STATE OF NEVADA
DEPARTMENT OF TRANSPORTATION
CONSTRUCTION DIVISION

SYNOPSIS OF

MATERIALS DIVISION TESTING MANUAL

FOR FIELD TESTING

CARSON CITY, NEVADA
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State of Nevada
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Materials Division

METHOD OF TEST FOR MAXIMUM DENSITY AND RELATIVE COMPACTION OF SOILS USING THE HARVARD MINIATURE COMPACTION DEVICE

SCOPE

This test method is used to determine the relationship between the moisture content and the density of - 4.75 mm (- No. 4) graded soil when compacted in a specified mold using a spring loaded tamper preset to develop a foot load of 1317 kPa (191.0 psi). The maximum density determined by this test shall be used for determining compaction in the field.

APPARATUS (See Figure 1 and 2)

1. Mold, metal, machined and polished to the following dimensions:

Diameter	33.34 mm ± 0.05 mm (1.3125 ± 0.002 in.)
Length	71.52 mm ± 0.05 mm (2.8156 ± 0.002 in.)
Area	872.99 mm^2 (1.3530 $in.^2$)
Volume	$6.24 \times 10^{-5} m^3$ (3.8095 $in.^3$)

$$6.24 \times 10^{-5} m^3 = 0.0000624\ m^3 \left(\frac{3.8095}{1728}\ in.^3 = 0.0022046\ ft^3\right)$$

2. Spring loaded tamper, assembled to meet the following requirements:

Diameter of Foot	12.7 mm (0.5 in.)
Area of Foot	126.68 mm^2 (0.19635 $in.^2$)
Spring Load	17.01 kg (37.5 lb)
Foot Load	1317 kPa (191.0 psi)

3. Extruder, lever-frame, used for the purpose of extruding compacted specimens from the mold.

4. Balance, having a capacity of 12000 g and sensitive to 0.1 g.

5. Oven, capable of maintaining a temperature of 110 ± 5°C (230 ± 9°F).

6. Electric hot plate or gas stove.

7. Microwave oven.

8. Sieve, 4.75 mm (No. 4).

9. Large mixing bowl, teaspoon (tsp), fork, large mixing spoon, straight edge spatula, 100 mL graduated plastic cylinder, plastic syringe, cloth and a steel rod with a smooth end approximately 25.4 mm (1 in.) in diameter.

PROCEDURE

1. Split and screen sufficient material passing the 4.75 mm (No. 4) sieve until a 1500 g sample is obtained. Place this material in the mixing bowl. Squeeze a handful of material, and if a cast is formed which can be picked up readily with the thumb and index finger, sufficient moisture is present in the soil to begin the test. If a cast is not formed, add a maximum of 30 mL of water (depending on soil consistency) and mix thoroughly until the soil mixture appears uniform. Repeat this procedure until the suitable moisture content for beginning the test is found. Mix and adjust the sample weight to 1500 g of material and perform the test. If the material is too wet, dry back the material slightly, using the oven method in accordance with Test Method Nev. T112 stirring every 5 minutes. Mix and adjust the sample to 1500 g and perform the test. Cover material in the mixing bowl with a damp cloth and keep covered throughout this test procedure.

2. Level out the material in the mixing bowl, remove approximately 10 mL (2 tsp) of material from a single location and place it in the mold. Tamp 25 times moving the tamping foot after each tamp to give uniform coverage over the surface area of the soil in the mold. Proper tamping has been achieved when the handle and the nut at the top of the tamper separates slightly. Repeat this process for three additional lifts, making sure the fourth and final lift will leave the compacted soil surface in the collar above the top of the mold. Obtain the soil for each lift from a single location of material in the bowl so that when the specimen is compacted there will be four source holes providing a double check on the number of lifts per specimen. Place the 25.4 mm (1 in.) steel rod on the compacted soil surface, apply slight pressure downward with one hand and with the other hand, turn and lift the collar vertically to remove. Carefully trim the top surface of the compacted soil specimen so that it is flush with the top of the mold and is free of any voids. Place the mold with compacted specimen in the sample extruder and pull the handle down to extrude specimen. Weigh the specimen plus any portion separated during the extrusion operation to the nearest 0.1 g. Record the wet weight in grams divided by 62.4 = Mg/m^3 (weight in grams is the net weight in lbs/ft^3). Place the specimen in a suitable container for drying in an oven capable of maintaining 110 ± 5°C (230 ± 9°F), electric hotplate, gas stove or microwave oven (separate the specimen particles during the process for more thorough drying).

3. Add 2 percent water at 25 ± 5°C (77 ± 9°F) in mL (1 mL = 1 g) to the soil remaining in the mixing bowl (weigh the material in mixing bowl after each specimen to obtain 2 percent moisture; or by adding 28 mL to the second specimen, 26 mL to the third specimen and continue as more specimens are molded). Repeat the process outlined in paragraph 2 above. Initial moisture additions are controlled by the weight of the material available for the test. (Weight of material x 0.02 = mL or grams of water to be added). (Hint: Moisture addition will decrease approximately 2 mL or grams with each additional specimen).

4. Continue and repeat the procedures as outlined in paragraphs 2 and 3 above until the highest dry density is established. The following three scenarios are indicators that the highest dry density has been achieved:

    a. When the last compacted specimen fails to gain more than 1.4 g (wet).

    b. When free water, or a thin ribbon of plastic material, is extruded at the bottom of the mold and the base plate connection.

    c. When the spring loaded tamping foot penetrates the specimen in excess of 6.35 mm (0.25 in.) on the top lift of the specimen, when the total load of 17.01 kg (37.5 lbs) is carefully applied. To check this, carefully trim the top surface of the soil specimen so that it is flush with the top of the mold. Place the mold and specimen back in the mold holder, and apply the spring loaded tamper to the center of the sample. If the penetration exceeds 6.35 mm (0.25 in.), the moisture content is above optimum, and this specimen will not be used as the maximum dry density (even if it is the highest dry weight).

    If any of the scenarios described in 4.a. to 4.c. occur prior to the third specimen, the material shall be dried back before continuing the test procedure. Refer to No. 1 under PROCEDURE for drying back or split another 1500 g sample and start the test over.

5. Dry all specimens using one of the methods outlined in Test Method Nev. T112 or by the following microwave oven procedure: Place a 600 mL glass beaker or other suitable container filled with approximately 300 mL of water (maintain water level during drying) into the microwave oven to prevent overheating during the drying process. Place specimen in a microwave safe container, then place in the microwave oven. Dry the sample for 5 minutes, then at 2 minute intervals until a constant weight is achieved. Drying times may be adjusted based on type and size of the microwave oven.

6. At the completion of the drying procedure, allow specimens to cool. Weigh and record the dry weight of each specimen to the nearest 0.1 g, then calculate the percent moisture to the nearest 0.1%. Record the weight in grams divided by 62.4 = Mg/m^3 (weight in grams is in lbs/ft^3) for each respective specimen. The weight of the specimen having the greatest dry density is the maximum density for this particular - 4.75 mm (- No. 4) soil fraction. After all specimens have been dried, and the dry weight is still increasing, the curve is not complete, and additional specimens must be produced (unless the highest specimen was due to 4.c. above). EXCEPTION: The only time you do not use the highest dry density from the Harvard Miniature Curve Test is if that specimen had excessive penetration as described in 4.c. above. If this occurs, place an asterisk next to this specimen, and note “*penetration in excess of 6.35 mm (0.25 in.)”.

MOISTURE CONTROL

1. The optimum moisture content of the Harvard Miniature Curve Test can only be used as a moisture control in the field on the - 4.75 mm (- No. 4) fraction of the material. If the total material contains + 4.75 mm (+ No. 4) material, then an approximate optimum moisture content will be calculated after first determining the percent + 4.75 mm (+ No. 4) = (1-P) and percent - 4.75 mm (- No. 4) = (P). The following equation shall be used for this calculation:

   Total Sample Approximate Optimum Moisture = [(1-P) x 2] + [P x Test Optimum Moisture]

   Where: 1-P = Decimal equivalent of % + 4.75 mm (+ No. 4)

   Where: P = Decimal equivalent of % - 4.75 mm (- No. 4)

COMPACTION CONTROL

1. Compaction control of any material having a suitable range of moisture content may be achieved by the appropriate use of one of the following three methods depending on the gradation of the material:

   a. Maximum size 100 mm (4 in.) or less with the percent passing the 4.75 mm (No. 4) sieve within the following limits:

Sieve Designation	Percent Passing 4.75 mm (No. 4) Sieve
100 mm (4 in.)	21.5 to 100
90 mm (3 1/2 in.)	23.0 to 100
75 mm (3 in.)	24.8 to 100
63 mm (2 1/2 in.)	27.2 to 100
50 mm (2 in.)	30.4 to 100
37.5 mm (1 1/2 in.)	35.1 to 100
25.0 mm (1 in.)	43.0 to 100
19.0 mm (3/4 in.)	49.7 to 100

Sieve Designation is determined by the smallest sieve that will pass at least 90% of the sample being tested.

The Calculated Maximum Density of the above sized material within their respective gradation limits shall be calculated as follows:

$$D = GK\,(1-P) + Pd\,(1.03)$$

D = Calculated Maximum Density, Mg/m^3 (pcf)

G = Apparent Specific Gravity of the coarse aggregate + 4.75 mm (+ No. 4), Test Method Nev. T104

K = 0.90 (metric) or 56.16 (English), rock correction factor

P = Percent of fine aggregate - 4.75 mm (- No. 4) expressed as a decimal

d = Maximum Dry Density of the fine aggregate - 4.75 mm (- No. 4) as determined by the Harvard Miniature Curve Test

b. Maximum size 100 mm (4 in.) or less with gradation limits outside of those shown for sized material in paragraph 1.a. above: A Calculated Maximum Density for field use will be determined by the Materials Division. Submit the following information with a request to the Materials Division: Gradation results, apparent specific gravity of the coarse aggregate and maximum dry density of the fine aggregate (H.M.C.T., dry).

c. Maximum size larger than 100 mm (4 in.) in sufficient quantities as determined by the Engineer: No field density tests will be performed for this type of material, as adequate compaction can best be controlled by means of a proof rolling test by following the conditions as set forth in the specifications for proof rolling.

2. Relative Compaction is defined as the ratio of the in-place field density dry of a soil or aggregate to its Calculated Maximum Density. The percent compaction is computed from the following formula:

$$\text{Percent Compaction} = \left(\frac{\text{Field Density Dry}}{\text{Calculated Maximum Density}}\right) \times 100$$

REPORT

Report percent compaction to the nearest whole percent.

NOTES

1. It is important to leave the material loose in the mold prior to tamping each lift. If the material is even slightly pre-tamped with the rod or finger, a bridging condition may develop during the compaction procedure, and the bottom of that lift will show a considerable amount of voids resulting in weight less than should be obtained.

2. Densities too high will result when any of the following discrepancies occur:

    a. Excessive compression of the spring during the tamping process.

    b. Excessive number of tamps per lift.

    c. Excessive number of lifts per specimen.

    d. Excessive mold wear increasing the inside diameter of the mold.

3. Specimens over optimum moisture may not support the 1317 kPa (191.0 psi) spring load, and the foot will penetrate through the soil layer resulting the excessive penetration, displacing the soil upward around the spring loaded tamping foot. Continue performing the specimen and remaining lifts, lessen the required load to the spring loaded tamper. Compact such a specimen by allowing 6.35 mm (0.25 in.) or less penetration (hand tamping) by the spring loaded tamping foot and a suitable specimen will be produced.

4. A valid Harvard Miniature Curve Test shall consist of a minimum of three points for the maximum density determination (one below optimum, one at optimum and one over optimum).

5. A new Harvard Miniature Curve Test shall be performed whenever the material changes, a second re-test is required, test results exceed 102 percent compaction, and for every tenth compaction test on the same material.

6. When completing a Harvard Miniature Curve Test on gypsum or material blended with recycled asphalt pavement, dry in accordance with Test Method Nev. T112, Method A, under “PROCEDURE”, using a temperature of 60°C (140°F), to avoid changing the nature of the sample.

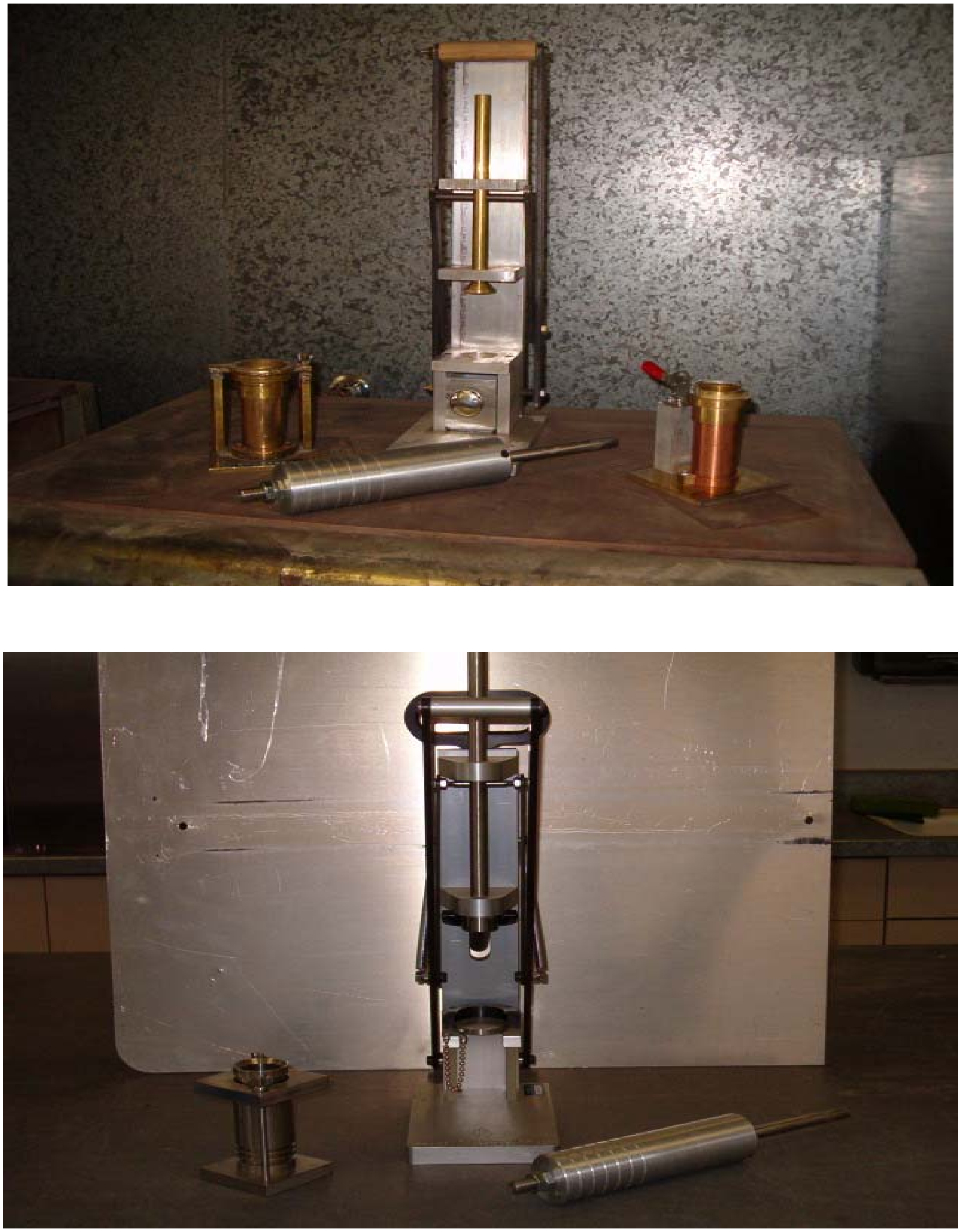

FIGURE 1

FIGURE 2

Test Method Nev. T102H
January 1, 2014

State of Nevada
Department of Transportation
Materials Division

METHOD OF TEST FOR IN-PLACE DENSITY OF TREATED AND UNTREATED SOILS AND AGGREGATES

SCOPE

This test method is used to determine in-place density of treated and untreated soils, aggregate bases, sub-bases, cement or lime treated bases and selected materials. In-place density is the density of a soil as it exists in its natural state or compacted condition. As used herein, the term soil includes all material types and all particle sizes present in the material to be tested.

Density is defined as the unit weight of the soil or aggregate, usually expressed in terms of Mg/m^3 (lb/ft^3). If oven-dry condition does not prevail, the unit weight is termed wet density. If the soil or aggregate is in an oven-dry condition, the unit weight is termed dry density. Oven-dry condition is the condition of soil after it has been dried to a constant weight at a temperature of 110 ± 5°C (230 ± 9°F).

This test method requires excavating and weighing a sample of soil, measuring the volume of the sample, and calculating its density. If dry density is desired, this procedure also details the determination of the moisture content of an excavated sample, and converting from wet density to dry density.

The use of the maximum density and relative compaction of soils shall be determined in accordance with Test Method Nev. T108. This method shall be used to obtain the maximum density value for volume-to-weight conversion factors.

APPARATUS

1. Sand cone volume apparatus, Figure 1 - three piece sand cone with 200 mm (8 in.) measuring vessel (hat); or Figure 2 - one piece sand cone with 250 mm (10 in.) measuring vessel (hat).

2. Scale, hanging balance or platform type, 31 kg (70 lb) minimum capacity, graduated to 0.05 kg (0.1 lb) or finer.

3. Oven, capable of maintaining a temperature of 110 ± 5°C (230 ± 9°F).

4. Electric hot plate or gas stove.

5. Sand, 20 mesh, consisting of clean, dry, free-flowing particles that will not degrade under repeated use. Beach sand containing organic materials, deliquescent salts or sand having any hygroscopic properties is not acceptable.

   If the sand is coarser than the material being excavated, 50 mesh sand may be utilized. Should the use of 50 mesh sand occur, a dust mask shall be used and documented by the Resident Engineer accepting its use.

6. Drum, metal 208 L (55 gal.) with pour spout for sand.

7. Sample containers, any suitable container with a lid that will prevent loss of moisture during transport.

8. Drying pans, scoops, brushes, etc.

9. Digging bar, maximum length of 914 mm (36 in.) and maximum diameter of 25 mm (1 in.).

10. Sample splitter or quartering canvas.

CALIBRATION OF STANDARD TEST SAND

Step 1: Calibration of cone and measuring vessel (hat)

Use a 200 mm ± 12.7 mm (8 in. ± 0.5 in.) measuring vessel (hat) with the three piece sand cone and a 250 mm ± 12.7 mm (10 in. ± 0.5 in.) measuring vessel (hat) with the one piece sand cone. Determine the volume of the measuring cone and volume of the measuring vessel (hat) before calibrating the sand. The calibration of the test sand determines the weight per unit volume of sand when poured into a container under controlled conditions. Calibration of the sand shall be performed in a vibration free location. The function of the sand cones shown in Figures 1 and 2 are to assure that the sand will be poured under identical conditions in each instance. For this calibration procedure, sand is poured into a measuring vessel (hat) rather than into a test-hole.

1. If using the three piece sand cone (Figure 1), it is noted that variations in the volume of the measuring cone differ, therefore the unit shall be calibrated annually. Calibration is performed using water and a glass plate to eliminate entrapped air. The following procedure shall be used: Level the scale; place the overflow vessel on the scale; cover the neck of the cone to avoid losing any water (duct tape, etc.) and place in the overflow vessel (make sure the cone is level in the overflow vessel); place the glass plate over the cone and zero the scale; remove the glass plate and carefully fill the cone with water at 25 ± 3°C (77 ± 5°F); place the glass plate over the opening to ensure there is not any entrapped air under the glass plate. Refer to number 3. of this section for the calculations.

Use the 200 mm ± 12.7 mm (8 in. ± 0.5 in.) measuring vessel (hat) with the three piece sand cone. Determine the volume of the 200 mm ± 12.7 mm (8 in. ± 0.5 in.) measuring vessel (hat) using water and a glass plate. The following procedure shall be used: Level the scale; place the measuring vessel (hat) on the scale with the glass plate over the measuring vessel (hat) and zero the scale; remove the glass plate and carefully fill the measuring vessel (hat) with water at 25 ± 3°C (77 ± 5°F); place the glass plate over the opening to ensure there is not any entrapped air under the glass plate. Refer to number 3. of this section for the calculations.

2. If using the one piece sand cone (Figure 2), it is noted that variations in the volume of the cone differ, therefore the unit shall be calibrated annually. Calibration is performed using water and a glass plate to eliminate entrapped air. The following procedure shall be used: Level the scale; turn the one piece sand cone upside down on the scale; close the sand valve and make sure it is water tight using petroleum jelly (Vaseline, etc); place the glass plate over the cone and zero the scale; remove the glass plate and carefully fill the measuring cone with water at 25 ± 3°C (77 ± 5°F); place the glass plate over the opening to ensure there is not any entrapped air under the glass plate. Refer to number 3. of this section for the calculations.

   Use the 250 mm ± 12.7 mm (10 in. ± 0.5 in.) measuring vessel (hat) with the one piece sand cone. Determine the volume of the measuring vessel (hat) using water and a glass plate. The following procedure shall be used: Level the scale; place the measuring vessel (hat) on the scale with the glass plate over the measuring vessel (hat) and zero the scale; remove the glass plate and carefully fill the measuring vessel (hat) with water at 25 ± 3°C (77 ± 5°F); place the glass plate over the opening to ensure there is not any air trapped under the glass plate. Refer to number 3. of this section for the calculations.

3. Record the weight of water required to fill the cone or the measuring vessel (hat) to the nearest 0.1 lb and designate as "W". Use the following formula to calculate the volume of the cone and the volume of the measuring vessel (hat):

   Volume = W/62.4 (English units must be used):

   V = Volume in cubic feet
   W = Weight of water used to fill the cone or the measuring vessel (hat) in pounds
   62.4 = Weight of one cubic foot of water

   If the volume is required in cubic meters, multiply the volume in cubic feet by 0.0283168 (rounded to the nearest 0.001)

   Do not write the volume on the equipment. Record results on NDOT form 040-067.

Step II: Sand Calibration

1. Determine the sand density by filling the sand cone and measuring vessel (hat) with three trial pours of sand, weigh and record to the nearest 0.1 lb. Average the three trial pours and divide by the volume of the cone and measuring vessel (hat), this equals the sand density in lb/ft^3. To obtain Mg/m^3, divide the lb/ft^3 by 62.4. (rounded to the nearest 0.001)

2. The three trial pours shall be within ± 0.2 lb of each other. If the three trial pours are not within 0.2 lb of each other, repeat this procedure.

Calibrate each shipment of sand prior to the start of each project, before using it in any test-hole measurements, and each time new sand is added to the barrel (thoroughly mix old sand with new sand). Do not blend sand supplied by different manufacturers.

Record results on NDOT form 040-068.

EXCAVATION OF TEST SAMPLE

1. Location of the test site should be such that the soil and degree of compaction encountered will be representative of the average conditions in the area. If large rocks are encountered, it may be necessary to move to a new test site. If organic material (leaves, sticks, etc.) is encountered, it must be removed from the test sample after total wet weight has been obtained.

2. Prior to starting excavation, clear away all loose surface material and level off a test site area at least 0.2 m^2 (2 ft^2). For areas compacted by pneumatic tired or steel wheeled rollers, remove disturbed surface material. Where a sheeps foot or tamping roller are used, remove loose surface material to a depth of not less than 50 mm (2 in.) below the deepest disturbance by the roller after completion of compaction. When testing on a slope, level the testing area as much as possible without building a pad (the cone shall not be tilted, this may result in erroneous density values). The edge of the leveling plate may be used as a scraper to level the surface.

3. Place the leveling plate on the prepared test area and secure the leveling plate to the surface by driving the corner pins into the soil. Using the circular template as a guide and without disturbing the surrounding material, dig a neat, clean-cut hole 250 to 300 mm (10 to 12 in.) in diameter and a depth of 75 to 200 mm (3 to 8 in.).[1] To maintain the necessary degree of accuracy in weighing and measuring operations, test sample excavation shall not be less than 0.0042 m^3 (0.150 ft^3). Scoops or digging bars may be used to excavate the test-hole. When digging bars are used, do not pry back against the wall of the hole in any manner that will compress the area. Regardless of the method of excavation, trim the sides and bottom of the hole as smooth as possible. A small, soft brush shall be used to sweep the sides and bottom of the hole to remove all loose material.

