pycnometer **(Steps 28 – 39 must be completed in less than 2 minutes)**
41. Repeat steps 22 – 40 one more time, record the average of the 2 samples

TM-81 CoreLok
Step by Step Procedure

42. Place weight pan on the scale

43. Tare the scale

44. Tear off 1 small and 1 large bag

45. Check both for any holes or deformities (if any discard and get a new one)

46. Weigh the 2 bags

47. Record the weight (0.1 gm.)

48. Weigh the 2 rubber pads (make sure that they are dry)

49. Record weight (0.1 gm.)

50. Weigh out a 2000 +/- 10 grams of sample

51. Record weight (0.1 gm.)

52. Place Large bag on the spacer plates in the CoreLok

53. Place 1 of the rubber sheets into the Large bag

54. Carefully pour the sample into the small bag (use the brush for any fines)

55. Carefully place the small bag into the large bag, centering it on the rubber sheet.

56. Using your hand, level out the material in the small bag, make sure that all material is within the edges of the rubber sheet (lightly spray mist material with a high minus #200 to avoid dust before sealing).

57. Center the second rubber sheet over the small bag

58. Make sure that the sheets and small bag are as far back in the large bag as possible, make sure that the small bag is open

59. Pull the large bag forward until approximately ½ inch of the bag is past the sealer wire.

60. Make sure that the small bag is completely on the spacer plates

61. Slowly close the lid on the CoreLok

TM-81 CoreLok
Step by Step Procedure

62. Tare the scale with the basket attached to the scale

63. When the CoreLok opens, quickly move the large bag to the water bath

64. Completely submerge the large bag in the water bath

65. Using the scissors, cut along and just below the seal of the large bag, approximately 3 to 4 inches. Hold the bag open for 25 seconds.

66. When the bag is full of water, slowly open the small bag to let in water.

67. When the small bag is full, cut along and just below the seal on the other side of the large bag, approximately 3 inches (this is to help in the removal of the air bubbles)

68. Remove all air bubbles

69. When all the air bubbles are removed, place the bag on the basket making sure that the bag stays completely submerged

70. Start the timer

71. After 20 minutes, record the weight on the form.

72. Enter the data into the Software.

IMPORTANT: Once the bag or bags are submerged, they must stay submerged at all times until the final weight has been recorded.

APPENDIX

The following have been used on materials that do not readily slump:

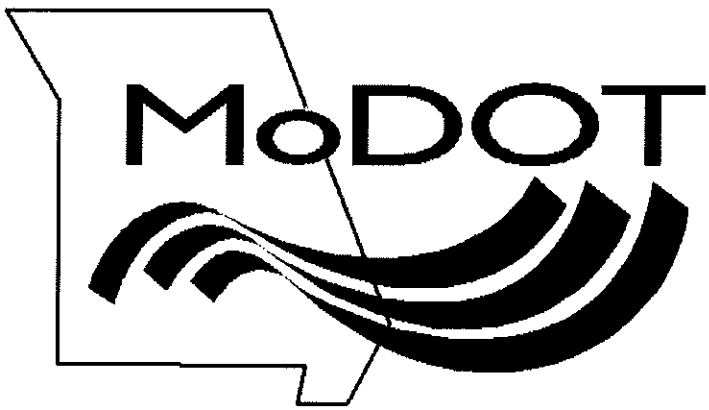
1. **Provisional Cone Test** - Fill the cone mold as described in the presentation for T84, except only use 10 drops of the tamper. Add more fine aggregate and use 10 drops of the tamper again. Then add material two more times using three and two drops of the tamper, respectively. Level off the material even with the top of the mold, remove loose material from the base, and lift the mold vertically.

2. **Provisional Surface Test** – If airborne fines are noted when the fine aggregate is such that it will not slump when it is at a moisture condition, add more moisture to the sand, and at the onset of the surface-dry condition, with the hand lightly pat approximately 100g of the material on a flat, dry, clean, dark, or dull nonabsorbent surface such as a sheet of rubber, a worn oxidized, galvanized, or steel surface, or a black-painted metal surface. After 1 to 3 seconds, remove the fine aggregate. If noticeable moisture shows on the test surface for more than 1 to 2 seconds, then surface moisture is considered to be present on the fine aggregate.

3. **Colorimetric** procedures described by Kandhal and Lee, Highway Research Record No. 307, page 44.

4. For reaching the SSD condition on a **single-size material** that slumps when wet, hard-finish paper towels can be used to surface-dry the material until the point is just reached where the paper towel does not appear to be picking up moisture from the surfaces of the fine aggregate particles.

GLOSSARY



Glossary of Terms

Absorption: The increase in the mass of aggregate due to water in the pores of the material, but not including water adhering to the outside surface of the particles, expressed as a percentage of the dry mass. The aggregate is considered "dry" when it has been maintained at a temperature of 110 ± 5°C for sufficient time to remove all uncombined water by reaching a constant mass.

Bulk Specific Gravity (also known as Bulk Dry Specific Gravity): The ratio of the weight in air of a unit volume of aggregate (including the permeable and impermeable voids in the particles, but not including the voids between particles) at a stated temperature to the weight in air of an equal volume of gas-free distilled water at a stated temperature.

Bulk Specific Gravity (SSD): The ratio of the mass in air of a unit volume of aggregate, including the mass of water within the voids filled to the extent achieved by submerging in water for 15 to 19 hours (but not including the voids between particles) at a stated temperature, compared to the weight in air of an equal volume of gas-free distilled water at a stated temperature.

Apparent Specific Gravity: The ratio of the weight in air of a unit volume of the impermeable portion of aggregate at a stated temperature to the weight in air of an equal volume of gas-free distilled water at a stated temperature.

SSD – Saturated Surface Dry: The condition in which the aggregate has been soaked in water and has absorbed water into its pore spaces. The excess, free surface moisture has been removed so that the particles are still saturated, but the surface of the particle is essentially dry.

Specific Gravity – The ratio of the mass (or weight in air) of a unit volume of a material to the mass of the same volume of gas-free distilled water at stated temperatures. Values are dimensionless.