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[1] Size of the plate used will depend on the thickness of the soil layer to be tested to obtain the required volume of material. In minimum thickness layers, a 250 mm ± 12.7 mm (10 in. ± 0.5 in.) leveling plate shall be used. When the soil layer is 75 mm (3 in.) or less, a 300 mm ± 12.7 mm (12 in. ±0.5 in.) leveling plate shall be used.

4. Exercise care to prevent loss of any excavated sample or its moisture prior to weighing. Use a tightly covered container to reduce loss of moisture. Weigh and record to the nearest 0.01 kg (0.1 lb).

Where different types of material are deposited in layers, do not penetrate different layers with a single test-hole or combine excavated material into a single sample. Each of these soil types might be compacted to specification requirements based on their individual maximum densities, but test maximum density of the combination may be entirely different, and result in an erroneous test result.

SAND VOLUME MEASUREMENT OF THE TEST-HOLES

1. Obtain at least 23 kg (50 lb) of sand in a suitable pouring container and record to the nearest 0.01 kg (0.1 lb).

2. If using the three piece sand cone, center the three piece sand cone over the leveling plate and test-hole. Pour the calibrated sand into the regulating funnel rapidly enough to maintain a sand level in the funnel at about 19 mm (3/4 in.) below the top edge. Pour until the hole and cone are filled, as indicated by sand overflowing into the overflow vessel. Tests have shown that a steady sand flow while pouring is essential and that an inconsistent flow of sand through the orifice may result in a considerable error. Do not stop the flow of sand once the pouring has begun. Stop the sand pour immediately upon overflow and allow the balance of sand remaining in the regulating funnel to completely empty into overflow vessel. Hold the large measuring cone so it cannot move and rotate the overflow vessel a few turns to free it from the neck of the measuring cone prior to its removal. Remove the regulating funnel and lift the overflow vessel off the measuring cone. Sand that has overflowed into the overflow vessel is not incorporated into the test-hole measurement and is returned to the original sand supply remaining in the pouring container. Weigh and record sand in the pouring container as (weight of residue) to the nearest 0.01 kg (0.1 lb). The difference between initial weight of sand in the pouring container and weight of residue remaining after pouring the sand, represents the weight of sand used to fill the volume of the hole, cone and leveling plate. Use the same sand cone during testing that was used to calibrate the sand.

3. If using the one piece sand cone, center the one piece sand cone over the test-hole and leveling plate. Close the sand valve and pour the weighed sand into the upper portion of the one piece sand cone and cover the opening with a lid. Open the sand valve and let the sand flow into the excavated hole and measuring cone until the sand stops moving. Immediately close the sand valve and place the one piece sand cone on top of the pouring container. Open the sand valve and allow the remaining sand to flow into the container. Weigh and record sand in the pouring container as weight of residue to the nearest 0.01 kg (0.1 lb). The difference between the initial weight of sand in the pouring container and weight of residue remaining after pouring the sand, represents the weight of sand used to fill the volume of the hole, cone and leveling plate. Use the same sand cone during testing that was used to calibrate the sand.

During the pouring of sand, the apparatus must not vibrate or be touched. Stop any equipment causing ground vibration during the pouring process.

If the sand contained in the measuring cone does not become contaminated with the soil in the excavated area, it may be salvaged for reuse. Recover sand from measuring cone by placing the edge of large recovering scoop slightly under the edge of cone, then slide cone onto the scoop and place in an empty pouring container.

The sand in the test-hole may have picked up moisture or foreign matter, therefore salvage may not be possible.

CALCULATION OF TEST-HOLE VOLUME

Knowing both the weight per unit volume of the sand (sand density) when it is poured into the test-hole by the sand cone procedure, and weight of sand used to fill the test-hole, measuring cone and leveling plate (weight of sand used), the test-hole volume in m^3 (ft^3) may be computed from the following formula:

Report all volumes to the nearest 0.001

$$\text{Volume of Test-Hole} = \left(\frac{\text{weight of sand used}}{\text{sand density}}\right) - (\text{volume of cone} + \text{leveling plate})$$

Volume of the cone and plate in m^3 (ft^3) may be computed using the following formula:

$$\text{Volume of Cone} = m^3 = W/62.4\ (0.0283168) \quad \text{or} \quad ft^3 = W/62.4$$

$$\text{Volume of Leveling Plate} = m^3 = \frac{\pi r^2 h}{1{,}000{,}000{,}000} \quad \text{or} \quad ft^3 = \frac{\pi r^2 h}{1728}$$

Where $\pi = 3.1416$
r = radius of circular cut-out of plate, mm (in.)
h = thickness of leveling plate, mm (in.)
W = weight of room temperature water 25 ± 3ºC (77 ± 5°F) to fill up the measuring cone

IN-PLACE WET DENSITY

Determine the in-place wet density from the following formula:

Report to the nearest 0.1

$$\text{In-place Wet Density} = \left(\frac{\text{wet weight of total excavated sample}}{\text{volume of hole}}\right)$$

MOISTURE DETERMINATION

Where it is desired to ascertain the density of soil in terms of oven-dry weight, it is necessary to perform a moisture determination using a representative portion in accordance with Test Method Nev. T200. Moisture sample must be of sufficient size to represent the total excavated sample with consideration given to the amount and nature of the coarse aggregate fraction. Accurately weigh the amount to be used for moisture determination, then thoroughly dry in accordance with Test Method Nev. T112. Re-weigh after drying and calculate the moisture content from the following formula:

Report to the nearest 0.1

$$\text{Percent Moisture} = \left(\frac{\text{weight of wet soil - weight of dry soil}}{\text{weight of dry soil}} \right) \text{x } 100$$

This moisture content is known as in-place moisture content because it denotes the moisture condition of in-place soil and will be used to determine the in-place dry density. As the materials maximum dry density is determined per Test Method Nev. T108, additional screening to determine retained fractions of + 4.75 mm (+ No. 4) and or + 19.0 mm (+ 3/4”) of the excavated material is unnecessary.

CONVERSION OF WET DENSITY TO DRY DENSITY

Convert wet density to dry density from the following formula:

Report to the nearest 0.1

$$\text{In-place Dry Density} = \left(\frac{\text{in-place wet density}}{\text{in-place \% moisture content + 100}} \right) \text{x } 100$$

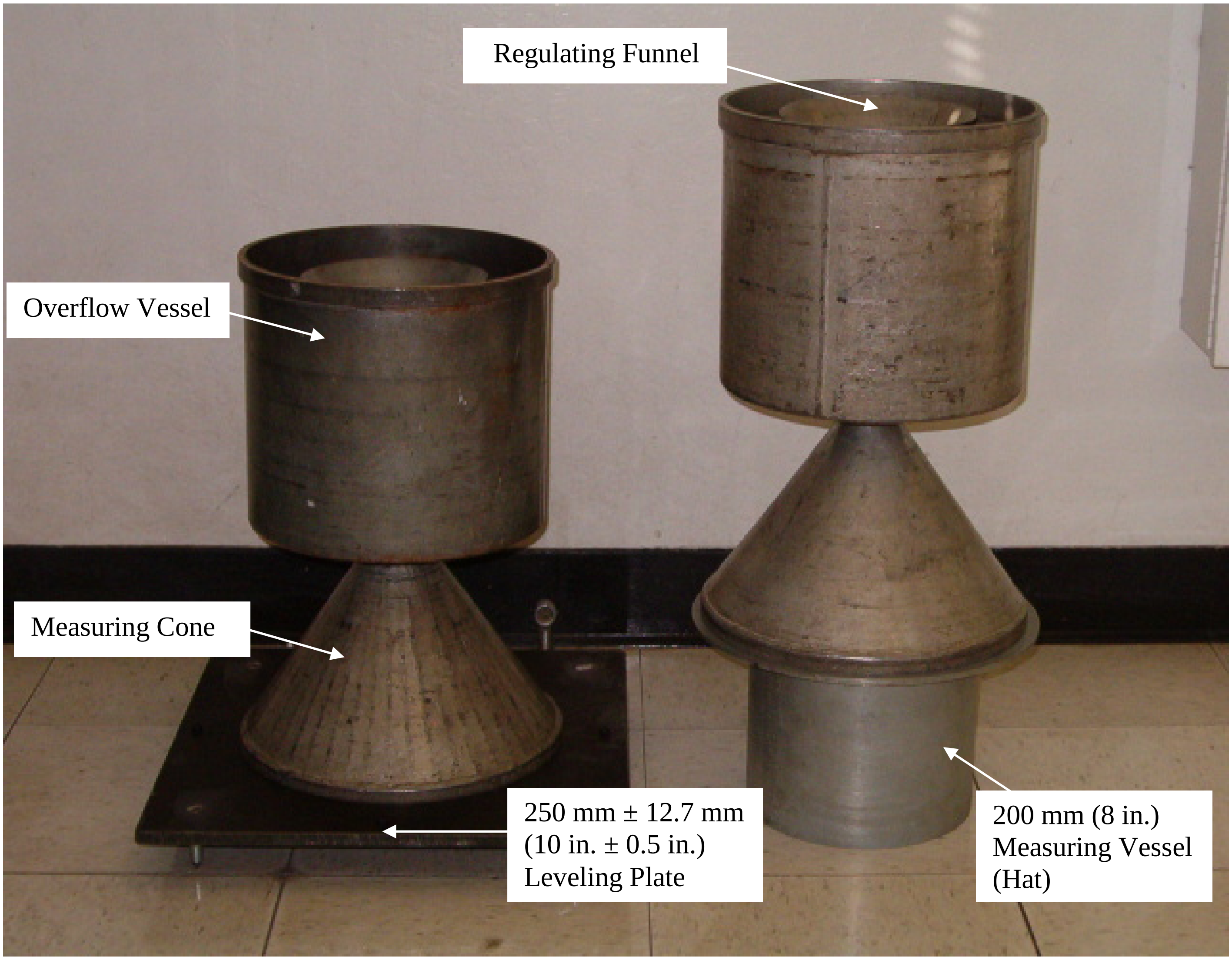
REPORT

Report compaction to the nearest whole percent.

NOTES

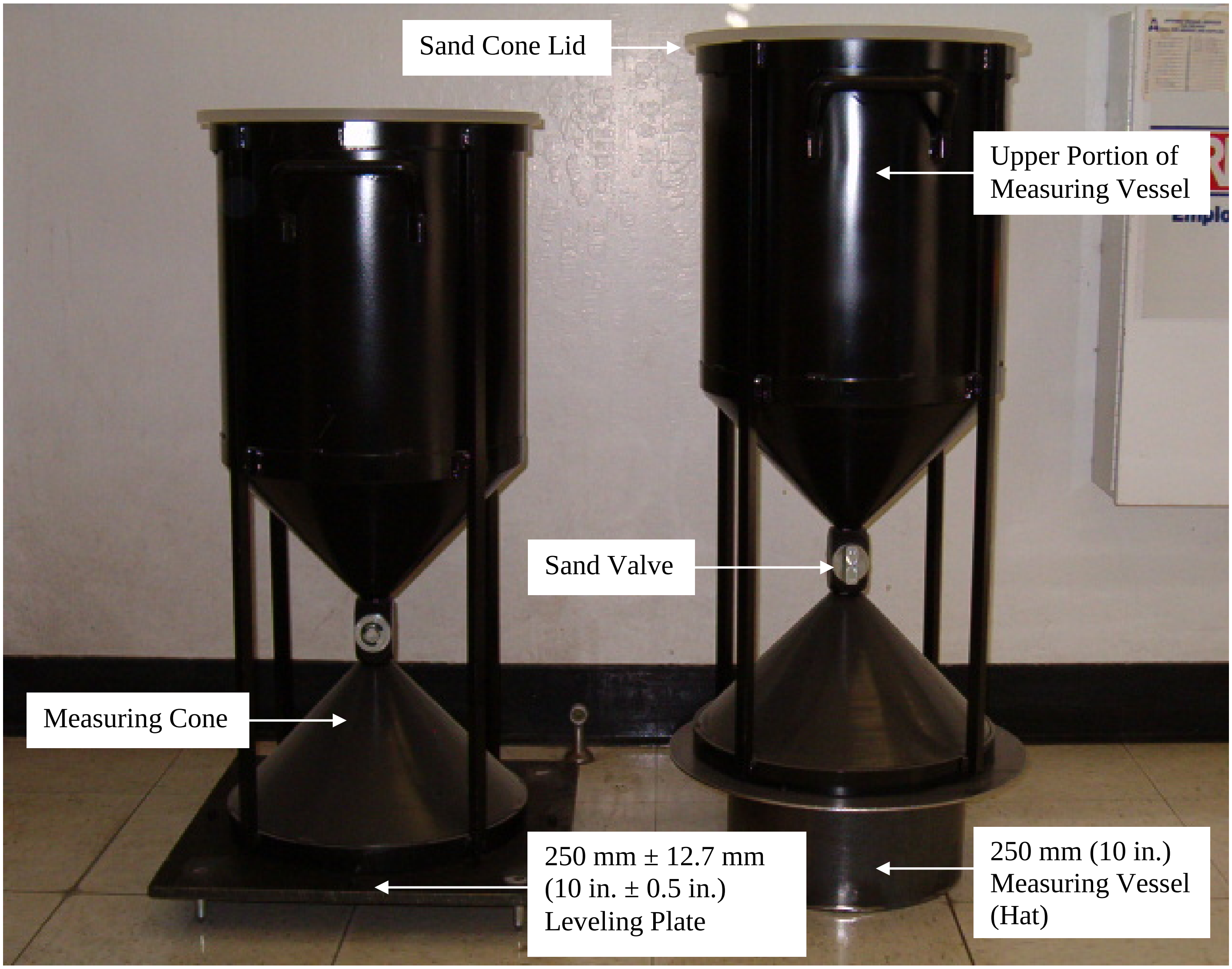
1. Test Method Nev. T104 and T108 must be performed whenever the material changes, a second re-test is required or test results exceed 102 percent compaction. These two test methods shall be performed concurrently.

2. When drying gypsum or material blended with recycled asphalt pavement, dry in accordance with Test Method Nev. T112, Method A, using a temperature of 60°C (140°F), to avoid changing the nature of the sample.



Three piece sand cone and 200 mm (8 ın.) measuring vessel (hat)

FIGURE 1



One piece sand cone and 250 mm (10 in.) measuring vessel (hat)

FIGURE 2

Test Method Nev. T103G
January 1, 2014

State of Nevada
Department of Transportation
Materials Division

METHOD OF TEST FOR DENSITY AND MOISTURE CONTENT OF SOILS AND AGGREGATES BY THE USE OF NUCLEAR DENSITY GAUGES

SCOPE

This test method is used to determine in-place density and moisture content of soils and aggregates by the use of nuclear equipment. The wet density in kg/m^3 (lb/ft^3) is determined using the "Direct Transmission Mode". The rod containing the Cesium-137 (Cs-137) source is lowered to the desired depth, resulting in Gamma radiation emission. It is a rapid, non-destructive technique, designed for control and acceptance testing of compaction of soils and aggregates for highway construction.

This method described for density is suitable to a test depth from 50 to 200 mm (2 to 8 in.). The moisture test is generally suitable to a depth of up to 175 mm (7 in.). However, it is heavily dependent on the moisture content, with very high moisture contents reducing the effective depth to about 100 mm (4 in.). Test results may be affected by the chemical composition, sample heterogeneity and surface texture of the material.

Nuclear density gauges utilize radioactive materials, which, that even though present in small quantities, must be handled with care to avoid health hazards to the operator and other individuals surrounding the moisture-density gauge.

APPARATUS

1. Moisture-Density Gauge, Troxler Model 3440 or 3450, consisting of the following major components:

    a. Gamma Source, housed in the probe, shall be an encapsulated and sealed radio isotopic source such as Cesium-137 (Cs-137).

    b. Probe, containing the gamma source, designed for inserting into a preformed hole in the soil. It shall be marked in increments to indicate the depth it is to be placed in the soil. It shall be constructed so that when moved to a desired depth, it will be held securely in position at that depth and have an automatic depth indicator with a back up manual depth indicator.

    c. Gamma Detector, such as a Geiger-Mueller tube or tubes.

    d. Fast Neutron Source, a sealed isotope material such as Americium 241:Beryllium (AM 241:Be). It shall be contained in a separate sealed capsule.

   e. Slow neutron detector, such as helium three tubes (He-3 tubes).

   f. Readout Device, any suitable type which usually includes a high and low voltage power supply necessary to operate the detectors, readout, and accessory devices. Commonly referred to as the scaler.

   g. Housing, shall be moisture and dust proof and of rugged construction to protect the sources, detectors, readout device and power supplies which are contained therein.

   h. Offsets, capable of performing density, moisture and trench adjustments through offset functions.

2. Drill Rod, a steel pin having a nominal diameter slightly greater than the probe, but not to exceed the diameter of the probe by more than 3 mm (1/8 in.). Used to form a hole in the soil to be tested.

3. Guide and Site Preparation Device, one piece of equipment, a steel or aluminum plate leveling tool used to plane the test site to the required smoothness and for aligning the hole perpendicular to the prepared surface for the probe.

4. Reference Standard Block, provided with each moisture-density gauge for checking equipment operation and to provide a stable condition for a reproducible count rate.

STANDARDIZATION

1. Warm up period: Turn the moisture-density gauge on and warm up for ten minutes. This allows the regulators and deflectors to stabilize.

2. At the start of each shift, standardize the moisture-density gauge to check equipment operation. This procedure can also be used as an operational check whenever test measurements are suspect or when poor correlation is encountered during the correlation check.

3. The site chosen for standardization should remain the same throughout the contract. Outline the standard block with keil (lumber crayon) to ensure the same location is used.

4. Place the standard block on a solid surface having a density of 1600 kg/m^3 (100 lb/ft^3) or greater, preferably a plantmix or concrete surface. Ensure that the standard block is level and does not rock back and forth. This location should be at least 3 m (10 ft) from any large object such as a vehicle, field lab, wall, or any water source and at least 9 m (30 ft) from another nuclear gauge.

5. Place the moisture-density gauge on the standard block and properly seat within the recessed area of the standard block. Place the scaler end against the metal plate on the standard block and check to make sure the moisture-density gauge does not rock on the standard block.

6. With the lock attached and the handle in the "safe" position, press the "STANDARD" key on the keypad. The screen will show "Standard Count DS=XXX MS=XXX Take a new count"? Press the "YES" key. The screen will then show "Is gauge on standard block and source rod in safe position"? Check to make sure, then press the "YES" key. The moisture-density gauge will begin taking a four-minute standard count.

7. When counting stops, at the end of the four minutes, screen will say "MS = XXX XX.XX % P, DS = XXX XX.XX % P, Do you want to use new standards"? If it shows a PASS/PASS, record the density standard count (DS) and moisture standard count (MS) in the gauge log book and on the appropriate form, then press the "YES" key. If you receive a PASS/PASS to the right of the percentages, it indicates that the standard counts are within the 1% density tolerance and 2% moisture tolerance.

8. If the density standard (DS) or moisture standard (MS) count fails, the screen will show "Do you want to use the new STD"? Press the "YES" key. Check the moisture-density gauge seating and positioning, is the standard block on a flat and recommended surface? If yes, then take another standard count.

9. It may take up to five standard counts before obtaining a PASS/PASS result. In the event that a PASS/PASS result is not obtainable, contact the Independent Assurance Lab for further assistance.

DENSITY CORRELATION (3440 or 3450 SERIES GAUGES)

1. During correlation, the offsets must be off.

2. Perform correlation tests at three locations. Correlation tests may be performed on the jobsite or an informational pad using approved representative material that will be incorporated into the project. Take the moisture-density gauge tests first. Refer to Figure 1 for correct positioning of the moisture-density gauge during correlation testing. For the correlation procedure, be sure to perform all of the nuclear density tests and the sand cone tests at the same depth to allow all tests to be compared as a group. Once correlated, the moisture-density gauge may be used at any rod depth.

3. After the three correlation holes are completed in accordance with Test Method Nev. T102 and this test method, average the three sand cone wet densities and average the three moisture-density gauge wet densities. Subtract the moisture-density gauge wet density average from the sand cone wet density average, this equals the moisture-density gauge offset for the wet density. See Table 1 for an example.

4. Enter the density offset, calculated above in kg/m^3 (lb/ft^3) with the proper sign (±) into the moisture-density gauge. Follow the flow chart in the moisture-density gauge manual under wet density offsets.

5. Check the density offset every shift and every time a different material is used to ensure that the number entered into the moisture-density gauge is still the correct value for the material being tested. If the moisture-density gauge turns off, all offsets may default to the off position.

MOISTURE CORRELATION (3440 or 3450 SERIES GAUGES)

1. During correlation, the offsets must be off.

2. Perform correlation tests at three locations. Correlation tests may be performed on the jobsite or an informational pad using approved representative material that will be incorporated into the project. Take moisture-density gauge tests first. Refer to Figure 1 for correct positioning of the moisture-density gauge during correlation testing. For the correlation procedure, be sure to perform all of the moisture-density gauge tests and the sand cone tests at the same depth to allow all tests to be compared as a group. Once correlated, the moisture-density gauge may be used at any rod depth.

3. After the three correlation holes have been completed in accordance with Test Method Nev. T102 and this test method, average the three sand cone moistures and average the three moisture-density gauge moistures. See Table 1 for an example.

4. Determine the moisture content of the samples obtained from the moisture-density gauge/sand cone correlation tests per Test Method Nev. T112. Record these results on the appropriate form. See Table 1 for an example.

5. Use the formula in Table 1 to calculate the moisture correction factor.

6. Follow the flow chart in the moisture-density gauge manual under "Moisture Offsets". Select "Gauge Derived" for source of offset. The moisture-density gauge will derive the moisture offset.

7. Once derived, follow the flow chart in the moisture-density gauge manual under "Moisture Offset - Gauge Derived".

8. Check the moisture offsets every shift and every time a different material is used to ensure that the number entered in the gauge is still the correct value for the material being tested. If the moisture-density gauge turns off, all offsets may default to the off position.

Table 1
In-Place Wet Density Correlation
With Offsets Disabled

Test No.	Sand Cone Wet Density	Nuclear Gauge Wet Density	Difference (±)
1-1B-95	2.239 (139.7)	2.228 (139.0)	
2-1B-95	2.210 (137.9)	2.189 (136.6)	
3-1B-95	2.212 (138.0)	2.228 (139.0)	
Average	2.220 (138.5)	2.215 (138.2)	+ 0.005 (+ 0.3)

Avg. Sand Cone - Avg. Nuclear Gauge = Nuclear Gauge Offset
(carry to .001 (0.1))

Test No.	% Moisture Oven Dry	% Moisture Gauge
1-1B-95	4.8	5.0
2-1B-95	5.4	6.9
3-1B-95	4.9	6.3
Average	5.0	6.1

Calculate the moisture correction factor using the average % moisture oven dry and average % moisture gauge as follows:

$$\text{Moisture Correction Factor} = \left(\frac{\text{avg. \% moisture oven dry - avg. \% moisture gauge}}{\text{100 + avg. \% moisture gauge}} \right) \text{x } 1000$$

Example:

Round to the nearest 0.01

$$\text{Moisture Correction Factor (M.C.F.)} = \left(\frac{5.0 - 6.1}{100 + 6.1} \right) \text{x } 1000 = -10.37$$

Enter the moisture correction factor value into the moisture-density gauge as per the manufacturer's instruction manual. Pay close attention to the algebraic sign.

Once the density and moisture offsets have been entered into the moisture-density gauge, perform two “check tests” at two random locations with the offsets “enabled”. Check tests may be performed on the jobsite or an informational pad using representative material to ensure the results are within the maximum deviation tolerance as shown in Table 2.

Table 2
Tolerances for Two Check Tests
With Offsets Enabled

Maximum deviation is defined as the largest difference between any single moisture-density gauge test and sand cone test (at the same site) obtained during the check tests.

Maximum Deviation for Wet Density:
± .032 Mg/m^3 (± 2.0 lb/ft^3)

Check Tests
(Gauge Correlation Check)

Test No.	Sand Cone Wet Density	Nuclear Gauge Wet Density	Difference (±)
4-1B-95	2.271 (141.7)	2.255 (140.7)	+ 0.016 (+ 1.0)
5-1B-95	2.256 (140.8)	2.239 (139.7)	+ 0.017 (+ 1.1)

Maximum Deviation for Wet Density: + 0.017 (+ 1.1)
(± 0.032 Mg/m^3 or ± 2.0 lb/ft^3 Allowable)

Check Test
(Every 25 Compaction Test)

Test No.	Sand Cone Wet Density	Nuclear Gauge Wet Density	Difference (±)
10-1B-95	2.271 (141.7)	2.255 (140.7)	+ 0.016 (+ 1.0)

Maximum Deviation for Wet Density: + 0.016 (+ 1.0)
(± 0.032 Mg/m^3 or ± 2.0 lb/ft^3 Allowable)

NOTES PERTAINING TO MOISTURE-DENSITY GAUGE CORRELATION PROCEDURE

1. When performing the correlation tests, special attention should be given to ensure the sand cone tests and oven-dry moisture tests are completed carefully and accurately. If the soil is found to be non-uniform during the excavation of the sand cone test, or if the first two moisture-density gauge tests do not check within the 6% tolerance described in the PROCEDURE section, the test site should be abandoned and another site chosen for correlation test purposes.

2. Each correlation will consist of three moisture-density gauge tests and three sand cone tests.

3. Perform all three moisture-density gauge tests and sand cone tests (correlation tests), at the same time to avoid a deviation in the material. Once the density and moisture offsets have been determined and entered into the gauge, perform the moisture-density gauge tests and sand cone tests (check tests), to ensure the offsets were entered correctly, and that the correlation meets the maximum deviation specification for wet density (Table 2).

4. The two check tests for gauge correlation only need to be completed through the field density dry in accordance with Test Method Nev. T102 and this test method.

5. Once the moisture-density gauge is correlated, that moisture-density gauge correlation will be used until any of the conditions listed under RECORRELATION REQUIRED occur.

6. Correlation is gauge specific and will not be used for other gauges.

7. If the moisture-density gauge <u>fails</u> to meet the correlation tolerances, try to re-correlate the moisture-density gauge. If the moisture-density gauge re-correlation is still outside of the correlation tolerances, then sand cone Test Method Nev. T102 shall be performed on that material. There are no exceptions to the correlation procedure. Partial correlations will not be accepted.

PROCEDURE (3440 or 3450 SERIES GAUGES)

1. Use the moisture-density gauge for acceptance testing when a passing moisture-density gauge correlation has been accepted per the correlation tolerances.

2. Prior to performing the moisture-density gauge test, use the "Guide and Site Preparation Device" to clear away all loose surface material to obtain a smooth surface large enough to seat the moisture-density gauge. After the completion of compaction, where sheepsfoot and similar type compaction rollers have been used, remove the loose surface material to a depth of not less than 50 mm (2 in.) below the deepest disturbance by the rollers. If voids are present, fill them in using the material to be tested. Avoid building a pad, by using the 4.75 mm (No. 4) sieve to obtain the - 4.75 mm (- No. 4) material to smooth minor depressions or protrusions to a smoothness within ± 3 mm (± 1/8 in.).

3. Set the count time to one minute by pressing the "TIME" key. The screen will show "TIME: XX min 1 - 15 sec, 2 - 1 min, 3 - 4 min", press the "2" key to select one minute tests. The screen will then go back to the normal display.

4. Check the density and moisture offsets to make sure the proper correlation values are in the gauge for the material being tested. Press the "OFFSET" key and check.

5. Use the guide and drill rod to perforate a hole in the soil that is perpendicular to the surface. The hole shall be 50 mm (2 in.) deeper than the desired test depth. When using the guide and drill rod provided with the moisture-density gauge, the drill rod accounts for the extra 50 mm (2 in.). Place the drill rod through the extraction tool and insert into the scraper plate guide. Remove the drill rod by rotating and pulling up horizontally. Do not loosen the drill rod by tapping from side to side with a hammer. Care should be taken to avoid penetrating the lift below the material being tested.

6. Place source rod in the hole to the desired test depth. Ensure that the bottom of the moisture-density gauge is firmly seated and is in contact with the soil without rocking or tilting. Pull the moisture-density gauge backwards so the source rod is in firm contact with the side of the hole toward the scaler end of the moisture-density gauge.

7. Press the "START/ENTER" key. The screen will show "DEPTH: XX PR: XXXX, TIME: XX sec." After one minute, the counting will stop. The screen will show "%PR= XXX%, DD= XXX WD=XXX M=XX, %M=XX %VOIDS= XXXX". Record the wet density (WD), moisture (M), dry density (DD), and percent moisture (%M) on the appropriate form. Press the "SHIFT" key, then press the "COUNTS" key, and record the density counts and moisture counts. Rotate the moisture-density gauge 10 to 20 degrees and repeat this step. If the difference between the two density counts or the two moisture counts is less than or equal to 6% of the average of the two counts, then the average of these two tests constitutes one in-place test. The 6% rule is used to determine if the material under the moisture-density gauge is uniform.

<u>Example</u>**:**

Density Counts = 1486 and 1512	Moisture Counts = 69 and 64
1512 - 1486 = 26 (difference)	69 - 64 = 5 (difference)
$\frac{1486 + 1512}{2} = 1499$	$\frac{69 + 64}{2} = 67$
1499 x .06 = 90 (maximum allowable)	67 x .06 = 4 (maximum allowable)
* $26 \leq 90$	** $5 > 4$

* Density counts are within the 6% rule.

** Moisture counts are not within the 6% rule.

If either set of counts are <u>not</u> within this tolerance, obtain two additional one minute tests by rotating the moisture-density gauge each time to a new position. Rotate the moisture-density gauge 10 to 20 degrees to the left and right of the first two tested positions. In this case, the average of all four readings constitutes one in-place test and the 6% rule does not apply to the four sets of density counts and moisture counts.

RECORRELATION REQUIRED

The moisture-density gauge shall be re-correlated if any of the following occur:

a. Change in project.
b. Visual change in material or fails with the same compactive effort and moisture.
c. Change in source of material.
d. Check tests not within tolerances.
e. Change in the moisture-density gauge.
f. Moisture-density gauge is calibrated by Manufacturer or CRSO.
g. Compaction readings are over 102 percent.
h. At the discretion of the Engineer.
i. If, at any time, a single check test is out of the ± 0.032 Mg/m^3 (± 2.0 lb/ft^3) maximum deviation per Table 2, a new moisture-density gauge correlation is required.

TEST MAXIMUM DENSITY AND PERCENT RELATIVE COMPACTION

1. Obtain a representative sample of soil from the moisture-density gauge test site.

2. Determine the maximum dry density of the soil sample in accordance with Test Methods Nev. T104 and T108.

3. When the "SHIFT" and "% PR" buttons are pressed at the same time, the moisture-density gauge calculates the % relative compaction of the soil using the following formula:

$$\text{\% Relative Compaction} = \left(\frac{\text{in-place dry density}}{\text{maximum dry density}} \right) \text{x } 100$$

Note 2: Since there will always be at least two and sometimes four tests at each test site, % relative compaction will have to be calculated using the average of the dry densities from the site, divided by the maximum dry density of the particular material.

Note 3: In-place dry density is obtained by averaging the two or four in-place dry densities. Maximum dry density is obtained from Test Methods Nev. T104 and T108.

CHECK TEST

1. Every twenty five acceptance test performed with the moisture-density gauge will require a check of the moisture-density gauge correlation.

2. Run a single moisture-density gauge test and a sand cone test (refer to Figure 1 for correct positioning of the moisture-density gauge and sand cone test). It will also be required that a new calculated maximum dry density be determined. These tests shall be completed in accordance with Test Methods Nev. T102, T104, T108 and this test method.

3. During the check test, the gauge offsets must be enabled.

4. If the single correlation test between the moisture-density gauge and the sand cone test (wet densities) is not within the tolerance ± 0.032 Mg/m^3 (± 2.0 lb/ft^3) listed in Table 2, a new correlation will be required.

NOTES

1. Under no circumstance is the moisture-density gauge (Troxler Model 3440) to be used for testing the compaction of concrete or plantmix bituminous surface. Excessive temperatures may cause serious damage to the gauge affecting its longevity and operating performance.

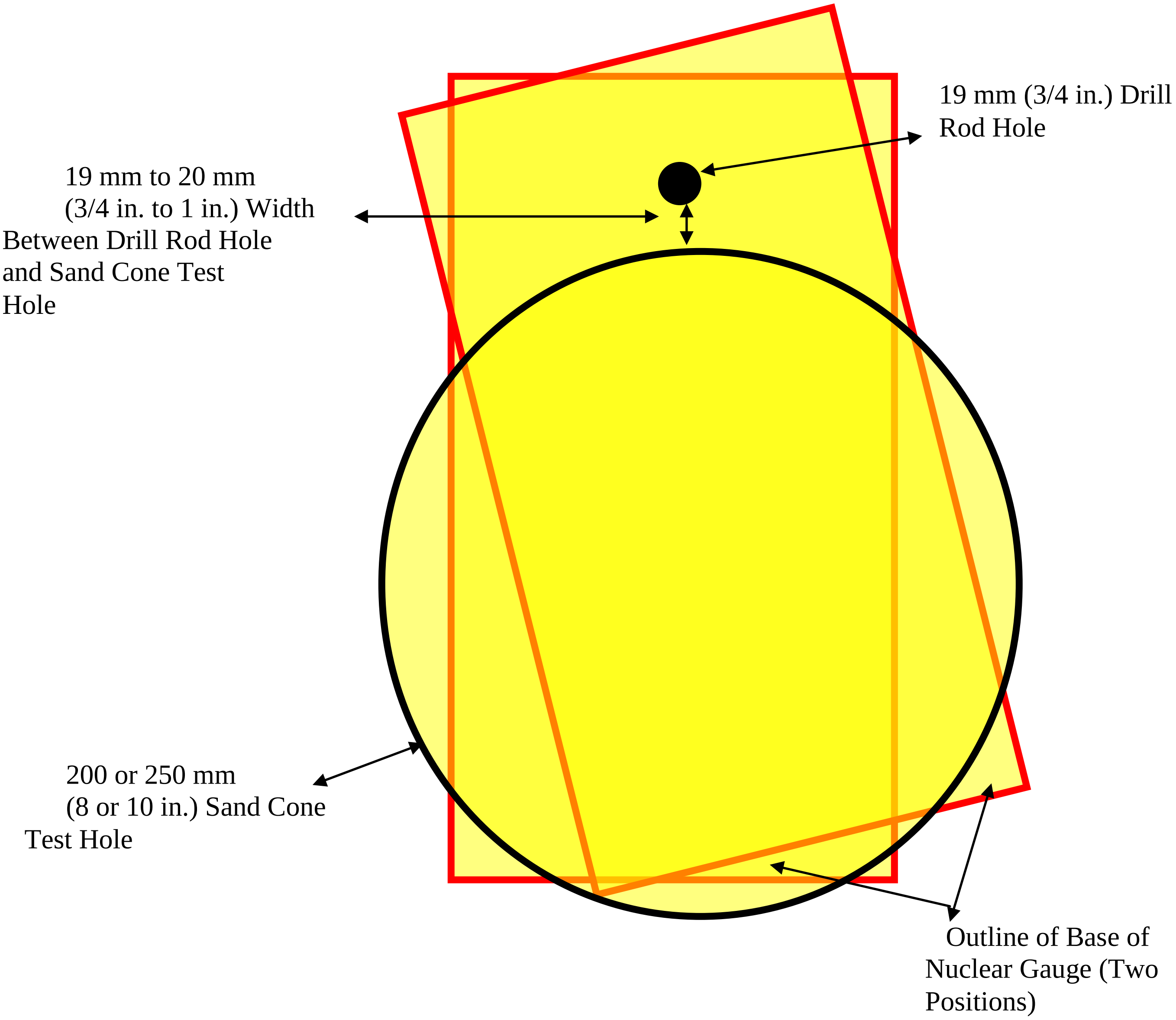
2. When the moisture-density gauge is within .6 m (2 ft) of any vertical object, a trench correction must be used for the moisture tests. Procedures for this setting are outlined in each individual gauge manual.

3. A total of 5 in-place densities (sand cones) are required to be performed for a valid Moisture/Density gauge correlation. A single maximum dry density determination as obtained per Test Method Nev. T108 may be utilized for all five locations.

4. Test Methods Nev. T104 and T108 must be performed whenever a second re-test is required.

REPORT

Report percent compaction to the nearest whole percent.



Correlation Test Site Location
Showing Relative Positions of the Moisture-Density Gauge and the Sand Cone Test

FIGURE 1

Test Method Nev. T104D
October 1, 2008

State of Nevada
Department of Transportation
Materials Division

METHOD OF TEST FOR APPARENT SPECIFIC GRAVITY OF COARSE AGGREGATES

SCOPE

This test method is used to determine the apparent specific gravity of aggregate particles retained on the 4.75 mm (No. 4) and larger sieve sizes.

APPARATUS

1. Balance, having a capacity of 12000 g and sensitive to 0.1 g.
2. Pycnometer, 1 L (1 qt) glass jar fitted with a conical lid having a small opening at the top of the cone.
3. Sieve, U.S. Standard, 4.75 mm (No. 4).

CALIBRATION OF PYCNOMETER

The pycnometer shall be cleaned, dried, and the weight (p) recorded to the nearest gram. Fill the pycnometer with room temperature water 25 ± 5°C (77 ± 9°F). Dislodge any air bubbles clinging to the inside of the pycnometer by gently tapping on the outside of the jar. Top off the pycnometer, forming a meniscus at the top of the opening on the conical lid. Dry the outside of the pycnometer. Weigh the pycnometer + water (p + M) and record to the nearest gram. The weight of the (pycnometer + water) - pycnometer = (M). Record (M) to the nearest gram.

PREPARATION OF SAMPLE

Use the 4.75 mm (No. 4) sieve to obtain a large enough wet sample that will allow for 500 g of dry + 4.75 mm (+ No. 4) material. Thoroughly wash the sample over a 4.75 mm (No. 4) sieve and dry in accordance with Test Method Nev. T112. Obtain 500 g of + 4.75 mm (+ No. 4) dry material (A) and record to the nearest gram.

PROCEDURE

1. Fill the pycnometer to approximately one third full of water before the sample is introduced, this will decrease the chances of breaking the jar. Place the sample in the pycnometer. Use caution not to lose any of the sample while transferring it to the pycnometer. Fill the pycnometer with room temperature water 25 ± 5°C (77 ± 9°F) to the top of the opening on the conical lid.

2. Remove entrapped air by placing a finger over the opening on the pycnometer lid while turning the pycnometer to a horizontal position, then rotating it in the hands. Set the pycnometer aside for a few minutes and repeat the rolling procedure. Removal of air bubbles clinging to the inside of the jar is facilitated by moving the jar so that aggregate particles slide across the side of the jar, dislodging the bubbles during the rolling process and by tapping the side of the jar after rolling is completed.

3. After removing entrapped air, add room temperature water 25 ± 5°C (77 ± 9°F) to refill the pycnometer, forming a meniscus at the top of the opening of the conical lid. Dry the outside of the pycnometer. Weigh the pycnometer + water + aggregate (p + M + A) and record to the nearest gram. The weight of the (pycnometer + water + aggregate) – (pycnometer + aggregate) = (M_1). Record (M_1) to the nearest gram.

4. Place a straw into the opening of the lid and pour off the water into a tared container, recovering as much of the water as possible. Weigh the water recovered from the pycnometer (M_2) and record to the nearest gram.

    a. If the difference between the amount of water added (M_1) and the amount of water recovered (M_2) is 14 g or less, use Formula No. 1 under the "CALCULATIONS" Section, to calculate the apparent specific gravity.

    b. If the difference between the amount of water added (M_1) and the amount of water recovered (M_2) exceeds 14 g, use Formula No. 2 under the "CALCULATIONS" Section, to calculate the apparent specific gravity.

CALCULATIONS

1. When $M_1 - M_2$ is less than or equal to 14 g:

$$\text{Apparent Specific Gravity} = \frac{A}{M - M_1}$$

2. When $M_1 - M_2$ is greater than 14 g:

$$\text{Apparent Specific Gravity} = \frac{A}{(M - M_1) + 0.5\,(M_1 - M_2 - 14)}$$

Where:

A = Weight of dried aggregate

p = Weight of pycnometer

M = Weight of water used to calibrate pycnometer

M_1 = Weight of water used in pycnometer with sample

M_2 = Weight of water recovered from pycnometer and aggregate

REPORT

Report apparent specific gravity to the nearest 0.01.

Test Method Nev. T108B
January 1, 2014

State of Nevada
Department of Transportation
Materials Division

METHOD OF TEST FOR THE DETERMINATION OF MAXIMUM DENSITY AND OPTIMUM MOISTURE CONTENT OF SOILS USING THE MODIFIED PROCTOR DEVICE

SCOPE

This test method is intended to determine the relationship between the moisture content and density of soils when compacted in a specified mold using a 4.54 kg (10 lb) rammer with a 457 mm (18 in.) drop. The maximum density and optimum moisture determined by this test shall be used for determining relative percent compaction in the field.

Method A applies to materials that have 40% or less retained on the 4.75 mm (No. 4) sieve. This value may be obtained from results determined per Test Method Nev. T206. Perform Test Method Nev. T206 to determine the percentage of the +4.75 mm (+No. 4) coarse aggregate.

Method D applies to materials that have 30% or less retained on the 19.0 mm (3/4 in.) sieve. This value may be obtained from results determined per Test Method Nev. T206. Perform Test Method Nev. T206 to determine the percentage of the +19.0 mm (+3/4 in.) coarse aggregate.

When both criteria are met for determining “Method A” and “Method D”, “Method A” shall be used.

For materials that do not otherwise require a sieve analysis to be performed, a representative sample shall be obtained, split, dried and screened through both a 4.75 mm (No. 4) and 19.0 mm (3/4 in.) to determine as to whether “Procedure Method A” or “Procedure Method D” is to be performed.

If the specified oversized maximum tolerances are exceeded, other methods of compaction control must be used.

APPARATUS

1. Mold, machined solid-wall metal cylinder having the dimensions as detailed in Table 1 or Table 2, a detachable collar and base plate to which the mold can be fastened to.

2. Rammer, mechanically or manually operated rammer as detailed in Table 1 or Table 2. A manually operated rammer shall be equipped with a suitable guide sleeve to control the path and height of the specified drop. The guide sleeve shall also be equipped with at least four vent holes no smaller than 9.5 mm (3/8 in.). A mechanically operated rammer shall be equipped with a device to uniformly distribute drops at specified heights.

3. Sample Extruder, jack, lever-frame, or other suitable device used for the purpose of extruding compacted specimens from the mold.

4. Balance, with a capacity of 12000 g and sensitive to 0.1 g.

5. Oven, capable of maintaining a temperature of 110 ± 5 °C (230 ± 9 °F).

6. Microwave, electric hot plate or gas stove.

7. Sieves, **Method A** - 4.75 mm (No. 4) or **Method D** - 19.0 mm (3/4 in.)

8. Straightedge, steel straightedge at least 250 mm (10 in.) in length, having one beveled edge and at least one plane surface, used for final trimming of the compacted specimen.

9. Mixing Tools, large mixing bowl, large pan, mixing spoon, scoop, tamper, trowel, spatula, hammer, etc. or other suitable devices for mixing the sample with water.

Table 1 (Metric)
Comparison of Apparatus, Sample, and Procedure

	Method A	Method D
Mold Volume, m^3	0.000943	0.002123
Mold Diameter, mm (Internal)	101.60 ± 0.41	152.40 ± 0.66
Mold Height, mm	116.43 ± 0.13	116.43 ± 0.13
Rammer Diameter, mm	50.80 ± 0.64	50.80 ± 0.64
Rammer Mass, kg	4.54 ± 0.01	4.54 ± 0.01
Lifts	5	5
Blows per Lift	25	56
Material Size, mm	4.75	19.0
Test Sample Size, kg	3.5	11.0
Rammer Drop Height, mm	457	457
Energy, kN-m/m^3	2,693	2,693

Table 2 (English)
Comparison of Apparatus, Sample, and Procedure

	Method A	Method D
Mold Volume, ft³	0.0333	0.0750
Mold Diameter, in. (Internal)	4.00 ± 0.02	6.00 ± 0.03
Mold Height, in.	4.58 ± 0.01	4.58 ± 0.01
Rammer Diameter, in.	2.00 ± 0.03	2.00 ± 0.03
Rammer Mass, lb	10.0 ± 0.02	10.0 ± 0.02
Lifts	5	5
Blows per Lift	25	56
Material Size, in.	No. 4	¾”
Test Sample Size, lb	7.71	24.25
Rammer Drop Height, in.	18	18
Energy, lb-ft/ft³	56,250	56,250

PROCEDURE – METHOD A

1. **Method A** - From a thoroughly blended sample as obtained per Test Method Nev. T200, thoroughly screen the blended sample over a 4.75 mm (No. 4) sieve. Split the remaining material passing the 4.75 mm (No. 4) sieve until a 3,500 g ± 350 g sample is obtained.

2. Squeeze a handful of material, and if a mold is formed which can be picked up readily with the thumb and index finger, sufficient moisture is present in the soil to begin the test. If a cast is not formed, add sufficient moisture to the sample at a rate not to exceed 2% of the total weight of the sample (depending on soil consistency) and mix thoroughly until the soil mixture appears uniform (ex. 3,500 g x .02 = 70 mL). Repeat this procedure until a sufficient moisture content for beginning the test is found. Cover the mixing bowl or pan with a damp cloth; keeping it covered throughout the test procedure. If the material is above its optimum moisture, it may be air dried or dried back in an oven not to exceed 60 °C (140 °F)

3. Determine the weight of the clean, dry mold. Include the base plate, but exclude the collar extension and record this weight to the nearest 1 g.

4. Form a specimen by compacting the prepared sample in the mold (with the collar extension attached) in 5 equal lifts. For each lift, uniformly spread the loose material in the mold and tamp it flat with the tamper. Compact each lift with 25 uniformly distributed blows from the rammer, dropping free from a height of 457 mm (18 in.). Make sure the fifth and final lift will leave the compacted soil surface in the collar approximately 6 mm (¼ in.) above the top of the mold.

5. Remove the extension collar using a twisting motion to avoid shearing off the sample below the top of the mold. Trim the compacted specimen even with the top of the mold using the beveled edge of the straightedge.

6. Determine the weight of the compacted specimen, mold and base plate and record this weight to the nearest 1 g.

7. Determine the weight of the compacted specimen by subtracting the weight of the mold as determined in Step 3 of this procedure.

Wet Weight of Specimen = (Weight of Mold + Specimen) – Weight of Mold

Wet Density = Wet Weight of Specimen / Volume of Mold

8. Place the mold in the sample extruder and remove the compacted specimen. Cutting vertically through the center, take a representative sample (approx. 200g – 500g) from the full length and width of the specimen as illustrated in FIGURE 1. Separate the particles of the representative sample; place the sample in a suitable drying container and immediately record the weight of the wet sample to the nearest 0.1 g. Dry the sample in accordance with Test Method Nev. T112.

9. Break up the remaining portion of the compacted specimen until it will pass through a 4.75 mm (No. 4) sieve and recombine it with the remaining portion of the sample in the mixing bowl or pan being tested. Thoroughly blend the sample in a mixing bowl or pan and add 2 percent water at 25 ± 5 °C (77 ± 9 °F) NOTE: (1 mL = 1 g).

10. Continue to repeat the procedures as outlined in Step 4 thru Step 9 until there is either a decrease or no change in the wet density of the compacted specimen. With moisture additions in increments of 2 %, multiple determinations may be necessary to determine a materials maximum dry density.

11. Dry all specimens using one of the methods outlined in Test Method Nev. T112 or by the following microwave oven procedure: Place a 600 mL glass beaker or other suitable container filled with approximately 300 mL of water (maintain water level during drying) into the microwave oven to prevent overheating during the drying process. Place specimen in a microwave safe container, then place in the microwave oven. Dry the sample for 5 minutes, then at 2 minute intervals until a constant weight is achieved. Drying times may be adjusted based on type and size of the microwave oven.

12. At the completion of the drying procedure, allow specimens to cool. Weigh and record the dry weight of each specimen to the nearest 0.1 g, then calculate the percent moisture to the nearest 0.1%.

% Moisture = [(Wet Weight of Specimen – Dry Weight of Specimen) / (Dry)] x 100

Dry Density = [(Wet Density) / (100 + % Moisture)] x 100

PROCEDURE – METHOD D

1. **Method D -** From a thoroughly blended sample as obtained per Test Method Nev. T200, thoroughly screen the blended sample over a 19.0 mm (3/4 in.) sieve. Split the remaining material passing the 19.0 mm (3/4 in.) sieve until an 11,000 g ± 1,100 g sample is obtained.

2. Squeeze a handful of material, and if a mold is formed which can be picked up readily with the thumb and index finger, sufficient moisture is present in the soil to begin the test. If a cast is not formed, add sufficient moisture to the sample at a rate not to exceed 2% of the total weight of the sample (depending on soil consistency) and mix thoroughly until the soil mixture appears uniform (ex. 11,000 g x .02 = 220 mL). Repeat this procedure until a sufficient moisture content for beginning the test is found. Cover the mixing bowl or pan with a damp cloth; keeping it covered throughout the test procedure. If the material is above its optimum moisture, it may be air dried or dried back in an oven not to exceed 60 °C (140 °F)

3. Determine the weight of the clean, dry mold. Include the base plate, but exclude the collar extension and record this weight to the nearest 1 g.

4. Form a specimen by compacting the prepared sample in the mold (with the collar extension attached) in 5 equal lifts. For each lift, uniformly spread the loose material in the mold and tamp it flat with the tamper. Compact each lift with 56 uniformly distributed blows from the rammer, dropping free from a height of 457 mm (18 in.). Make sure the fifth and final lift will leave the compacted soil surface in the collar approximately 6 mm (¼ in.) above the top of the mold.

5. Remove the extension collar using a twisting motion to avoid shearing off the sample below the top of the mold. Trim the compacted specimen even with the top of the mold using the beveled edge of the straightedge.

6. Determine the weight of the compacted specimen, mold and base plate and record this weight to the nearest 1 g.

7. Determine the weight of the compacted specimen by subtracting the weight of the mold as determined in Step 3 of this procedure.

   Wet Weight of Specimen = (Weight of Mold + Specimen) – Weight of Mold

   Wet Density = Wet Weight of Specimen / Volume of Mold

8. Place the mold in the sample extruder and remove the compacted specimen. Cutting vertically through the center, take a representative sample (approx. 200g – 500g) from the full length and width of the specimen as illustrated in FIGURE 1. Separate the particles of the representative sample; place the sample in a suitable drying container and immediately record the weight of the wet sample to the nearest 0.1 g. Dry the sample in accordance with Test Method Nev. T112.

9. Break up the remaining portion of the compacted specimen until it will pass through a 19.0 mm (3/4 in.) sieve and recombine it with the remaining portion of the sample in the mixing bowl or pan being tested. Thoroughly blend the sample in a mixing bowl or pan and add 2 percent water at 25 ± 5 °C (77 ± 9 °F) NOTE: (1 mL = 1 g).

10. Continue to repeat the procedures as outlined in Step 4 thru Step 9 until there is either a decrease or no change in the wet density of the compacted specimen. With moisture additions in increments of 2 %, multiple determinations may be necessary to determine a materials maximum dry density.

11. Dry all specimens using one of the methods outlined in Test Method Nev. T112 or by the following microwave oven procedure: Place a 600 mL glass beaker or other suitable container filled with approximately 300 mL of water (maintain water level during drying) into the microwave oven to prevent overheating during the drying process. Place specimen in a microwave safe container, then place in the microwave oven. Dry the sample for 5 minutes, then at 2 minute intervals until a constant weight is achieved. Drying times may be adjusted based on type and size of the microwave oven.

12. At the completion of the drying procedure, allow specimens to cool. Weigh and record the dry weight of each specimen to the nearest 0.1 g, then calculate the percent moisture to the nearest 0.1%.

$$\% \text{ Moisture} = [(\text{Wet Weight of Specimen} - \text{Dry Weight of Specimen}) / (\text{Dry})] \times 100$$

$$\text{Dry Density} = [(\text{Wet Density}) / (100 + \% \text{ Moisture})] \times 100$$

MOISTURE-DENSITY RELATIONSHIP

1. Calculations shall be made to determine a materials wet density (unit mass) and oven-dry density (unit mass). The oven-dry densities of the soil shall be plotted as ordinates (y-axis) and corresponding moisture contents as abscissa (x-axis).

2. When the densities and corresponding moisture contents for the soil sample have been determined and plotted, it shall be found that by connecting the plotted points with a smooth line, a curve is produced. The moisture content corresponding to the peak of the curve shall be termed the “optimum moisture content.”

3. The oven-dry density in kilograms per cubic meter or pounds per cubic foot of the soil at optimum moisture content shall be termed “maximum density” under the above compaction.

COARSE AGGREGATE CORRECTION

Method A, When the test specimen contains material exceeding 5 percent by mass retained on the 4.75 mm (No.4) sieve, use the following “Coarse Aggregate Correction” calculations. Use Test Method Nev. T104 to determine the apparent specific gravity of the +4.75 mm (+No. 4) aggregate. Use the percent of +No. 4 aggregate as determined per Test Method Nev. T206.

Method D, When the test specimen contains material exceeding 5 percent by mass retained on the 19.0 mm (3/4 in.) sieve, use the following “Coarse Aggregate Correction” calculations. Use Test Method Nev. T104 to determine the apparent specific gravity of the +19.0 mm (+3/4 in.) aggregate. Use the percent of +3/4 in. aggregate as determined per Test Method Nev. T206.

Correction for the +4.75 mm (+No.4) or +19.0 mm (+3/4 in.) material shall be calculated as follows:

$$D = \frac{dG}{(d)(1\text{-}P) + (G)(P)}$$

Example:	D	= Corrected Calculated Max. Density	
	d	= Maximum Dry Density	140.4 lbs/ft³
	1- P	= Percent +No.4 or +3/4 in. Aggregate	(0.27) 27%
	P	= Percent -No.4 or -3/4 in. Aggregate	(0.73) 73%
		Apparent Specific Gravity of Coarse Aggregate	2.70
	G	= Mass per Volume of Coarse Aggregate: (2.70 x 62.4)	168.5 lb/ft³

$$D = \frac{(140.4\ \text{lb/ft}^3) \times (168.5\ \text{lb/ft}^3)]}{[(140.4\ \text{lb/ft}^3 \times 0.27) + (168.5\ \text{lb/ft}^3 \times 0.73)]}$$

$$D = 147.0\ \text{lb/ft}^3$$

Corrected Optimum Moisture Calculation:

$$[(1\text{-}P) \times 2] + [P \times \text{Test Opt. Moisture}]$$

REPORT

Report optimum moisture content or corrected optimum moisture content to the nearest 0.1% and maximum density or corrected maximum density to the nearest 0.1 lb/ft³

NOTES

1. When preparing the initial sample, thoroughly mix with a sufficient amount of water to moisture condition it to approximately three percentage points below the samples optimum moisture content.

2. It's important to place the loose material into the mold and spreading it into a layer of uniform thickness and tamp it with the tamper prior to the compaction of each lift. Do not allow material to build up the sides of the mold between lifts. If this occurs, break down and tamp the material before the final blow is completed or before the next lift is started.

3. When completing a Proctor Compaction Curve Test on gypsum or material blended with recycled asphalt pavement, dry in accordance with Test Method Nev. T112, Method A, under "PROCEDURE", using a temperature of 60 °C (140 °F), to avoid changing the nature of the sample.

4. A valid Modified Proctor Test shall consist of a minimum of three points for the maximum dry density determination consisting of one point below optimum, one near optimum and one over optimum.

5. A new Proctor Curve Test shall be performed whenever results indicate changes to materials, a second re-test is required, test results exceeding 102% compaction or at the discretion of the Resident Engineer.

6. Percentages retained on the +4.75 mm (+No. 4) and +19.0 mm (+3/4 in.) should be determined each time a Proctor Curve is performed to verify that the correct method is being utilized as described in the SCOPE of this Method.

7. In instances where soil materials indicate fragile characteristics (such as the breaking of aggregate) that will reduce significantly by repeated compaction, a separate and new sample shall be used for each compaction test.

   When utilizing "Method A", obtain a minimum of three separate samples approximately 2,500 g as described in Step 1 of "PROCEDURE – METHOD A". Each individual sample shall represent one compaction test after it has been properly moisture conditioned in increments of 2%.

   When utilizing "Method D", obtain a minimum of three separate samples approximately 5,500 g as described in Step 1 of "PROCEDURE – METHOD D". Each individual sample shall represent one compaction test after it has been properly moisture conditioned in increments of 2%.

8. When developing a compaction curve for free draining soils, such as uniform sands and gravels, where seepage occurs at the bottom of the mold and base plate, taking a representative moisture sample from the mixing bowl shall be acceptable.

9. Do not use the hammer to extract the material from the mold.

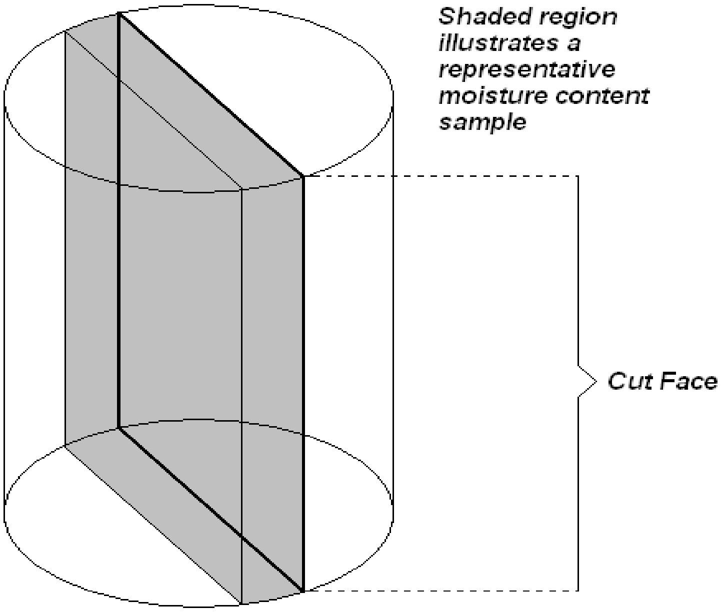


FIGURE 1

Test Method Nev. T111D

State of Nevada
Department of Transportation
Materials and Testing Division

METHOD OF TEST FOR SPECIFIC GRAVITY AND ABSORPTION OF COARSE AGGREGATE

SCOPE

This test method, which is a modification of AASHTO Designation T85, specifies procedures for the determination of the bulk and apparent specific gravity, and absorption of coarse aggregates, and is designed for the use in the Headquarters, Progress, and Field Laboratories.

The oven-dry basis calculation for bulk specific gravity shall be used for the determination of the specific gravity of riprap aggregates, and is also used for bituminous mix aggregates. The saturated surface-dry basis calculation for bulk specific gravity is used for portland cement concrete aggregates. The apparent specific gravity is used in determining the calculated maximum density, Nev. T101

A. APPARATUS

1. A balance having a capacity of at least 5,500 g. and sensitive to 0.5 g. or less and accurate within 0.1 percent of the test load at any point within the range used for the test.

2. A wire basket made of 3.35mm (No. 6) or 2.36mm (No. 8) mesh, and dimensions such that the basket will have sufficient capacity for samples up to 5,500 g. maximum. A generally satisfactory size is 203.2mm x 203.2mm x 114.3mm (8 x 8 x 4-1/2 in.) deep.

3. A container of sufficient size to allow the wire mesh basket to be completely immersed. A copper tank, 292.1mm x 355.5mm x 203.2mm (11-1/2 x 14 x 8 in.) deep is satisfactory for the 203.1mm sq. (8-in. sq.) basket described above.

4. Suitable apparatus for suspending the immersed basket from the balance so that the weight of the aggregate in water can be obtained.

5. Vessels, each of approximately 7.6 liters (2-gallon) capacity, that are deep enough to permit immersing entire sample during soaking period.

B. TEST RECORD FORM

Record the test data on worksheet

C. PREPARATION OF SAMPLE

Obtain approximately 5,000 g. of the coarse aggregate (retained on 4.75 mm (No. 4)sieve) either by careful quartering or by the use of an accurate mechanical sample reducer. (Refer to Test Method Nev. T203.)

D. TEST PROCEDURE

1. Place sample in vessel, cover with water at a temperature of 23± 1.7° C. (73.4± 3° F.) and allow to soak for a minimum period of 15 hrs.

2. Pour sample into wire basket, rinse clean, suspend the wire basket from the center of the balance scale pan, immerse basket completely in the water at 23± 1.7° C.(73.4± 3° F.) use suitable tare weight, and weigh to nearest gram. Record weight as Weight of Sample in Water.

3. Remove basket, drain off free water for a few seconds, then pour sample out of basket onto large absorbent cloth, and roll the sample in the cloth until all visible films of water are removed, although the surface of the particles may still appear to be damp. Large aggregate particles may be individually wiped in lieu of rolling in cloth. In order to avoid evaporation of absorbed water, perform this surface drying operation as rapidly as possible and then immediately weigh to the nearest gram. Record weight as Weight of Saturated Surface-dry Sample in air.

4. Pour sample into suitable drying pan, dry sample to constant weight in oven at a temperature of 110± 5° C. (230± 9° F.), cool to room temperature, for 1 to 3 hours, pour sample into balance, use suitable tare weight, and weigh to nearest gram. Record weight as Oven-dry Weight.

E. CALCULATIONS

1. Calculate the bulk specific gravity, oven-dry basis, from the following formula:

$$\text{Bulk specific gravity (oven-dry basis)} = \frac{\overset{A}{\cancel{B}}}{B - C}$$

Where:

A= weight in grams of sample in oven-dry condition

B= weight in grams of sample in saturated surface-dry condition, and

C= weight in grams of saturated sample immersed in water

2. Calculate the bulk specific gravity, saturated surface-dry basis, from the following formula:

$$\text{Bulk specific gravity (saturated surface-dry basis)} = \frac{B}{B - C}$$

3. Calculate the apparent specific gravity from the following formula:

$$\text{Apparent specific gravity} = \frac{A}{A - C}$$

4. Calculate the percentage of absorption from the following formula:

$$\text{Percent absorption} = \frac{B - A}{A} \times 100$$

F. PRECAUTIONS

When tare weights are used to compensate the weight of the basket and/or apparatus used to suspend the basket from the balance, be certain the correct tare weight is used.

G. REPORTING THE RESULTS

Report the specific gravities to the nearest hundredth (2.65, 2.52, etc.), and absorptions to the nearest tenth 1.4, 2.3, etc.).

REFERENCE

AASHTO Designation T85

Test Method Nev. T112F
January 1, 2014

State of Nevada
Department of Transportation
Materials Division

METHOD OF TEST FOR MOISTURE CONTENT IN SOILS AND AGGREGATES

SCOPE

This test method is used to determine the percent of moisture in soil or aggregate samples where rapid determinations of moisture contents are necessary. The moisture content is expressed as the percentage by weight of the dry material.

Alternative methods identified as Method A and B are provided. Method A, "Thermostatically Controlled Oven", is used for standard moisture content or in the event of a dispute (referee method). Method B, "Hot Plate or Gas Stove", is used for rapid determination of moisture content.

APPARATUS

1. Balance, having a capacity of 12000 g and sensitive to 0.1 g.
2. Oven, capable of maintaining a temperature of 110 ± 5ºC (230 ± 9ºF).
3. Electric hot plate or gas stove.
4. Sample containers, any suitable container with a lid that will prevent loss of moisture during transport.
5. Drying pans, trowels, spoons, spatulas, gloves, safety glasses, etc.

SAMPLING

Sample in accordance with Test Method Nev. T200.

PREPARATION OF SAMPLE

1. Samples shall be transported in covered and sealed containers to prevent moisture loss. Do not remove sample until material is ready to be tested. All samples should be tested within 1 hour of sampling.
2. Obtain a representative sample in accordance with Test Method Nev. T203, with as little handling of the material as possible to avoid moisture loss due to evaporation.

3. The size of sample for Method A or B shall be a 1000 g minimum for material up to 25 mm (1 in.) maximum size. For all larger sizes, the size of the moisture sample shall be 2000 g minimum.

PROCEDURE

METHOD A (Thermostatically Controlled Oven), referee method

1. Weigh wet sample and record to the nearest 1 g.
2. Spread sample uniformly in drying pan and dry for a minimum of 12 hours and until a constant weight has been achieved, using a thermostatically controlled oven at 110 ± 5ºC (230 ± 9ºF). Drying time is influenced by soil type, size of the sample and number of samples in the drying oven.
3. Remove dry sample from the oven and allow it to cool to room temperature.
4. Weigh dry sample and record to the nearest 1 g.

METHOD B (Hot Plate or Gas Stove Method)

1. Weigh wet sample and record to the nearest 1 g.
2. Spread material uniformly in a drying pan and dry to a constant weight on a hot plate or gas stove, taking care not to burn the material. Stir the sample frequently to ensure complete and uniform drying. Avoid temperatures at which free water boils violently, causing material to spatter out of the pan, or the rock particles containing entrapped moisture to fracture.
3. Remove dry sample from the hot plate or gas stove and allow it to cool to room temperature.
4. Weigh dry sample and record to the nearest 1 g.

CALCULATIONS

1. Calculate the moisture content using the following formula:

$$\%\ \text{Moisture} = \left(\frac{\text{wet weight - dry weight}}{\text{dry weight}} \right) \text{x } 100$$

REPORT

Report moisture content to the nearest 0.1 percent.

PRECAUTIONS

When obtaining a moisture content for gypsum or recycled asphalt pavement material (rap material), dry in accordance with Method A, under “PROCEDURE”, using a temperature of 60°C (140°F), to avoid changing the nature of the sample.

Test Method Nev. T200D
Effective March 21, 2003

State of Nevada
Department of Transportation
Materials Division

STANDARD METHODS OF SAMPLING STONE, GRAVEL, SAND AND PAVING MIXTURES FOR USE AS HIGHWAY MATERIALS

SCOPE

This method, which is a modification of AASHTO Designations T2 and T168 is intended to apply to the sampling of stone, gravel, sand and certain paving mixtures for the following purposes:

- Preliminary investigation of sources of supply.
- Acceptance or rejection of sources of supply.
- Inspection of shipments of materials.
- Inspection of materials on the site of the work.

Among the types of materials covered by this method are'base aggregates, aggregates for bituminous courses, aggregates for Portland Cement products, plantmix and roadmix bituminous paving mixtures, and Portland Cement treated base mixtures.

A. SECURING SAMPLES

1. Samples of all materials for tests upon which are to be based the acceptance or rejection of the supply, shall be taken by the Engineer or his authorized representative. Samples for informational tests may be submitted by the contractor, seller or owner of the supply.
2. Sampling is as important as the testing, and the sampler shall use every precaution to obtain samples that will show the true nature and condition of the materials that they represent.

B. PROCEDURES

1. Stone from Ledges or Quarries
    a. Inspect the ledge or quarry face of the stone to determine any variation in different strata.
    b. Obtain separate samples of stone from all strata that appear to vary in color and structure. Include overburden as a separate sample.

c. Each sample should weigh at least 50 pounds (23 kg), and should consist of specimens that are not obviously weathered beyond a degree of usefulness for the purposes intended.

d. When the toughness or compression test is required, include one piece in each sample of not less than 6" x 6" x 4" (150 mm x 150 mm x 100 mm) in size with the bedding plane clearly marked. This piece should be free of seams or fractures.

e. Pieces that have been damaged by blasting shall not be included in the sample.

2. Field Stone and Boulders

Carefully inspect the deposits of field stone and boulders over the area where the supply is to be obtained. Note and record the different kinds of stone and the condition in the various deposits.

a. Select separate samples of all classes of stone that visual inspection indicates would be considered for use in construction. Individual samples shall weigh at least 50 pounds (23 kg).

b. Estimate and record the percentages of different classes of stone that were sampled, and the percentages of material that can be rejected by visual examination and may therefore have to be handled and rejected.

3. Deposits of Sand and Gravel

a. If the deposit is worked as an open-face bank or pit, take the sample by channeling the face vertically, bottom to top, so that the sample will be representative of the material to be used.

   (1) If visual inspection indicates that there is considerable variation in the material, select individual samples to represent the material in each well-defined stratum. Include overburden or disturbed material as a separate sample. Note and record the elevations of the individual strata.

   (2) Where there is little or no variation in the material, obtain a large sample from each test location and reduce to the proper size by thorough mixing and quartering.

b. If the deposit does not have an exposed face, or if samples are desired in other parts of a proposed deposit, excavate or drill test holes at numerous locations to determine the quality of the material and the extent of the deposit. The number and depth of these test holes will depend on the quantity of the material needed, topography of the area, nature of the deposit, character of the material and value of the resultant product.

c. Size of the samples shall be such that at least 25 pounds (12 kg) of sand and 75 pounds (34 kg) of gravel are available for tests, if both are present.

d. Estimate the quantity of the different materials that are available in the deposit

4. Stockpiles

a. Sample at the top, middle, bottom and around the circumference. Do not sample exposed material. Be aware of the segregation that usually occurs when material is stockpiled, with the coarser particles rolling to the outside base of the pile.

(1) Separate samples may be tested individually to show the extent of variation existing in the stockpile.

(2) Separate samples may be combined to form a composite sample to show the overall quality of the stockpile.

(3) When possible, use power equipment to expose various levels of the stockpile.

(4) Use a board shoved into the pile above the point of sampling to aid in preventing further segregation during sampling.

b. Sample size shall be as outlined in Section C below.

5. Conveyor Belt

a. Sample aggregate when the plant is in full production and there is a uniform layer of material on the belt. Stop the belt before sampling unless a special device is used to sample the complete cross section of flow. (See paragraph 11a. below)

b. Sample from the entire width of the belt. Use a metal plate, shaped to fit the contour of the belt, to isolate the sample and to prevent segregation during sampling.

c. Use a brush to collect all fines.

   d. Sample size shall be as outlined in Section C below.

6. Storage Bins

   a. Sample from the bin as the material is being discharged.

   b. Allow sufficient material to flow before sampling to insure normal uniformity.

   c. Sample from the complete cross section of flow.

   d. Sample size shall be as outlined in Section C below.

7. Transport Vehicles

   a. Use the following procedure for trucks, railroad cars or any other uncovered vehicle.

   b. Make three or more trenches across the width of the load, depending on the size of the load and the amount of material segregation.

      (1) The bottom of the trench should be at least one foot below the surface of the aggregate at the sides of the vehicle and approximately one foot wide at the bottom.

      (2) The bottom of the trench should be as level as possible.

   c. Take five different equal portions from the trench at equally spaced intervals with two portions being against the sides of the vehicle.

   d. Sample size shall be as outlined in Section C below.

8. Processed Windrows

   a. Remove the top one-half of the windrow by cutting a trench across the width of the windrow.

      (1) Slope the sides of the trench to prevent segregation during sampling.

      (2) Remove all disturbed material from the sampling area.

      (3) Strike off the ends of the trench vertically with the blade of the shovel.

b. Sample the full length of the trench prepared as above.

  (1) Remove material to a depth of at least one and one-half times the maximum size of the particles.

  (2) Sample from each end of the trench toward the center.

c. Sample size shall be as outlined in Section C below.

9. Paving Machine

  a. Sample from the windrow in front of paving machine or in front of the auger before spreading and screeding.

  b. Collect the sample at intervals to represent and entire truckload of material.

  c. Obtain the sample from both sides of the paving machine.

  d. Sample size shall be as outlined in Section C below.

10. Roadbed, behind laydown machine

  a. Take samples from the roadbed behind the laydown machine and prior to rolling.

  b. Take three samples of material deposited from one truckload and combine to form a single composite sample.

    (1) Samples shall be taken from the first, middle and last parts of the load.

    (2) Samples shall be equal portions from the left, center and right segments of the placement.

    (3) Remove material in a neat, clean-cut hole to prevent segregation. Remove all loose particles to the full depth of placement.

    (4) Composite sample size shall be as outlined in Section C below.

11. Sampling with Mechanical Devices

    a. Crushing plants may be equipped with some type of mechanical device for securing samples of the finished product prior to or as the material leaves the conveyor belt for the bin or stockpile.

C. NUMBER AND SIZE OF SAMPLES

1. The number of samples required depends on the intended use of material, quantity of material, involved and variations in the material. A sufficient number of samples must be obtained, as outlined above, to cover all variations in the material. Where multiple samples are taken to show variation, each sample shall conform to the minimum size specified below.

2. Frequencies for sampling processed construction materials in the field are set forth in the Department's Construction Manual, Section 4-701.2, and in the Material Division's Sampling Letter for each contract.

3. Sample Sizes

    a. The sample sizes set forth below are tentative. Quantities must be based on the type and number of tests to which the material is to be subjected and sufficient material obtained to provide for proper execution of these tests. Generally speaking, the amounts specified in Table 1 will provide adequate material for routine grading analysis. The minimum amount depends on maximum size of the particles, as follows:

TABLE 1 – SIZE OF SAMPLES

Nominal Maximum Size of Particles, Passing Sieve	Minimum Weight of Field Sample, Pounds (Kilograms)
No. 10 (2.00 mm)	10 (5 kg)
No. 4 (4.75 mm)	10 (5 kg)
3/8" (9.75 mm)	10 (5 kg)
1/2" (12.50 mm)	20 (10 kg)
3/4" (19.00 mm)	30 (15 kg)
1" (25.00 mm)	50 (25 kg)
1-1/2" (37.00 mm)	70 (30 kg)
2" (50.00 mm)	90 (40 kg)
2-1/2" (63.00 mm)	100 (45 kg)
3" (75.00 mm)	125 (60 kg)
3-1/2" (90.00 mm)	150 (65 kg)

b. Field samples of bituminous and cement treated mixtures taken from the roadbed behind the paver, shall not be less than 144 square inches (1000 sq cm) of pavement surface area, and shall extend full depth of the course of bituminous mixture placed.

4. The samples prepared for tests shall be obtained from the field sample by quartering or other suitable means to insure a representative portion.

D. MARKING AND SHIPPING SAMPLES

1. Each sample or separate container of material submitted for testing shall be accompanied by form # 032-018.

    a. Location of proposed use of material (County, Contract or E.A. Number, Project Number).

    b. Type of material (if classified), name of producer and if commercial source.

    c. Geographic location of source.

    d. Quantity of material or amount of work represented by sample.

        (1) By whom taken, and official title of the sampler.
        (2) Date sampled and date shipped.

2. Immediately upon sampling, samples shall be placed in sample sacks or buckets and covered to prevent contamination.

3. Coarse aggregate shall be shipped in a secure container or sample sack.

4. Samples containing fine aggregate shall be shipped in a tight container or sample sack that will prevent the loss of fines.

5. In addition to the transmittal form inside the container, attach a tag to the outside to each container giving a brief description of the contents which includes the material type and contract number.

Test Method Nev. T203F

Effective 9-2-96

State of Nevada
Department of Transportation
Materials and Testing Division

METHOD OF TEST FOR SOIL AND AGGREGATE SAMPLE PREPARATION

SCOPE

This method describes the process for preparing untreated aggregate and disturbed soil samples, as received from the field, for the required tests. Separation by sieving, weighing, removing soil coatings from aggregate, breaking up clods, and splitting out representative test samples of specified size are some of the more important phases of sample preparation.

A. APPARATUS

1. Sieves. Woven wire cloth sieves with 75 mm (3 in.), 63 mm (2 1/2 in.), 50 mm (2 in.), 37.5 mm (1 1/2 in.), 25 mm (1 in.), 19 mm (3/4 in.), 12.5 mm (1/2 in.), 9.5 mm (3/8 in.), 4.75 mm (No. 4), 2.00 mm (No.10), and 0.425 mm (No. 40) sieves with square openings conforming to AASHTO Designation M92.

2. Sieve shaker. Any mechanical sieve shaker may be used which produces the thoroughness of sieving required, i.e., not more than 1 percent by weight of the residue retained on any sieve after mechanical sieving is completed shall pass that sieve during one minute of continuous hand sieving as described under Sieving Procedure of Test Method Nev. T206.

3. Crusher. A jaw crusher which can be adjusted to produce material passing the 4.75 mm (No. 4) sieve. A sledge hammer may be used to reduce oversize particles enough to permit the material to be fed into the crusher.

4. Heavy duty scale. A scale with a minimum of 20 000 g capacity and sensitive to 20 g.

5. Scale or balance. A scale or balance with 5000 g capacity and sensitive to 1 g.

6. Splitter. Any device may be used which will divide the sample into representative portions. However, the riffle-type splitter is preferable to hand quartering. When riffle splitters are used, three are required; one with

chutes approximately 37.5 mm (1-1/2 inches) wide for coarse aggregates up to 25 mm (1 inch) maximum in size, one with chutes approximately 19 mm (3/4 inch) wide for samples passing 4.75 mm (No. 4) sieve for material weighing 5000 g or more, and one with chutes approximately 9.5 mm (3/8 inch) wide for samples passing 4.75 mm (No. 4) sieve for material weighing less than 5000 g.

7. Pulverizing apparatus. Either a mortar and rubber-covered pestle or a mechanical device consisting of a power-driven rubber-covered muller suitable for breaking up the aggregations of soil particles without reducing the size of the individual grains.

   NOTE 1: Other types of apparatus, such as a revolving drum into which the soil sample and rubber-covered rollers are placed and tumbled until soil aggregations are pulverized, are satisfactory if the aggregations of soil particles are broken up without reducing the size of the individual grains.

8. Sample containers. Various sized metal containers are required, some of which have the following approximate capacities: 50 000 g, 7000 g, 3500 g, 300 g, and 100 g.

B. SAMPLE IDENTIFICATION

Each sample shall be given an identification number which shall be written on suitable cards or tickets. One of these cards or tickets bearing the sample identification number shall accompany each portion of the sample throughout the processing and testing of the material.

C. TEST RECORD FORM

Record the test data on the appropriate work sheet.

D. INITIAL PREPARATION OF TEST SAMPLES FOR LIQUID LIMIT AND/OR PLASTIC LIMIT

1. The soil or aggregate sample shall be dried thoroughly in air or a drying apparatus at a temperature not exceeding 60°C (140° F). A representative test sample shall then be obtained with the sampler, or by splitting or quartering as per section G. of this test method.

This sample shall be approximately 6000 g for coarse material (retained on the 4.75 mm (No. 4) sieve and approximately 1000 g for fine material (passing the 4.75 mm (No. 4) sieve). Split the sample in half and perform the following procedures on one half of each sample (either 3000 g or 500 g). The aggregations of soil particles shall then be broken up in the pulverizing apparatus in such a way as to avoid reducing the natural size of individual particles.

NOTE 2: Samples dried in an oven or other drying apparatus at a temperature not exceeding 60°C (140° F) are considered to be air dried.

2. The dried sample shall first be separated into two fractions using a 2.00 mm (No. 10) sieve. The fraction retained on this sieve shall be ground thoroughly with the pulverizing apparatus, and/or thoroughly cleaned with a stiff brush, if coatings exist, until the aggregation of soil particles are broken into separate grains. This process of grinding, brushing, and sieving over the 2.00 mm (No. 10) sieve shall be repeated until the material is visibly free of clay lumps, clods, and coatings, and until no appreciable amount of material passes the 2.00 mm sieve, and the material retained on the 2.00 mm sieve consists only of individual sand and gravel grains. The ground soil shall then be separated into two fractions using the 2.00 mm sieve, and the material now retained on the 2.00 mm sieve shall be discarded.

3. The portion of the material passing the 2.00 mm (No. 10) sieve shall then be separated into two parts by means of a 0.425 mm (No. 40) sieve. The fraction retained on the 0.425 mm sieve shall be ground with the pulverizing apparatus in such a manner as to break up the aggregations without fracturing the individual grains. If the sample contains brittle particles, such as flakes of mica, fragments of sea shells, etc., the pulverizing operation shall be done carefully and with just enough pressure to free the finer material that adheres to the

coarser particles. The ground soil shall then be separated into two fractions by means of the 0.425 mm sieve, and the material shall be reground as before.

This process of grinding and sieving over the 0.425 mm sieve shall be repeated until no appreciable amount of material passes the 0.425 mm sieve, and the material retained on the 0.425 mm sieve consists only of individual sand and gravel grains. At this point, the material retained on the 0.425 mm sieve shall be discarded. The several fractions passing the 0.425 mm sieve obtained from the grinding and sieving operations just described, shall be thoroughly mixed together and set aside for use in performing the physical tests.

If unable to obtain specified material quantity required in performing physical tests, reserve material obtained and repeat steps 2 through 3 on remaining half of split sample. If material quantity obtained by completing steps 2 through 3 on first half of split sample combined with quantity obtained on second half of split sample does not generate specified material quantity to perform the physical tests, physical tests shall be documented as "unable to obtain required amount of material".

E. SIEVING OF SAMPLES - COARSE AGGREGATE

1. If the coarse aggregate particles contained in a sample are clean or are only lightly coated with fines which can be easily removed by sieving it will not be necessary to subject the coarse portion to a cleaning process prior to performing the coarse sieve analysis.

2. Perform the coarse aggregate sieve analysis by separating the sample on the following sieves: 75 mm (3 in.), 63 mm (2 1/2 in.), 50 mm (2 in.), 37.5 mm (1 1/2 in.), 25 mm (1 in.), 19 mm (3/4 inch), 9.5 mm (3/8 inch), and 4.75 mm (No. 4). Include the 12.5 mm (1/2 in.) sieve for bituminous mix aggregates and screenings when required. The sieving may be performed either by hand or mechanical sieving. Place each size fraction in a separate container and combine all of the portions passing the 4.75 mm (No. 4) sieve (more than one portion when necessary to remove coatings and/or breakdown lumps). Weigh each size fraction and the passing 4.75 mm (No. 4) portion, and record these weights on the appropriate work sheet.

3. Crushing of samples. If the sample is submitted for preliminary tests and represents aggregate which will require crushing on the job, crush the oversize aggregate to such a degree that a blend made with the crushed and uncrushed portions will conform to the proposed grading specifications. Perform a coarse sieve analysis on the crushed portion and record the weight on the same card used for recording the as-received coarse sieve analysis.

F. ADJUSTING GRADING OF SAMPLES

If it is necessary to adjust the grading of a sample prior to testing in order to bring the material within a specified grading, the adjustments of scalping, wasting or combining materials should be such that they can be duplicated under field conditions.

G. SECURING REPRESENTATIVE PORTIONS FOR SPECIFIED TESTS

1. Refer to the respective test methods for grading requirements and quantity of material needed.

2. Split or quarter the sample into representative portions for the various tests. The use of a sample splitting device is preferred. However, hand quartering is acceptable, if carefully performed.

    a) Splitting sample with mechanical device.

        1) Make sure that the device is checked regularly for accuracy by taking a dry sample of material which tends to segregate and dividing it into four or more equal parts by use of the splitter. Then weigh and grade several of the parts and compare.

        2) The splitting device should have openings sufficiently wide to permit easy passage of the largest particles in the sample and yet not so wide that a nonrepresentative separation is obtained. Generally, the width of openings should be approximately 50 percent larger than the largest particles in the sample to be split.

3) Thoroughly mix the sample and spread it evenly across the pan or hopper. The pan or hopper used with a riffle-type splitter shall be equal in width to the overall width of the chutes so that the material will pour in equal amounts into each chute. Do not pour samples directly into chutes from anything other than the pan described above.

4) To increase the accuracy of the splitting method so as to insure a more representative sample for testing, "double split" all samples. This procedure involves quartering the original sample into four equal parts, then combining opposite quarters. Repeat this procedure until the desired sample size is obtained for the various tests.

b) Hand quartering of samples weighing over 45 kg (100 lbs).

1) Mix and pile the sample on a quartering canvas. Shovel the material into the center to form a cone. Place each shovelful so that the material spills over the cone equally in all directions to mix the sample. Dampen samples which tend to segregate before proceeding with the following steps.

2) Flatten the cone with a shovel, spreading the material to a circular layer of uniform thickness.

3) Insert a stick or pipe beneath the canvas and under the center of the pile, then lift both ends of the stick, dividing the sample into two equal parts. Remove the stick, leaving a fold of canvas between the divided portions.

4) Insert the stick under the center of the pile at right angles to the first division and again lift both ends of the stick, dividing the sample into four parts. In lieu of dividing by use of a stick, a shovel may be used to divide the sample into four equal parts.

5) Remove two diagonally opposite quarters, being careful to clean the fines from the canvas.

6) Remix the remaining material by taking alternate shovelfuls from each remaining quarter and placing it in the center so that a cone is formed as before. Repeat the quartering process until the sample is reduced to the desired size.

c) Hand quartering of samples weighing 11 kg to 45 kg (25 to 100 lbs.)

1) Pile the sample on the canvas and mix by alternately lifting each corner of the canvas and pulling it over the sample toward the diagonally opposite corner, causing the material to be rolled. Dampen material which tends to segregate.

(2) Flatten and quarter as specified above.

d) Hand quartering of samples weighing less than 11 kg (25 lbs.).

1) Place the sample on a canvas or a clean sheet of heavy paper. Mix thoroughly with a trowel and form the material into a conical pile. Dampen material which tends to segregate.

2) Flatten the cone by pressing it down with a trowel.

3) Separate into quarters with the trowel and remove diagonally opposite quarters.

4) Repeat the above process until the sample is reduced to the desired size.

3. After the required test samples have been removed, save the remainder of the sample for possible future check tests.

H. PRECAUTIONS

1. When possible, attempt to duplicate field conditions in preparation of a sample; for example, do not remove coatings from coated PMS bin samples.

2. Always use either a sample splitter or the quartering method to obtain test samples. Do not scoop or pour material for testing.

3. Check sieves frequently for broken or distorted wires, and repair or replace defective sieves.

4. Sample preparation shall be subject to controls specified by the individual test methods.

I. CALCULATIONS - COARSE AGGREGATE GRADING ANALYSIS

1. Calculate the coarse grading from the weights recorded on the work sheet (see Section E, Paragraph 2) as follows:

   a) Compute the percentage by weight of material retained on each sieve by the following formula.

$$P_r = \frac{100\ W_r}{W_t}$$

Where:

P_r = Percentage of test sample retained on each sieve size individually.

W_r = Weight of test sample retained on each sieve individually.

W_t = Total dry weight of sample.

   b) Compute the total percentage of material passing each sieve.

      1) Starting with the 4.75 mm (No. 4) sieve, add the percent passing that sieve to the percent retained on the same sieve, to give the total percent passing the next larger sieve 9.5 mm (3/8").

      (2) Continue in this manner for each sieve until the largest size is reached, at which time the "percent passing" figure will be 100%.

c. Example:

Sieve Size	W_r Weight Retained (g)	P_r Percent Retained	Percent Passing
75 mm (3")	0	0	100
63 mm (2-1/2)	405	1	99
50 mm (2")	1510	3	96
37.5 mm (1-1/2)	2375	5	91
25 mm (1")	3560	7	84
19 mm (3/4")	5215	10	74
9.5 mm (3/8")	7155	14	60
4.75 mm (No. 4)	7550	16	44
Minus 4.75 mm (No. 4)	22 230	44	--

Total weight of Sample, W_t = 50 000 g

HAZARDS

Dust, noise, improper lifting, and the operation of equipment are the most various health and accident hazard sources encountered in sample preparation. It is not possible to completely eliminate these hazards, but steps should be taken to minimize them as much as possible.

The use of dust collection units and the spraying of workroom floors with dust palliatives are very effective methods of reducing dust conditions.

Enclosures built around noisy equipment can eliminate much of the noise. The use of sound deadening materials should be utilized when possible to increase the efficiency of an enclosure.

Guards or shields should be provided around dangerously exposed moving parts of machinery. Also, personnel should be instructed in the proper operation of each machine and cautioned of the existing hazards.

Instruction and enforcement of proper lifting methods is important in reducing the hazards of strain or rupture. The use of table-high carts to move materials can eliminate much of the lifting.

REPORTING OF RESULTS

Report the percent passing each of the sieves used along with other test data on the appropriate test report forms.

REFERENCE: AASHTO Designation M 92 and T 87

Test Method Nev. T206F
Effective August 12, 1996

State of Nevada
Department of Transportation
Materials Division

METHOD OF TEST FOR SIEVE ANALYSIS OF COARSE AND FINE AGGREGATE

SCOPE

This test method, which is a modification of AASHTO Designation T 27 and T 11, covers the procedures for washing and sieving used for the determination of the particle size distribution of coarse and fine aggregate samples, including Base Aggregates, Aggregates for Bituminous Courses, Concrete Aggregates, and other selected materials. As used herein, the term "coarse aggregate" refers to material retained on the 4.75 mm sieve, and the term "fine aggregate" refers to material passing the 4.75 mm sieve.

A. APPARATUS

1. A balance or scale sensitive to within 0.2 percent of the weight of the sample to be tested. Normally, fine aggregate samples are weighed to the nearest gram, and coarse aggregate samples to the nearest gram.
2. Sieves. The testing sieves shall be of the woven-wire type with square openings, and shall conform to the Standard Specifications for Sieves for Testing Purposes, AASHTO Designation M 92.
3. An oven or other controllable heating device.
4. Hand washing vessel. A pan or container of a size sufficient to contain the sample covered with water and to permit vigorous agitation without loss of any material.

B. TEST RECORD FORM

Record the test data on the appropriate work sheet. A sample work sheet in common use is shown in Figures 1 & 2.

C. PREPARATION OF TEST SAMPLES

1. Obtain the test sample from the material submitted by the use of a sample splitter or by the method of hand quartering as outlined in Test Method Nev. T 203. Fine aggregate shall be thoroughly mixed in a moist condition before splitting or quartering. The sample for test shall be the end result of the sampling method. Samples shall weigh, after drying, not less than the amount indicated in Table 1. The selection of samples of an exact predetermined weight shall not be attempted.

2. Dry the test sample to constant weight at a temperature not exceeding 110°C.

3. Weigh the test sample on a scale or balance conforming to the requirements specified in Section A, "Apparatus", and record on the appropriate work sheet.

TABLE 1

Test Sample Size

Aggregate Size[1]	Minimum Dry Weight[2] Grams
100 ± 3.0 mm	At the discretion of the Engr.
90 ± 2.7 mm	30 000
75 ± 2.2 mm	25 000
63 ± 1.9 mm	20 000
50 ± 1.5 mm	15 000
38.1 ± 1.1 mm	9000
25 ± 0.8 mm	3000
19 ± 0.6 mm	2500
12.5 ± 0.5 mm	1500
9.5 ± 0.375 mm	1000
4.75 mm	500
2.36 mm	250

[1] For purposes of this test method, "Aggregate Size" is defined to be the smallest sieve which will pass at least 90 percent of the sample.

[2] Samples weighing 3000 grams or more shall be sieved through 40.640×10^{-2}m or larger diameter sieves, at least to reduce the sample aggregate down to a size that can be tested with 203.2 mm

diameter sieves. If this procedure is used, a combined sieve determination is made (refer to F.3.). The testing sieve frames may be square, round or rectangular, provided that not less than 1290.2 x 10^{-2}m of sieving area is exposed.

D. WASH TEST PROCEDURE

1. Perform the wash test on all samples except as follows:

   Samples containing large portions of plus 25 ± 0.8 mm aggregate may first be dry sieved over the required coarse aggregate sieve sizes down to the 9.5 ± 0.375 mm or 4.75 mm sieve. The portion passing the 9.5 ± 0.375 mm or 4.75 mm sieve is then split down to a representative sample of the required size (Table 1) and the wash test performed on this smaller sample.

   In case of dispute, however, the wash test shall be performed on the entire sample prior to making the sieve test.

2. Place the dried and weighed wash test sample in a container or containers and cover with water. If desired, a small amount of wetting agent may be added to assure a thorough separation of the finer aggregate particles from the coarser particles.

3. Agitate the contents of the container vigorously and immediately pour the wash water over a nest of two sieves consisting of a 2.36 mm or 1.18 mm sieve on top and a 75 micron sieve on the bottom.

   The agitation should be sufficiently vigorous to result in the complete separation from the coarse particles of all particles finer than the 75 micron sieve and bring the fine material into suspension, in order that it will be removed by decantation of the wash water. Care shall be taken to avoid, as much as possible, the decantation of the coarse particles of the sample.

   In order to remove all coatings and disperse all lumps, it may sometimes be necessary to scrub individual aggregate particles with a stiff fiber brush, and to rub soil lumps against sides and bottom of vessel. the use of a spoon or rod to stir and agitate the aggregate in the washing container has also been found satisfactory.

Repeat the agitation/decantation procedure until the wash water is clear.

4. Wash the fine material retained on the nested sieves with a gentle stream of running water. Check the cleanness of the soil retained on the 75 micron sieve by rubbing small amounts between the thumb and fingers. **DO NOT RUB THE SOIL OVER THE SURFACE OF THE 75 MICRON SIEVE.** Continue until the wash water runs clear.

5. Rinse the material retained on the nested sieves, plus the material remaining in the washing vessel, into a wide shallow pan. Pour the excess surface water back over the 75 micron sieve, and dry both the washed sample and the 75 micron sieve to constant weight at a temperature not exceeding 110°C.

6. Return any dry material retained on the 75 micron sieve to the washed and dried sample. Weigh the entire sample and record as "Washed Weight".

7. The amount of material removed from the sample by washing is found by subtracting the "washed weight" from the total dry weight of the test sample prior to washing, or from the "adjusted dry weight" as per the note in section F.1. The amount removed ("wash") will be combined with the weight passing the 75 micron sieve by dry sieving to give the total amount of material finer than the 75 micron sieve.

E. SIEVE TEST PROCEDURE

1. Make the sieve analysis on either the oven dried and cooled sample residue from the washing procedure, or the oven dried and cooled sample of material to be sieved without prior washing. See paragraph D.1. above.

2. Separate the sample into a series of sizes, using such sieves as are necessary to determine compliance with the specifications for the material under test. Either hand sieving or mechanical sieving may be used.

   (a) Hand sieving - Perform the hand method of sieving by means of a lateral and vertical motion of the sieve, accompanied by a jarring action so as to keep the sample moving continuously over the surface of the surface of the sieve. In no case shall fragments in the sample be forced through the sieve by hand. Sieving shall be continued until not more than one percent by weight of the residue passes any sieve during one of continuous shaking. For coarse aggregate, the thoroughness of sieving shall be determined with a single layer of material on the sieve.

(b) Mechanical sieving - Perform mechanical sieving on an approved mechanical shaker which gives the same type of shaking action described in (a) "Hand Sieving". Normally, shaking time is three to five minutes for coarse aggregate samples, and ten minutes for combined (coarse and fines) or fine aggregate samples. Sieving time and thoroughness of mechanical sieving shall be tested periodically by the above described hand sieving method.

3. When sieving coarse aggregate samples without prior washing, brush the larger aggregate particles with a stiff bristle brush to remove coatings, and break up soil lumps, taking care not to lose the fine particles thus obtained.

4. When sieving fine aggregate (passing 4.75 m sieve), in no case shall the fraction retained on any sieve at the completion of the sieving operation weigh more than 4 grams per 25.4 mm^2 of sieving surface. This amounts to 200 grams for the usual 20.32 x 10^{-2}m diameter sieve. To reduce the amount of material retained on the critical sieve, either use an additional sieve with openings slightly larger than the openings in the critical sieve, or split the entire sample into smaller portions, prior to sieving, and then combine respective fractions after sieving.

5. After sieving, weigh the material passing each sieve and retained on the next, and the amount passing the 75 micron sieve (pan) for fine aggregate samples, on the same scale or balance used to weigh the total sample prior to sieving, and record these weights on the work sheet. The summation of these various weights must check with the weight before sieving within 1 gram for fine aggregate or within 45 g for coarse aggregate.

6. Add the amount passing the 75 micron sieve by dry sieving to the amount removed by washing to give the total amount passing the 75 micron sieve.

F. CALCULATIONS

1. Convert the weights of fractions retained on the various sieves and the total passing the 75 micron sieve to percentages by the following formula:

$$P_r = \frac{100W_r}{W_t}$$

Where:

P_r = Percentage retained on each sieve (or percentage passing 75 micron sieve).

W_r = Weight retained on each sieve (or total amount passing 75 micron sieve).

W_t = Total weight of test sample (dry) prior to washing and sieving.

Make all calculations to the nearest 0.1 percent. The sum of the percentages retained on all sieves plus the percentage passing the 75 micron sieve must equal 100.0 percent.

***NOTE:** If the sieve analysis test is being performed on aggregates for bituminous mixes that have had mineral filler added, "W_t" shall first be adjusted by that amount before "P_r" is calculated for each sieve as follows:

$$\text{"}W_t\text{" (adjusted)"} = \frac{W_t}{1 + \text{(Decimal equiv. of percent mineral filler)}}$$

If, due to this adjustment, "W_t" (adjusted) is less than or equal to the dry weight total after washing, the "wash" section of the "weight retained" column of form 040-013 (Field Material Sieve Test) shall be reported as "0".

2. Calculate the percent passing each sieve by one of the following methods:

   a. Method 1: Add the percentage passing the 75 micron sieve to the percentage retained on the 75 micron sieve to give the percentage passing the next larger sieve. continue in this manner for each sieve until the largest size is reached, at which time the percentage passing should be 100.0 percent.

b. Method 2: Starting with the largest sieve size used, <u>subtract</u> the percent retained on that sieve from 100 percent to give the total percent passing that sieve. Then subtract the percentage retained on the next smaller sieve from the figure just obtained to give the total percent passing the second sieve. continue in this manner until the minus 75 micron is reached, at which time the percent passing should be 0.0 percent.

3. If a coarse aggregate sample has been separated into two sizes for testing (see paragraph D.1.), compute the combined grading as follows:

   a. Compute the individual grading of each size separately following the procedures outlined in paragraphs F.1. and F.2. above. this will give the percent passing each sieve in both the coarse and fine portions of the sample.

   b. Compute the percentage represented by each size, based on the total weight of the sample.

Example:

	Size		Weight	
<u>Fraction</u>	<u>Pass</u>	<u>Retained</u>	<u>Kilograms</u>	<u>Percentage</u>
Coarse	50 ± 1.5mm	9.5 ± 0.375mm	9.25 kg	49.5
<u>Fine</u>	9.5 ± 0.375mm	<u>0</u>	9.43 kg	<u>50.5</u>
Total	50 ± 1.5mm	0	18.69 kg	100.0

   c. Taking the coarse and fine sizes separately, multiply the percentage of that size by the percent passing each sieve.

   d. Add the products thus obtained on corresponding sieves. These sums constitute the overall grading on the combined sample.

   e. See Figure 2 for a sample work sheet involving the above calculations.

G. PRECAUTIONS

1. Proper care of the sieves is necessary for accurate sieving. Use the following procedure in removing particles stuck in the mesh of the fine aggregate sieves:
    a. No's. 4.75 mm, 2.36 mm and 1.18 mm sieves. Clean by brushing with a brass or steel wire brush. A rounded piece of wood, such as a brush handle, can be used if the hand is placed on the opposite side when pushing against the sieve in order to avoid stretching the sieve out of shape.

    b. No's. 600 micron and 425 micron, and 300 micron sieves. Clean by brushing with a stiff short bristle brush suck as a brass wire brush.

    c. No's. 150 micron and 75 micron sieves. Clean only by brushing with a small paint brush. these sieves are easily damaged.

    d. Do not use a sharp object to push out particles which are stuck in the mesh of the sieves because this will result in enlarging the openings.

2. Examine sieves each day for broken wires, and solder any breaks. This soldering decreases effective sieving area; therefore sieves with large breaks or several small breaks should be discarded.

3. Check all sieves from 4.75 mm through 75 micron periodically, with a standard sample of known grading made up from hard, clean aggregate that does not degrade from repeated sieve shaking procedure. this is especially useful for checking No's. 150 micron and 75 micron sieves, as small breaks and distortions are easily missed in these fine mesh sieves.

4. Never sieve hot sample, as hot aggregate will distort the fine meshes of the No's 150 micron and 75 micron sieves.

5. Take care to avoid loss of material during transfer of sample from washing container to nested sieves and also during rinsing.

6. Never allow any sieve to come into direct contact with hot drying device.

H. REPORTING OF RESULTS

Report the total percentages passing each sieve on the appropriate report form. Percentages shall be reported to the nearest whole number on the cover sheet (0.1% on the worksheet).

Test Method Nev. T210I
April 25, 2008

State of Nevada
Department of Transportation
Materials Division

METHOD OF TEST FOR DETERMINING THE LIQUID LIMIT OF SOIL

SCOPE

The liquid limit of a soil is that water content, as determined in accordance with the following procedure, at which the soil passes from a plastic to a liquid state.

APPARATUS

1. Porcelain dish or similar mixing dish, approximately 115 to 150 mm (4.5 to 6 in.) in diameter.

2. Spatula or pill knife having a blade approximately 75 to 100 mm (3 to 4 in.) in length and 13 to 20 mm (1/2 to 3/4 in.) in width.

3. Liquid limit device, manually operated or mechanically operated.

   Manually operated device, a device consisting of a brass dish and carriage, constructed to the plan and dimensions shown in Figure 1. If a manually operated device is used, it shall be noted on the worksheet.

   Mechanically operated device, a motorized device equipped to produce the rise and rate of shocks to a brass cup as described below in CALIBRATION. The cup and the critical dimensions of the device shall conform to those shown in Figure 1. The device shall give the same liquid limit values as obtained with the manually operated device.

   The base of the liquid limit device should have a resilience of at least 80 percent and not more than 90 percent when determined in accordance with the procedure given below in RESILIENCE TEST.

4. Curved grooving tool, conforming to the critical dimensions shown in Figure 1. The use of a flat grooving tool shall not be permitted in this test procedure.

5. Gage, whether attached to the grooving tool or separate, conforming to the critical dimension “d” shown in Figure 1 of this method. If separate, the gage may be a metal bar 10.0 ± 0.2 mm (0.394 ± 0.008 in.) thick and approximately 50 mm (2 in.) long.

6. Containers, made of materials resistant to corrosion and not subject to change in mass or disintegration on repeated heating and cooling. Containers shall have tight fitting lids to prevent loss of moisture from samples before initial mass determination and to prevent absorption of moisture from the atmosphere following drying and before final mass determination. One container is needed for each moisture content determination.

7. Glass beaker, 600 mL or other suitable microwave safe container.

8. Watch glass, approximately 75 mm (3.0 in.) in diameter.

9. Balance, 500 g minimum capacity, accurate to ± .01 g.

10. Oven, thermostatically controlled, capable of maintaining temperatures of 110 ± 5ºC (230 ± 9ºF).

11. Microwave oven, preferably with vented chamber and variable power control to prevent overheating of soil.

CALIBRATION

1. The manual or mechanical liquid limit device shall be inspected to determine that the device is in good working order; that the pin connecting the cup is not worn sufficiently to permit side play; the screws connecting the cup to the hanger arm are tight; the points of contact on the cup and base are not excessively worn; the lip of the cup is not excessively worn; and a groove has not been worn in the cup through long usage. The grooving tool shall be inspected to determine that the critical dimensions are as shown in Figure 1.

   Wear is considered excessive when the point of contact on the cup or base exceeds 13 mm (1/2 in.) in diameter, or when any point on the rim of the cup is worn to approximately half of the original thickness. Although a slight groove in the center of the cup is noticeable, it is not objectionable. If the groove becomes pronounced before other signs of wear appear, the cup should be considered excessively worn. Excessively worn cups shall be replaced. A base that is excessively worn may be refinished as long as the thickness does not exceed the tolerance shown in Figure 1 by more than -2.5 mm (-0.1 in.) and the distance between the cup at the cam follower and the base is maintained within the tolerances specified in Figure 1.

2. Adjust the height of drop of the cup so that the point on the cup that comes in contact with the base rises to a height of 10.0 ± 0.2 mm (0.394 ± 0.008 in.). See Figure 2 for proper location of the gage relative to the cup during adjustment.

   A convenient procedure for adjusting the height of the drop is a follows: Place a piece of masking tape across the outside bottom of the cup parallel with the axis of the cup hanger pivot. The edge of the tape away from the cup hanger should bisect the spot on the cup that contacts the base. For new cups, place a piece of carbon paper on the base (or use a marking pen to mark the base where it contacts the cup) and allow the cup to drop several times to mark the contact spot. Attach the cup to the device and turn the crank until the cup is raised to its maximum height. Slide the height gage under the cup from the front, and observe whether the gage contacts the cup or the tape. See Figure 2. If the tape and cup are both contacted, the height of drop is correct. If not, adjust the cup until simultaneous contact is made. Check adjustment by turning the crank at two revolutions per second while holding the gage in position against the tape and cup. If a ringing or clicking sound is heard without the cup rising from the gage, the adjustment is correct. If no ringing is heard or if the cup rises from the gage, readjust the height of the drop. If the cup rocks on the gage during this checking operation, the cam follower pivot is excessively worn and the worn parts should be replaced. Always remove tape after completion of adjustment operation.

METHOD A – THE THREE POINT METHOD

TEST PROCEDURE

1. The material for the liquid limit test is to be obtained by Test Method Nev. T203. Referee or dispute testing shall be performed using the mortar and rubber-covered pestle as the pulverizing apparatus.

2. A sample weighing about 100 g (minimum 85 g) shall be taken from the thoroughly mixed portion of the material passing the 425 µm (No. 40) sieve that has been obtained in accordance with Test Method Nev. T203. Note: If 85 g are not obtained, the sample is to be reported as insufficient material and no further testing is required.

   Place the sample in the mixing dish and thoroughly mix with 15 to 20 mL of water (distilled or demineralized) by alternately and repeatedly stirring, kneading and chopping with a spatula. Tap water may be used for routine testing if comparative tests indicate no differences in results between tap water and distilled or demineralized water. Referee or disputed tests shall be performed using distilled or demineralized water. Use sufficient force in the kneading action to allow the moisture to come into contact with as many of the soil particles as possible. Further additions of water shall be made in increments of 1 to 3 mL. Each increment of water shall be thoroughly mixed with the soil, as previously described, before another increment is added. Once testing has begun, no additional dry soil should be added to the moistened soil. The cup of the liquid limit device shall not be used for mixing soil and water. If too much moisture has been added to the sample, the sample shall either be discarded, or mixed and kneaded until natural evaporation lowers the closure point to an acceptable range.

   Add sufficient water to thoroughly coat and be absorbed into the soil sample uniformly.

   Some soils are slow to absorb water. It is possible to add increments of water so fast that a false liquid limit value is obtained. This can be avoided if more mixing and/or time is allowed.

   Once the 25-35 shock range (preferably 30-35) is achieved, the sample is then hydrated for 30 ± 1 minute in the dish under a damp rag. After the sample has been hydrated, add 1 mL of additional water to the sample and mix for 1 minute prior to placing in the brass cup of the liquid limit device.

3. A sufficient quantity of this mixture shall be placed in the cup above the spot where the cup rests on the base and shall be squeezed and spread with the spatula to level and at the same time trimmed to a depth of 10 mm (0.4 in.) at the point of maximum thickness. As few strokes of the spatula as possible shall be used, and care taken to prevent the entrapment of air bubbles within the mass. The excess soil shall be returned to the mixing dish and covered to retain the moisture in the sample. The soil in the cup of the device shall be divided by a firm stroke of the grooving tool along the diameter through the centerline of the cam follower so that a clean sharp groove of the proper dimensions will be formed as shown in Figure 3. To avoid tearing of the sides of the groove or slipping of the soil cake on the cup, up to six strokes from front to back or from back to front counting as one stroke, shall be permitted. The depth of the groove should be increased with each stroke and only the last stroke should scrape the bottom of the cup.

4. The cup containing the sample shall be lifted and dropped, mechanically or manually, at a rate of approximately two revolutions per second until the two sides of the sample come in contact at the bottom of

the groove along a distance of about 13 mm (1/2 in.). The number of shocks required to close this groove distance shall be recorded. When turning the crank of the manual device, do not hold the base of the machine with the free hand.

The soil being tested may slide on the surface of the cup instead of flowing. If this occurs, add more water to the sample, remix (including 30 ± 1 minute of hydration) and retest. If the soil continues to slide on the cup at less than 25 blows, the test is not applicable and a note should be made that the liquid limit could not be determined.

5. A slice of soil approximately the width of the spatula, extending across the soil cake perpendicular to the groove and including that portion of the groove in which the soil flowed together, shall be removed and placed in a suitable tared container. Weigh the container and soil and record the weight. Oven dry the soil in the container to a constant weight at 110 ± 5°C (230 ± 9°F) or by the following microwave oven procedure: Place a 600 mL glass beaker or other suitable container filled with approximately 300 mL of water (maintain water level during drying) into the microwave oven to prevent overheating during the drying process. Place the sample on a watch glass, then place into microwave oven. Dry the sample for 5 minutes, then at 2 minute intervals until a constant weight is achieved. Drying times may be adjusted based on type and size of microwave oven. Weigh and record the loss in weight as the weight of water.

   The soil remaining in the cup shall be transferred to the mixing dish. The cup and grooving tool shall then be washed and dried in preparation for the next trial.

   The foregoing operations shall be repeated for at least two additional portions of the sample to which sufficient water has been added to bring the soil to a more fluid condition. The object of this procedure is to obtain samples of such consistency that at least one determination will be made in each of the following ranges of shocks: 25-35, 20-30, 15-25, so the range in the three determinations is at least 10 shocks between the first and third shock range.

CALCULATION

The water content of the soil shall be expressed as the moisture content in percentage of the mass of the oven-dried soil and shall be calculated as follows:

$$\text{Percentage Moisture} = \frac{\text{mass of water}}{\text{mass of oven dried soil}} \times 100$$

Calculate the percentage of moisture to the nearest 0.1 percent.

PREPARATION OF FLOW CURVE

A AFlow Curve≅ representing the relation between moisture content and corresponding number of shocks shall be plotted on a semi-logarithmic graph with the moisture contents as abscissa on the arithmetical scale, and the number of shocks as ordinates on the logarithmic scale. The flow curve shall be a straight line drawn as nearly as possible through the three plotted points. A computer method of best-fit straight-line regression analysis may be used to determine the liquid limit. If the three points do not form a straight line, connect the points with three lines, forming a triangle. The difference between the two lines that intersect with the 25 shock ordinate shall not be more than 0.3 percent moisture. Perform the test again if this criterion is not met.

LIQUID LIMIT

The moisture content corresponding to the intersection of the flow curve with the 25 shock ordinate shall be taken as the liquid limit of the soil.

Calculate the liquid limit to the nearest 0.1. This liquid limit value will be utilized for calculating the plasticity index in Test Method Nev. T211.

REPORT

Report the liquid limit to the nearest whole number.

METHOD B – THE SINGLE POINT METHOD (For Headquarters Lab informational testing only)

TEST PROCEDURE

1. The material for the liquid limit test is to be obtained by Test Method Nev. T203.

2. A sample weighing about 100 g (minimum 85 g) shall be taken from the thoroughly mixed portion of the material passing the 425 µm (No. 40) sieve that has been obtained in accordance with Test Method Nev. T203. Note: If 85 g are not obtained, the sample is to be reported as insufficient material and no further testing is required.

3. Use the test procedure from Method A except that the initial amount of water to be added will be 8 to 10 mL instead of 15 to 20 mL, and the moisture sample taken shall be only for the accepted trial.

4. For accuracy equal to that obtained by the standard three point method, the accepted number of blows for groove closure shall be restricted to between 22 and 28 blows. After obtaining a preliminary closure in the acceptable blow range, immediately return the soil remaining in the cup to the mixing dish and, without adding any additional water, repeat as directed in Method A. If the second closure occurs in the acceptable range (22-28 blows) and the second closure is within two blows of the first closure, secure a water content specimen as directed in Method A.

5. Groove closures between 15 and 40 blows may be accepted if variations of ± 5 percent of the true liquid limit are tolerable.

CALCULATION

The water content of the soil at the time of the accepted closure shall be calculated in accordance with Method A.

LIQUID LIMIT

The liquid limit shall be determined by one of the following methods: The nomograph, Figure 4; the correction factor method, Table 1; or by any other method of calculation that produces equally accurate liquid limit values.

The key in Figure 4 illustrates the use of the nomograph (mean slope).

The correction factor method, Table 1, uses the moisture content of the liquid limit sample multiplied by a factor (k) of the second closure blow count. Figure 5 was developed for the calculation of the liquid limit.

$LL = W^N(N/25)^{0.121}$
or
$LL = kW^N$
where:

N = number of blows causing closure of the groove at water content,
LL = Liquid Limit corrected for closure at 25 blows,
W^4 = water content, and
k = factor given in Table 1.

REFEREE OR DISPUTE TESTING

METHOD

Method A shall be used in making referee or dispute tests. The results of the liquid limit are influenced by: The time required to make the test; the moisture content at which the test is begun; and the addition of dry soil to the hydrated sample (not allowed).

PROCEDURE

In making the liquid limit test for referee or dispute purposes, the following time schedule shall be used:

1. Mixing of soils with water: 5 to 10 minutes, the longer period being used for the more plastic soils.

2. Hydration: 30 ± 1 minute.

3. Remixing before placing in the brass cup: add 1 mL of water and mix for one minute.

4. Placing in the brass cup and testing: 3 minutes.

5. Adding water and remixing: 3 minutes.

6. Additional hydration: 30 ± 1 minute.

No trial requiring more than 35 blows or fewer than 15 blows shall be recorded. In no case shall dried soil be added to the hydrated soil being tested.

PRECISION STATEMENT

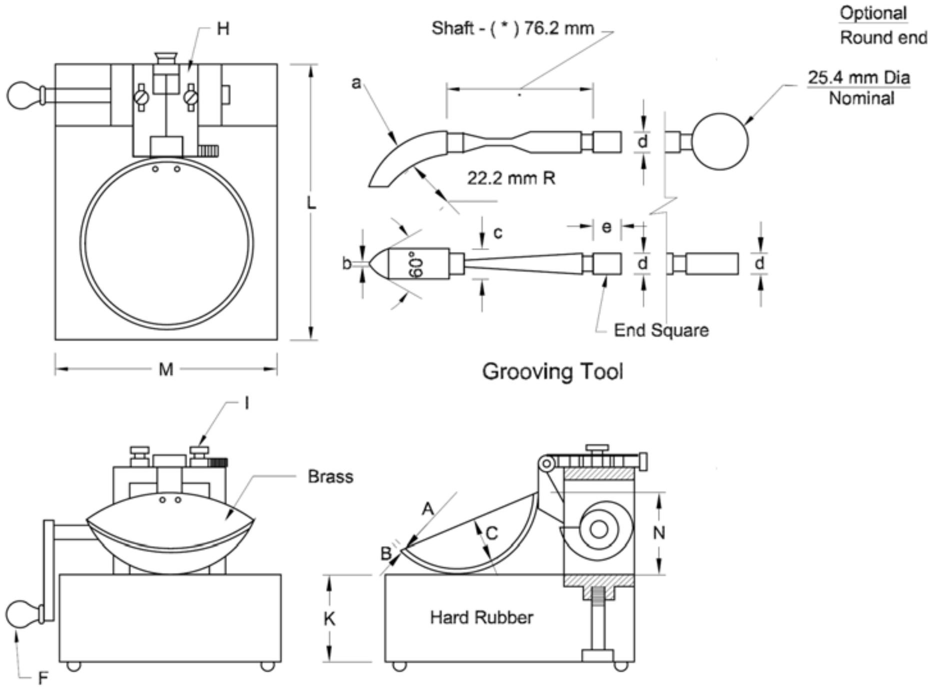
This precision statement applies to soils having a liquid limit range from 21 to 67.

1. Repeatability (single operator): Two results obtained by the same operator on the same sample in the same laboratory using the same apparatus, and on different days, should be considered suspect if they differ by more than 7 percent of their mean.

2. Reproducibility (multilaboratory): Two results obtained by different operators in different laboratories should be considered suspect if they differ from each other by more than 13 percent of their mean.

RESILIENCE TEST

A device for measuring the resilience of liquid limit device bases is shown in Figure 6 and Table 2. The device consists of a clear acrylic plastic tube and cap, an 8 mm diameter polished steel ball and a small bar magnet. The cylinder may be cemented to the cap or threaded as shown. The small bar magnet is held in the recess of the cap, and the steel ball is fixed into the recess in the underside of the cap with the bar magnet. The cylinder is then turned upright and placed on the top surface of the base to be tested. Holding the tube lightly against the liquid limit device base with one hand, release the ball by pulling the magnet out of the cap. Use the scale markings on the outside of the cylinder to determine the highest point reached by the bottom of the ball. Repeat the drop at least three times, placing the tester in a different location for each drop. The average rebound of the steel ball, expressed as a percent of the total drop, equals the resilience of the liquid limit device base. Tests should be conducted at room temperature.



	Liquid Limit Device							Grooving Tool				
	Cup Assembly				Base			Curved End			Gage	
Dimension	A	B	C	N	K	L	M	a	b	c	d	*e
Description	Radius of Cup	Thickness of Cup	Depth of Cup	Cup at Cam Follower to Base	Thickness	Length	Width	Thickness	Cutting Edge	Width	Depth	Length
Metric, mm	54	2.0	27	47	50	150	125	10.0	2.0	13.5	10.0	15.9
Tolerance, mm	2	0.1	0	1.5	5	5	5	0.1	0.1	0.1	0.2	—

Note: Plate “H” may be designed for using (1) one securing screw (I).
An additional wear tolerance of 0.1 mm shall be allowed for dimension “b” for used grooving tools.
Feet for base shall be of resilient material.
(*) Nominal dimensions.
All tolerances specified are plus or minus (±) except as noted above.

Figure 1—Manual Liquid Limit Device

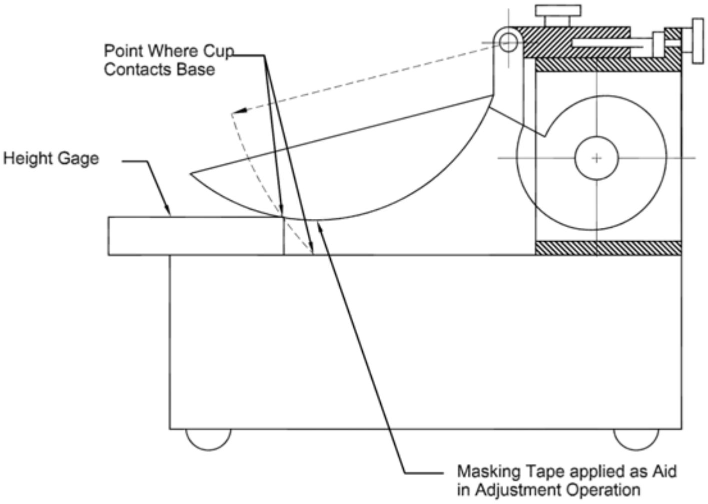


Figure 2—Calibration for Height of Drop

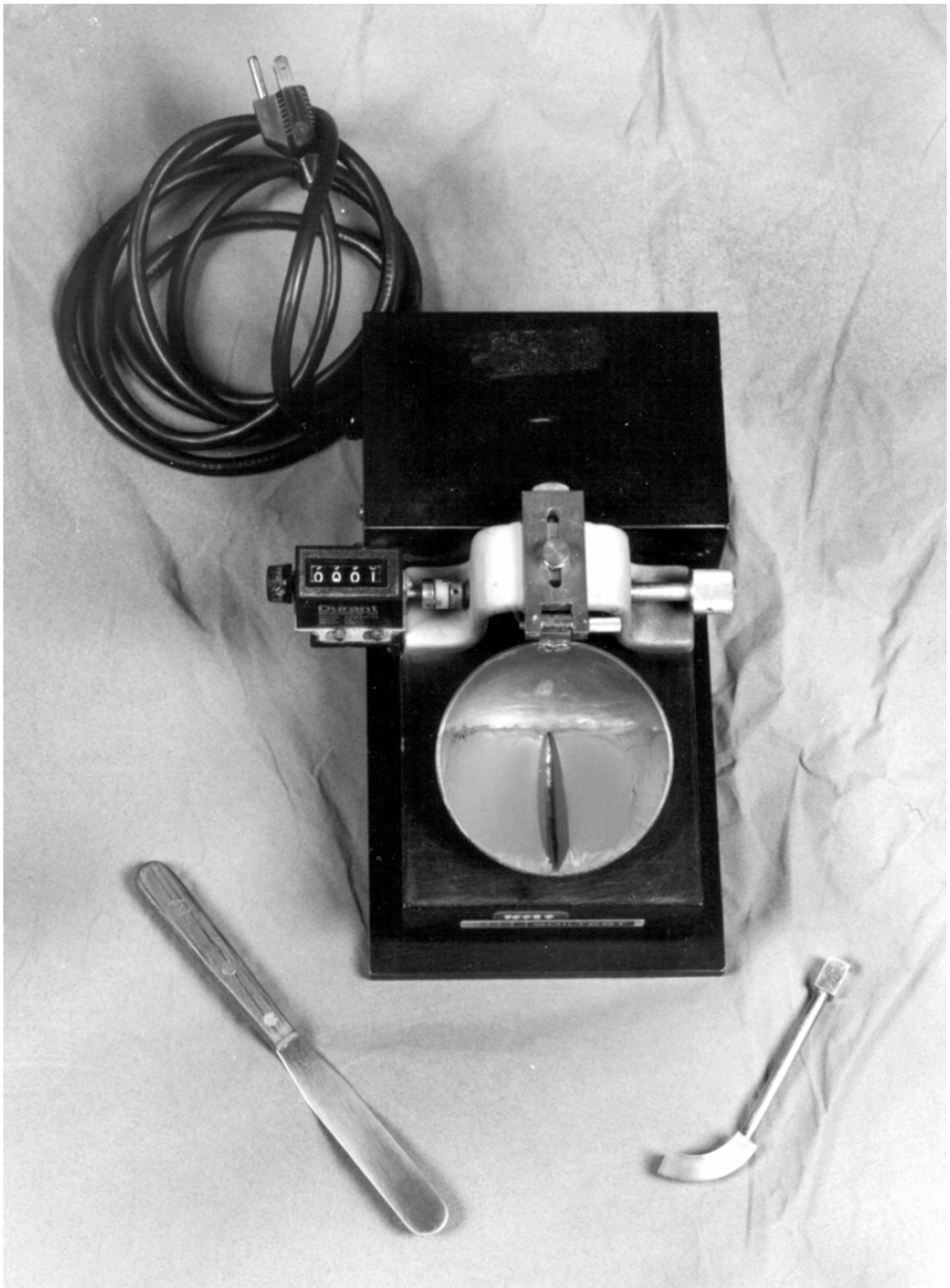


Figure 3—Liquid Limit Device with Soil Sample in Place

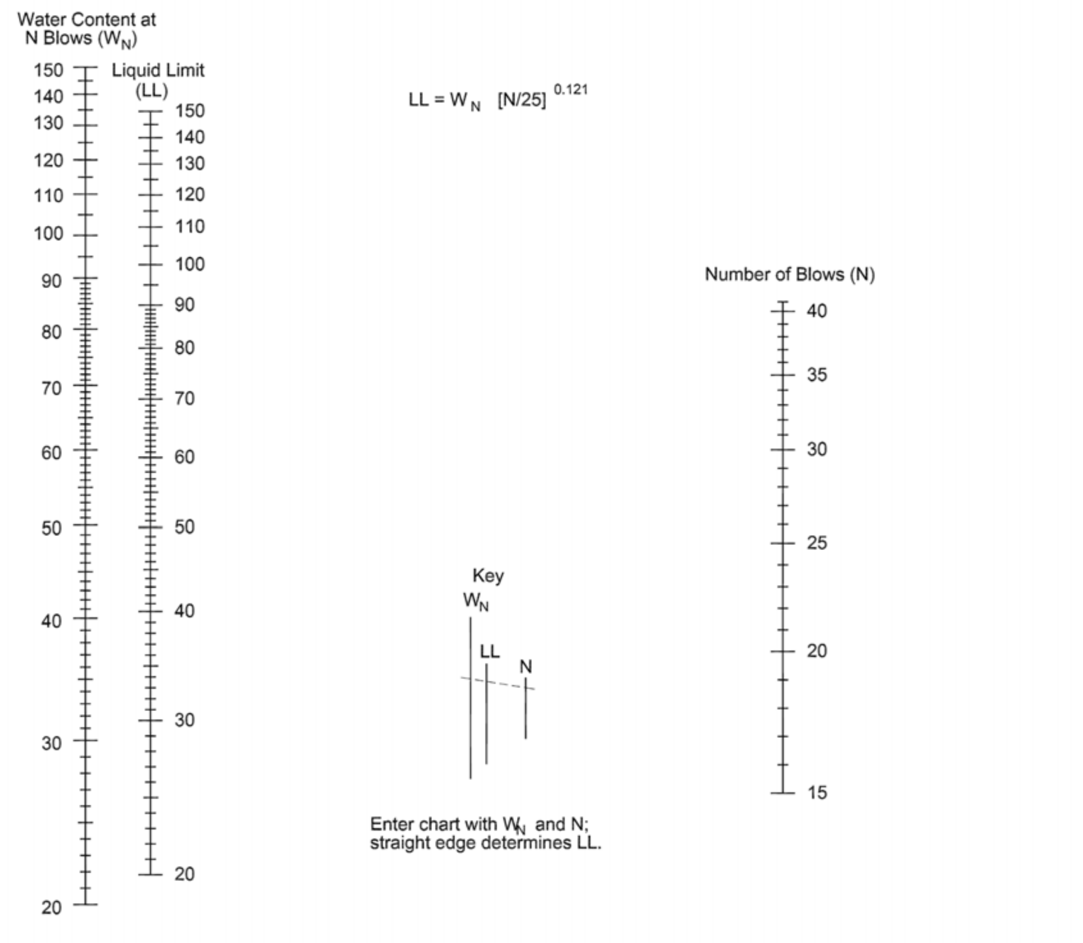


Figure 4—Nomographic Chart Developed by the Waterways Experiment Station, Corps of Engineers, U.S. Army, to Determine Liquid Limit Using Mean Slope Method

Table 1—Factors for Obtaining Liquid Limit from Water Content and Number of Blows Causing Closure of the Groove

Number of Blows, N	Factor for Liquid Limit, *k*
22	0.985
23	0.990
24	0.995
25	1.000
26	1.005
27	1.009
28	1.014

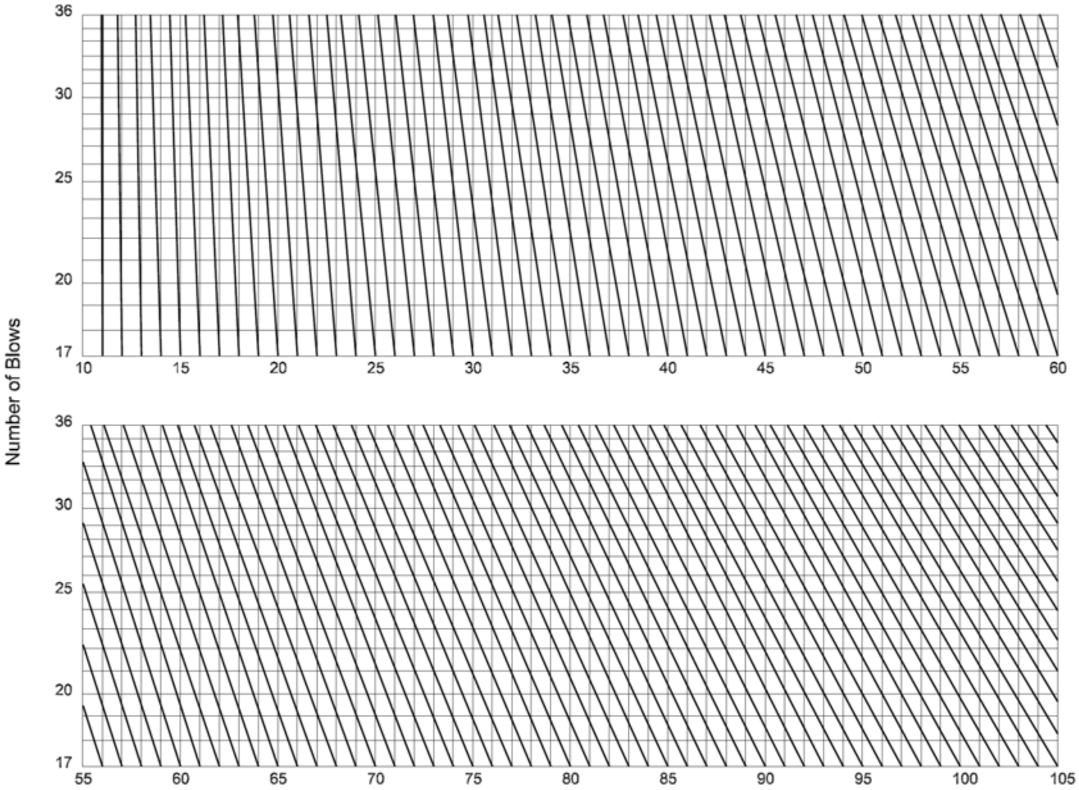


Figure 5—Chart Developed by Washington State Highway Department for the Calculation of the Liquid Limit

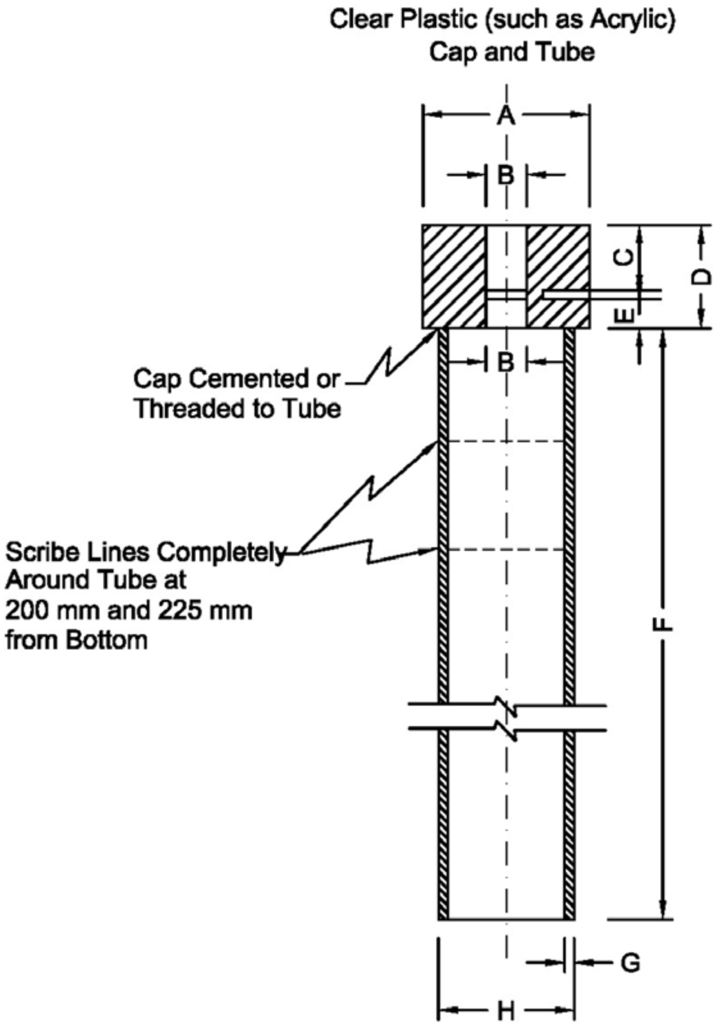


Figure 6—Resilience Tester

Table 2— Table of Measurements for Resilience Tester

Dimension	Description	Metric, mm
A	Diam. of Cap	38.0[a]
B	Diam. of Hole	9.0[a]
C	Depth of Hole	18.0[a]
D	Height of Cap	25.5[a]
E	Depth of Hole	8.0
F	Length of Tube	250.0
G	Wall Thickness	3.2[a]
H	O.D. of Tube	31.8[a]
Scribed lines from bottom	Upper 90%	225.0
	Lower 80%	200.0

[a] These dimensions are not critical in the performance of the test.

[b] Tube stands plumb.

Test Method Nev. T211I/T212I
April 25, 2008

State of Nevada
Department of Transportation
Materials Division

METHOD OF TEST FOR DETERMINING THE PLASTIC LIMIT AND PLASTICITY INDEX OF SOILS

SCOPE

The plastic limit of a soil is the lowest water content determined in accordance with the following procedure at which the soil remains plastic. The plasticity index of a soil is the range in water content, expressed as a percentage of the mass of the oven dried soil, within which the material is in a plastic state. It is the numerical difference between the liquid limit and the plastic limit of the soil.

APPARATUS

1. Porcelain dish or similar mixing dish, approximately 115 to 150 mm (4.5 to 6 in.) in diameter.
2. Spatula or pill knife having a blade approximately 75 to 100 mm (3 to 4 in.) in length and 13 to 20 mm (1/2 to 3/4 in.) in width.
3. Ground glass plate, on which to roll the sample.
4. Containers, made of materials resistant to corrosion and not subject to change in mass or disintegration on repeated heating and cooling. Containers shall have tight fitting lids to prevent loss of moisture from samples before initial mass determination and to prevent absorption of moisture from the atmosphere following drying and before final mass determination. One container is needed for each moisture content determination.
5. Glass beaker, 600 mL or other suitable microwave safe container.
6. Watch glass, approximately 75 mm (3.0 in.) in diameter.
7. Balance, 500 g minimum capacity, accurate to ± .01 g.
8. Oven, thermostatically controlled, capable of maintaining temperatures of 110 ± 5ºC (230 ± 9ºF).
9. Microwave oven, preferably with vented chamber and variable power control to prevent overheating of soil.

SAMPLE

After hydration, take a sample with a mass of about 8 g from the thoroughly wet and mixed portion of the soil prepared in accordance with Test Method Nev. T203 and Test Method Nev. T210. Take the sample during the mixing process when the mass becomes plastic enough to be easily shaped into a ball without sticking to the fingers excessively when squeezed. If the sample is taken before completion of the liquid limit test, set it aside until the liquid limit test has been completed. If the sample taken during the liquid limit test is too dry to permit rolling to a 3 mm (1/8 in.) thread, add more water and remix.

PROCEDURE

1. Squeeze and form the 8 g test sample into an ellipsoidal shaped mass. Divide the sample into 1.5 to 2.0 g portions. Cover the remainder of the 8 g sample to prevent moisture loss.

2. Roll each portion into a 3 mm (1/8 in.) thread at a rate of 80 to 90 strokes per minute, counting a stroke as one complete motion of the hand forward and back to the starting position again. Roll the mass between the palm or fingers and the ground glass plate on a smooth horizontal surface with just sufficient pressure to roll the mass into a thread of uniform diameter throughout its length. The thread shall be further deformed on each stroke so that its diameter reaches 3 mm (1/8 in.), taking no more than two minutes. The amount of hand or finger pressure required will vary greatly, according to the soil. Fragile soils of low plasticity are best rolled under the outer edge of the palm or at the base of the thumb.

3. When the diameter of the thread becomes 3 mm (1/8 in.), break the thread into six or eight pieces. Squeeze the pieces together between the thumb and fingers of both hands into a uniform mass roughly ellipsoidal in shape and reroll. Continue this alternate rolling into a thread 3 mm (1/8 in.) in diameter, gathering together, kneading and rerolling, until the thread crumbles under the pressure required for rolling and the soil can no longer be rolled into a thread. The crumbling may occur when the thread has a diameter greater than 3 mm (1/8 in.). This shall be considered a satisfactory end point, provided the solid has been previously rolled into a thread 3 mm (1/8 in.) in diameter. The crumbling will manifest itself differently with the various types of soils. Some soils fall apart in numerous small aggregations of particles; others may form an outside tubular layer that starts splitting at both ends. The splitting progresses toward the middle, and finally, the thread falls apart in many small platy particles. Heavy clay soils require much pressure to deform the thread, particularly as they approach the plastic limit, and finally, the thread breaks into a series of barrel shaped segments each about 6 to 9 mm (1/4 to 3/8 in.) in length. At no time shall the operator attempt to produce failure at exactly 3 mm (1/8 in.) diameter by allowing the thread to reach 3 mm (1/8 in.), then reducing the rate of rolling or the hand pressure, or both, and continuing the rolling without further deformation until the thread falls apart. It is permissible, however, to reduce the total amount of deformation for feebly plastic soils by making the initial diameter of the ellipsoidal shaped mass nearer to the required 3 mm (1/8 in.) final diameter. Note: If the soil will not roll out to the required 3 mm (1/8 in.) diameter and sufficient moisture has been added, the plastic limit will be reported as NA and the plasticity index will be reported as NP.

4. Repeat the procedure described above until the 8 g sample is completely tested.

5. Gather the portions of the crumbled soil together and place in a suitable tared container. Weigh the container and soil and record the weight.

6. Oven dry the soil in the container to a constant weight at 110°C (230°F) or by the following microwave oven procedure: Place a 600 mL glass beaker or other suitable container filled with approximately 300 mL of water (maintain water level during drying) into the microwave oven to prevent overheating during the drying process. Place the sample on a watch glass, then place into microwave oven. Dry the sample for 5 minutes, then at 2 minute intervals until a constant weight is achieved. Drying times may be adjusted based on type and size of microwave oven. Weigh and record the loss in weight as the weight of water.

CALCULATIONS

1. Calculate the plastic limit, expressed as the water content in percentage of the mass of the oven dry soil, as follows:

$$\text{Plastic Limit} = \frac{\text{mass of water}}{\text{mass of oven dry soil}} \text{ X } 100$$

Calculate the plastic limit to the nearest 0.1.

2. Calculate the plasticity index of a soil as the difference between its liquid limit and its plastic limit, as follows:

Plasticity Index = Liquid Limit – Plastic Limit

The plasticity index is the difference calculated above, except under the following conditions:

   a. When the liquid limit or plastic limit cannot be determined, report the plasticity index as NP (non-plastic).

   b. When the plastic limit is equal to, or greater than, the liquid limit, report the plasticity index as NP (non-plastic).

Calculate the plasticity index to the nearest 0.1.

REPORT

Report the plasticity index to the nearest whole number.

PRECISION STATEMENT

This precision statement applies to soils with a plastic limit range between 15 and 36.

Repeatability (Single Operator): Two results obtained by the same operator on the same sample in the same laboratory using the same apparatus should be considered suspect if they differ by more than 10 percent of their mean.

Reproducibility (Multilaboratory): Two results obtained by different operators in different laboratories should be considered suspect if they differ from each other by more than 18 percent of their mean.

Test Method Nev. T227H
April 5, 2010

State of Nevada
Department of Transportation
Materials Division

METHOD OF TEST FOR SAND EQUIVALENT

Follow AASHTO T 176-08 in its entirety with the following exceptions:

4.7. Note 2, delete the second sentence.

4.9. Delete the last sentence.

4.11. Delete and replace with:

A thermostatically controlled drying oven capable of maintaining a temperature of 60 ± 3ºC (140 ± 5ºF).

5.1. Delete and replace with:

The test may be performed without strict temperature control; however any referee testing must be performed with the temperature of the working solution at 22 ± 3ºC (72 ± 5ºF).

7. SAMPLE PREPARATION Delete this section in its entirety and replace with:

7.1. Prepare sand equivalent test samples from the passing 4.75 mm (No. 4) sieve portion of the material to be tested. Oven dry the samples at 60 ± 3ºC (140 ± 5ºF) sufficiently to permit a complete separation on the 4.75 mm (No. 4) portion passing the 4.75 mm (No. 4) sieve. Be sure all fines are cleaned from the retained 4.75 mm (No. 4) sieve portion and included with the passing 4.75 mm (No. 4) sieve material.

7.2. Split or quarter enough material from the passing 4.75 mm (No. 4) portion to fill the 85 mL (3 oz) tin to within 0.48 mm (3/16 in.) of the brim (three tins of material are required for source and contract samples) without overflowing the tin. Use extreme care in the sand equivalent test sample preparation to obtain a truly representative sample. Striking off the tin measure level is not allowed. Adjustments are usually required to provide the desired test sample size. However, make these adjustments before the sample is reduced below a volume equal to four tin measures, or approximately 450 g for material of average specific gravity.

Note: Experiments show that as the amount of material being reduced by splitting or quartering is decreased, the accuracy of providing representative portions is decreased. For this reason, it is imperative that the sand equivalent test sample, which is already relatively small, be split or quartered carefully. When it appears necessary, dampen the material to avoid segregation or loss of fines.

7.3. After obtaining the 85 mL (3 oz) tin measure of material, then dry the test samples in the tin, in an oven, to a constant mass at 60 ± 3ºC (140 ± 5ºF) and cool to room temperature before testing.

8.4.3. Delete this subsection and figure 4., the Hand Method will not be allowed.

9.3.2. Each of the three sand equivalent values must be within ± 4 points from the average of these values.

Test Method Nev. T228B
December 6, 2002

State of Nevada
Department of Transportation
Materials Division

METHOD OF TEST FOR EVALUATING CLEANNESS OF COARSE AGGREGATE

SCOPE:

This method shall be California Test 227 in its entirety (attached), with the following exceptions:

Delete C. 1.; replace this section with AASHTO T176,

2.7.1. 2.7.1. Stock solution with formaldehyde.
2.7.1.1. Anhydrous Calcium Chloride, 454 g (1.0 lb) of technical grade.
2.7.1.2. USP Glycerin, 2050 g (1640 mL).
2.7.1.3. 2.7.1.3. Formaldehyde, (40 volume % solution) 47 g (45 mL).
2.7.1.4. 2.7.1.4. Dissolve the 454 g (1.0 lb) of calcium chloride in 1.89 L (½ gal) of distilled water. Cool and filter it through ready pleated rapid filtering paper. Add the 2050 g of glycerin and the 47 g of formaldehyde to the filtered solution, mix well and dilute to 3.78L (1 gal).

Delete paragraph G.2, 2a and 2b.

Test Method Nev. T228A
Effective 02/22/2002

California Test 227
December 1999

STATE OF CALIFORNIA—BUSINESS, TRANSPORTATION AND HOUSING AGENCY

DEPARTMENT OF TRANSPORTATION
ENGINEERING SERVICE CENTER
Transportation Laboratory
5900 Folsom Boulevard
Sacramento, California 95819-4612

METHOD OF TEST FOR EVALUATING CLEANNESS OF COARSE AGGREGATE

CAUTION: Prior to handling test materials, performing equipment setups, and/or conducting this method, testers are required to read "**SAFETY AND HEALTH**" in Section I of this method. It is the responsibility of the user of this method to consult and use departmental safety and health practices and determine the applicability of regulatory limitations before any testing is performed.

A. SCOPE

The cleanness test provides an indication of the relative proportions of clay-sized material clinging to coarse aggregates or screenings.

B. APPARATUS

The following equipment is required to perform this test. Detailed descriptions and specifications are included as necessary to ensure standardization.

Items bearing a Business Management (OBM) or Office of Purchasing and Warehousing (OPW) catalog number are available to California State agencies from the Department of Transportation, Office of Purchasing and Warehousing. Detailed plans are available for those items bearing a Transportation Laboratory (TL) drawing number.

1. Agitator (Figure 1): A mechanical device designed to hold the wash vessel in an upright position while subjecting it to a lateral reciprocating motion at a rate of 285 ± 10 complete cycles per minute. The reciprocating motion shall be produced by means of an eccentric located in the base of the carrier, and the length of the stroke shall be 44.4 ± 0.6 mm. The clearance between the cam and follower of the eccentric shall be between 0.025 mm and 0.102 mm. Other types of agitators may be used provided the length of time and other factors are adjusted to produce the same results as those obtained using the agitator described above.

2. Wash vessel: A flat-bottom, straight-sided, cylindrical vessel conforming to the specifications and dimensions shown in Figure 2.

3. Washing pan: A pan of convenient size to submerge and scrub individual aggregate particles up to 64 mm in size.

4. Collection pot: A round pan or container with vertical or nearly vertical sides and equipped as necessary to hold the wire mesh of a standard 203 mm diameter sieve at least 76 mm above the bottom.

   An adapter which will not allow loss of fines or wash water may be used to nest the sieve with the container, or the sieve may be nested with a blank sieve frame resting in the bottom of the pan.

5. Graduated cylinder: A graduated cylinder with a capacity of 1000 mL to 1500 mL.

6. Graduated plastic cylinder: A sand equivalent test cylinder, Assembly B, specified in TL drawing number C 218.

7. Rubber stopper: A stopper to fit the plastic cylinder.

8. Funnel: A wide-mouth funnel suitable for directing water into the plastic cylinder.

9. Sieves: U.S. Standard Sieves 2.36 mm and 75 µm, standard 203 mm diameter, full height.

10. Box sieve assembly: A rocker and box sieves assembly conforming to the design shown in TL drawing No. D-574 (Figure 3). The screen shall be U.S. Standard Sieves, 4.75 mm and 25.0 mm.

11. Balance: A balance or scale accurate to 0.2 % of the mass of the sample to be tested.

12. Oven: A drying oven set to operate at 110 ± 5°C.

    a. Timer: A clock or watch graduated in minutes and seconds.

13. Stiff fiber brush.

C. MATERIALS

1. Calcium chloride solution.

    a. "Sand Equivalent Stock Solution" OPW catalog number 6810-0090-3.

    b. May be prepared from the following:

        120 g tech. grade anhydrous calcium chloride.

        542 g USP glycerin (95 %)

        Dissolve the calcium chloride in 500 mL of distilled or deionized water. Cool the solution to room temperature, then filter it through Watman No. 2V or equivalent filter paper. Add the glycerin to the filtered solution, mix well, and dilute to 1 L with distilled or deionized water.

2. Water.

    Use distilled or deionized water for the normal performance of this test. If it is determined, however, that the local tap water is of such quality that it does not affect the test results, it is permissible to use it in lieu of distilled or deionized water.

D. CONTROL

The temperature of the testing water should be maintained at 22.2 ± 2.8°C. If the temperature is below the recommended range, test results that meet the specified requirement are valid.

E. PREPARATION OF TEST SPECIMENS

1. Split or quarter the material to obtain a test specimen conforming to the mass specified in Table 1 for various primary aggregate nominal sizes.

Table 1

Primary Aggregate Nominal Size	Oven-Dry Mass (g)	Volume of Wash Water (mL)
63 mm X 37.5 mm	20 000 ± 1000	1500 ± 15
37.5 mm X 19.0 mm	10 000 ± 500	1250 ± 12
25.0 mm X 4.75 mm	2500 ± 125	1000 ± 5
12.5 mm Max.	1000 ± 50	500 ± 3

    a. If the material representing a primary aggregate nominal size for use in portland cement concrete has been separated into two or more bin sizes, prepare a combined sample representing the primary aggregate nominal size from representative portions of material from each bin. When preparing the combined sample, use the same proportions of material from each bin as is used in the mix.

b. Pit-run aggregates such as used for sacked concrete slope protection shall be oven dried and processed according to the instructions in Section E.4.c prior to splitting out the test specimen.

2. Dry to constant mass at 110 ± 5°C.

   a. When testing reclaimed aggregates containing traces of asphalt or asphalt concrete, the oven-drying temperature shall not exceed 38°C.

   b. Aggregates which are sampled immediately after being dried in an asphalt plant drier may be tested without additional drying provided they are not exposed to dampness prior to testing. Aggregates that are not tested on the same day they are sampled shall be oven-dried prior to testing unless they have been stored in moisture-proof containers.

   c. As a time-saving expedient in routine work, it is permissible to test materials in an air-dried condition. Air-dried materials that do not meet minimum requirements shall be retested in an oven-dried condition and the results of the oven-dried sample will control.

3. Cool to room temperature.

4. Complete the test sample preparation according to the following instructions for various materials.

   a. 63 x 37.5 mm and 37.5 x 19.0 mm aggregate.

      (1) Separate the material on the 4.75 mm box sieve (Figure 3) using the following procedure:

         (a) Divide the sample into portions weighing approximately 2500 g each.

         (b) Place one of the portions on the 4.75 mm box sieve and "rock" the assembly 10 complete cycles in approximately 12 s. One complete cycle is a back and forth motion with the stops on each end of the rocker assembly bumping the floor before the motion is reversed.

         (c) Repeat this sieving operation on each portion of the test sample.

         (d) Discard the material that passes the 4.75 mm sieve.

         (e) Save the material retained on the 4.75 mm sieve for determining the cleanness value.

      (2) Recombine all of the portions of the 63 x 37.5 mm test specimen.

      (3) Retain each of the four portions of the 37.5 x 19.0 mm test specimen in separate containers.

   b. 25.0 x 4.75 mm aggregate.

      No further preparation is required.

   c. Pit-Run Aggregate.

      (1) Dry the entire sample to constant mass at 110 ± 5°C and cool it to room temperature.

      (2) Separate the entire sample on the 25.0 mm and 4.75 mm box sieves using the following procedure.

         (a) Place the material on the nested 25.0 mm and 4.75 mm box sieves, and rock the assembly 10 complete cycles in approximately

12 s. Divide the sample into as many portions as necessary to avoid overloading the sieves.

(b) Discard the portion retained on the 25.0 mm sieve.

(c) Save the portion retained on the 4.75 mm sieve for determining the cleanness value.

(d) Split or quarter out a test specimen conforming to the mass requirements for 25.0 x 4.75 mm aggregate.

(e) Save the portion passing the 4.75 mm sieve for determining the sand equivalent.

d. 12.5 mm maximum size aggregates (screenings, chips, pea gravel, etc.).

No further preparation is required.

F. TESTING PROCEDURES

1. Measure out the appropriate volume of water for the test specimen according to Table 1.

2. Wash the prepared test specimen according to the appropriate procedure below:

a. 63 x 37.5 mm aggregate.

(1) Pour the wash water into the washing pan.

(2) Submerge each aggregate particle individually in the wash water and remove the fines by scrubbing with a stiff fiber brush.

(3) Discard the washed particle and repeat the procedure until all particles have been washed. Take care to avoid loss of wash water or fines.

(4) Pour the dirty wash water and accumulated fines through the 75 µm sieve into the collection pot.

(a) Prior to pouring, stir the water vigorously to bring the fines into suspension.

(b) Use a small amount of fresh water, as necessary, to rinse any remaining fines from the washing pan.

(5) Pour the wash water into a graduated cylinder and adjust the volume to 1500 ± 15 mL with fresh water. Return the wash water to the collection pot taking care to include all water and fines.

b. 37.5 x 19.0 mm aggregate.

(1) Place one of the 2500 g portions of the test specimen in the wash vessel.

(2) Add the wash water, clamp the lid in place, and secure the vessel in the agitator.

(3) At 1 min ± 10 s after adding the wash water, start the agitator, and agitate the vessel for a period of 1 minute ± 5 s.

(4) Immediately following the agitation period, take the vessel from the agitator, and remove the lid.

(5) Bring the fines into suspension by holding the vessel in an upright position and moving it vigorously in a horizontal circular motion 5 or 6 times to cause the contents to swirl inside.

(6) Immediately pour all of the contents of the vessel into the 2.36 mm and 75 µm sieves nested over the collection pot.

(7) Discard the material retained on the 2.36 mm sieve.

(8) Pour the wash water from the collection pot into a graduated cylinder, and adjust the volume to 1250 ± 12 mL with fresh water.

(9) Place the second portion of the test specimen in the washing vessel, add the same wash water, and wash according to the above procedures.

(10) Repeat this procedure with each of the four portions of the test specimen.

(11) After washing the last portion and pouring it into the nested sieves, use a small amount of fresh water to rinse the remaining fines from the washing vessel.

(12) Adjust the volume of water to 1250 ± 12 mL with fresh water. Return the wash water to the collection pot taking care to include all water and fines.

c. Aggregates having maximum nominal size of 25.0 mm or less.

(1) Place the test specimen in the washing vessel.

(2) Add the specified volume of wash water, clamp the lid in place, and secure the vessel in the agitator.

(3) At 1 min ± 10 s after adding the wash water, start the agitator, and agitate the vessel for a period of 2 min ± 5 s.

(4) Immediately following the agitation period, take the vessel from the agitator, and remove the lid.

(5) Bring the fines into suspension by holding the vessel in an upright position and moving it in a horizontal circular motion 5 or 6 times to cause the contents to swirl inside.

(6) Immediately pour all of the contents of the vessel into the 2.36 mm and 75 µm sieves nested over the collection pot.

(7) Use a small amount of fresh water to rinse the remaining fines from the washing vessel.

(8) Discard the material retained on the 2.36 mm sieve.

(9) If a concentration of material is retained on the 75 µm sieve, re-rinse the fine material by pouring the wash water through the sieve again, using the following procedure:

(a) Allow the wash water to stand undisturbed in the collection pot for a few moments to permit the heavier particles to settle to the bottom.

(b) Set the 75 µm sieve aside, and pour the upper portion of the wash water into a separate container.

(c) Place the 75 µm sieve back on the collection pot, and pour the water back through the material on the 75 µm sieve. (If two collection pots are available, the specimen may be rinsed by alternately placing the sieve on one and then the other while pouring the wash water through the material on the sieve. Before each rinsing, allow the heavier particles to settle to the bottom, and pour only the upper portion of the water through the material.)

(d) Repeat this procedure as necessary until all of the minus 75 µm material has been washed through the sieve. When the material has been rinsed sufficiently, the material on the sieve will be free of visible streaks of clay, and the wash water will flow freely through the sieve and accumulated material.

(10) Discard the material retained on the 75 µm sieve.

(11) Pour the wash water into a graduated cylinder, and adjust the volume to the original amount with fresh water. Return the wash water to the collection pot taking care to include all water and fines.

3. Fill the graduated plastic cylinder to the 3 unit mark with stock calcium chloride solution, and place the funnel on the cylinder.

4. Stir the wash water vigorously with one hand until all fines are in suspension. Use a circular motion allowing the fingers to rub the sides and bottom of the collection pot.

5. Immediately fill the graduated plastic cylinder to the 150 unit mark with the turbulent wash water.

6. Stopper the cylinder and thoroughly mix the wash water and calcium chloride solution by inverting the cylinder 20 times in approximately 35 seconds. Allow the air bubble to completely traverse the length of the cylinder each time.

7. Immediately place the cylinder on a work bench or table free of vibrations, remove the stopper, and allow it to stand undisturbed for 20 min ± 15 s.

8. At the end of the 20-minute period, read the top of the sediment column to the nearest 1 unit mark.

   a. If a clearly defined line of demarcation does not form between the sediment and the liquid above it in the specified 20 minute period and the test is being made with distilled or deionized water, allow the cylinder to stand undisturbed until the clear line of demarcation does form, then immediately read and record the time and the height of the column. If tap water was used, retest an untested portion of the same material using distilled or deionized water.

   b. If the liquid immediately above the line of demarcation is still darkly clouded at the end of 20 minutes, and the line of demarcation, although distinct, appears to be in the sediment column itself, read and record the level of this line at the end of the specified 20-minute period. If tap water was used, retest an untested portion of the sample using distilled or deionized water.

G. CLEANNESS VALUE DETERMINATION

1. Determine the Cleanness Value of individual test specimens from Table 2.

   a. This table is derived from the formula:

$$CV = x\ 100$$

Where:

CV = Cleanness value

H = Height of sediment in units.

2. When two or more primary sizes of coarse aggregate are combined in a mix, determine the weighted-average Cleanness Value for the mix. For Portland cement concrete mixes, calculate the weighted-average Cleanness Value using the combinations shown below regardless of the actual proportions to be used on the project.

   a. 37.5 mm Maximum aggregate mix

37.5 mm	x	19.0 mm	40%
25.0 mm	x	4.75 mm	60%

   b. 63 mm Maximum aggregate mix

63 mm	x	37.5 mm	30%
37.5 mm	x	19.0 mm	30%
25.0 mm	x	4.75 mm	40%

H. REPORTING OF RESULTS

1. Report the Cleanness Value to the nearest whole number.

2. The reported Cleanness Value shall be indicative of all the coarse aggregate in a product.

   a. When only one primary size of coarse aggregate is represented in a product, report the Cleanness Value determined for the test sample. No additional remarks are necessary.

   b. When a product is composed of more than one primary size aggregate, or when aggregates from more than one bin are combined to make a product, report the Cleanness Value calculated by averaging, on the weighted-average basis, the results of the individual samples. Also note the Cleanness Value of each test sample used in the computation.

   c. When more than one primary size of aggregate is being combined in a product, but only one size is tested, report the Cleanness Value of the tested sample and indicate that the reported value is for a primary aggregate size only and that this value may not be used for determining compliance with the specified cleanness value.

I. SAFETY AND HEALTH

Soils and aggregates may contain bacteria and/or organisms that can be harmful to your health. The wearing of dust masks and protective gloves when handling materials is advised.

The use of heat resistant gloves/mitts or potholders to remove samples from the ovens is required.

When preparing stock solution, protective eyewear, an approved respirator, protective gloves, and apron shall be worn.

The requirements listed for preparing stock solution should be considered for use when performing the Cleanness of Coarse Aggregate test.

Prior to handling, testing or disposing of any materials, testers are required to read Caltrans Laboratory Safety Manual: Part A, Section 5.0, Hazards and Employee Exposure; Part B, Sections: 5.0, Safe Laboratory Practices; 6.0, Chemical Procurement Distribution and Storage; and 10.0, Personal Protective Apparel and Equipment; and Part C, Section 1.0, Safe Laboratory Practices. Users of this method do so at their own risk.

REFERENCES:
California Tests 202 and 217

End of Text (California Test 227 contains 11 pages)

Table 2

CLEANNESS VALUES (C.V.) FOR 0 TO 150 UNITS SEDIMENT HEIGHT READINGS (H)

Sediment Height (Units)	C.V.	Sediment Height (Units)	C.V.	Sediment Height (Units)	C.V.	Sediment Height (Units)	C.V.	Sediment Height (Units)	C.V.
0	100	30	46	60	24	90	13	120	5
1	97	31	45	61	24	91	12	121	5
2	94	32	44	62	23	92	12	122	5
3	91	33	43	63	23	93	12	123	5
4	89	34	42	64	22	94	11	124	4
5	86	35	41	65	22	95	11	125	4
6	84	36	40	66	21	96	11	126	4
7	81	37	40	67	21	97	11	127	4
8	79	38	39	68	21	98	10	128	4
9	77	39	38	69	20	99	10	129	3
10	75	40	37	70	20	100	10	130	3
11	73	41	36	71	19	101	9	131	3
12	71	42	36	72	19	102	9	132	3
13	69	43	35	73	18	103	9	133	3
14	68	44	34	74	18	104	9	134	3
15	66	45	33	75	18	105	8	135	2
16	64	46	33	76	17	106	8	136	2
17	63	47	32	77	17	107	8	137	2
18	61	48	32	78	17	108	8	138	2
19	60	49	31	79	16	109	7	139	2
20	58	50	30	80	16	110	7	140	2
21	57	51	29	81	15	111	7	141	1
22	56	52	29	82	15	112	7	142	1
23	54	53	28	83	15	113	7	143	1
24	53	54	28	84	14	114	6	144	1
25	52	55	27	85	14	115	6	145	1
26	51	56	26	86	14	116	6	146	1
27	49	57	26	87	13	117	6	147	0
28	48	58	25	88	13	118	6	148	0
29	47	59	25	89	13	119	5	149	0
								150	0

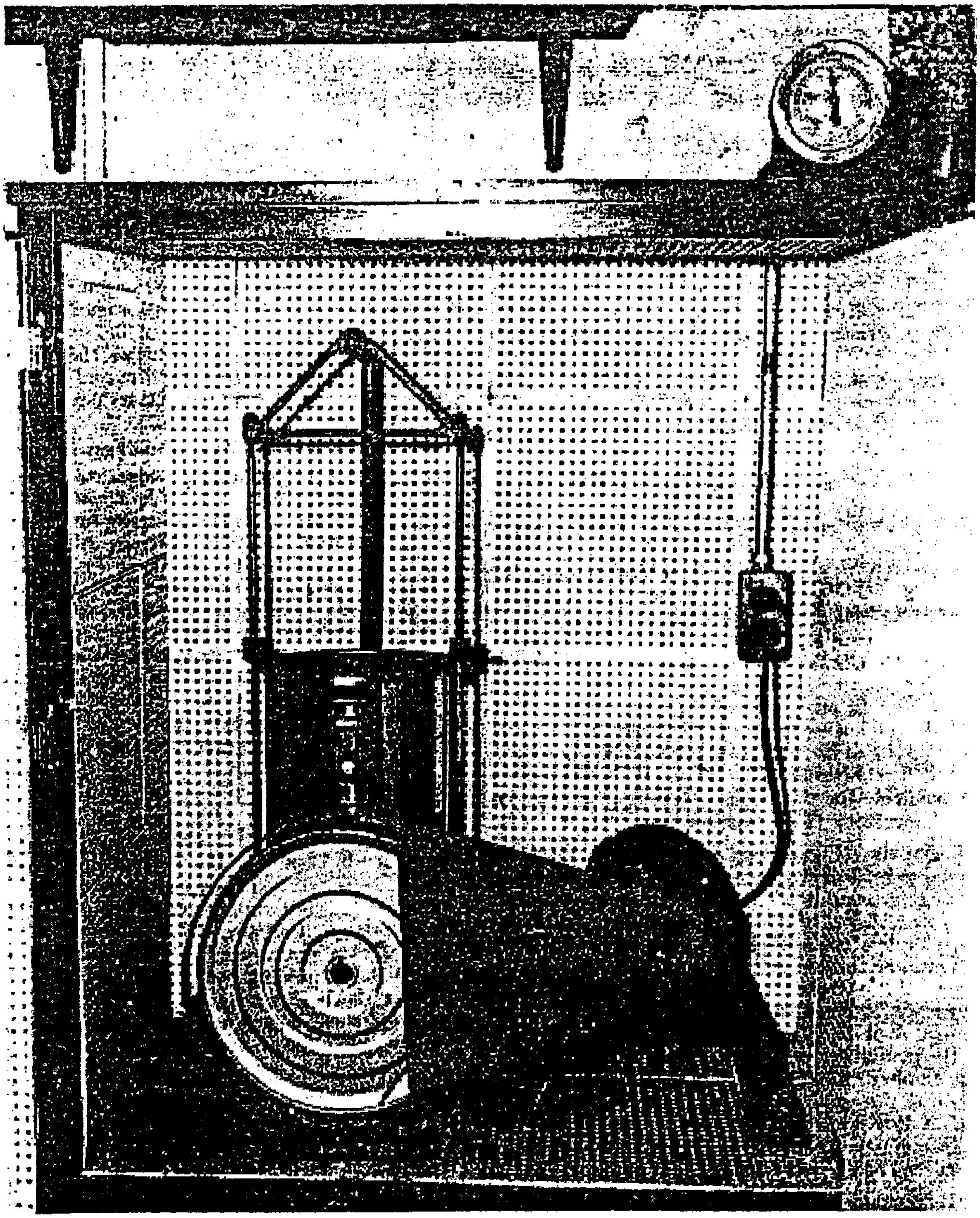
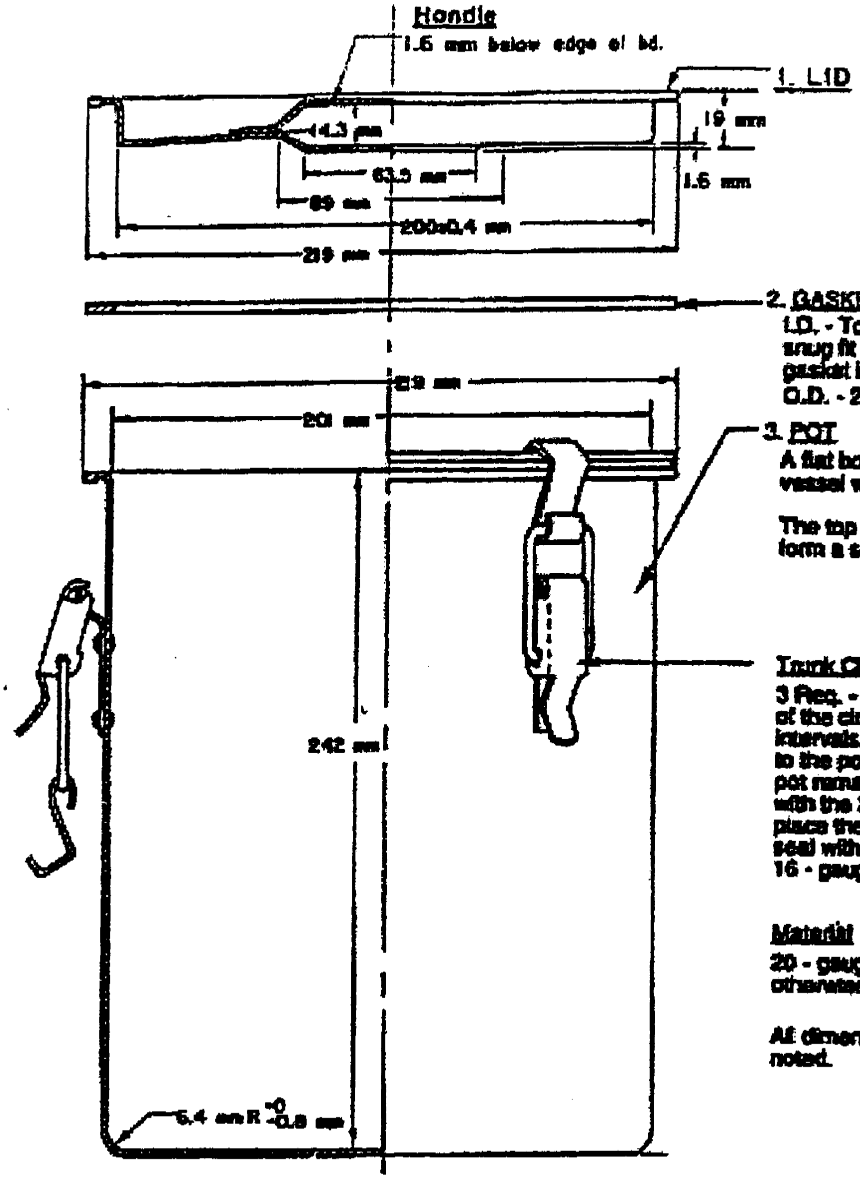


Figure 1

AGITATOR



2. GASKET - 3 mm rubber neoprene
I.D. - To be such dimension so snug fit lid wall will result when gasket is in place.
O.D. - 216 ±0.4 mm

3. POT
A flat bottom, straight sided, cylindrical vessel with a capacity of approx. 7.5 L

The top edge shall be flared outward to form a seat for the gasket and lid.

Trunk Clamps
3 Req. - placed at intervals of one-third of the circumference or at 120-degree intervals. The clamps shall be attached to the pot by rivets or welds so that the pot remains water tight. When fitted with the 3 mm gasket and clamped in place the lid shall form a watertight seal with the flared edge of the pot.
16 - gauge stainless steel.

Material
20 - gauge stainless steel unless otherwise noted.

All dimensions ±0.8 mm otherwise noted.

Figure 2

MECHANICAL WASHING VESSEL

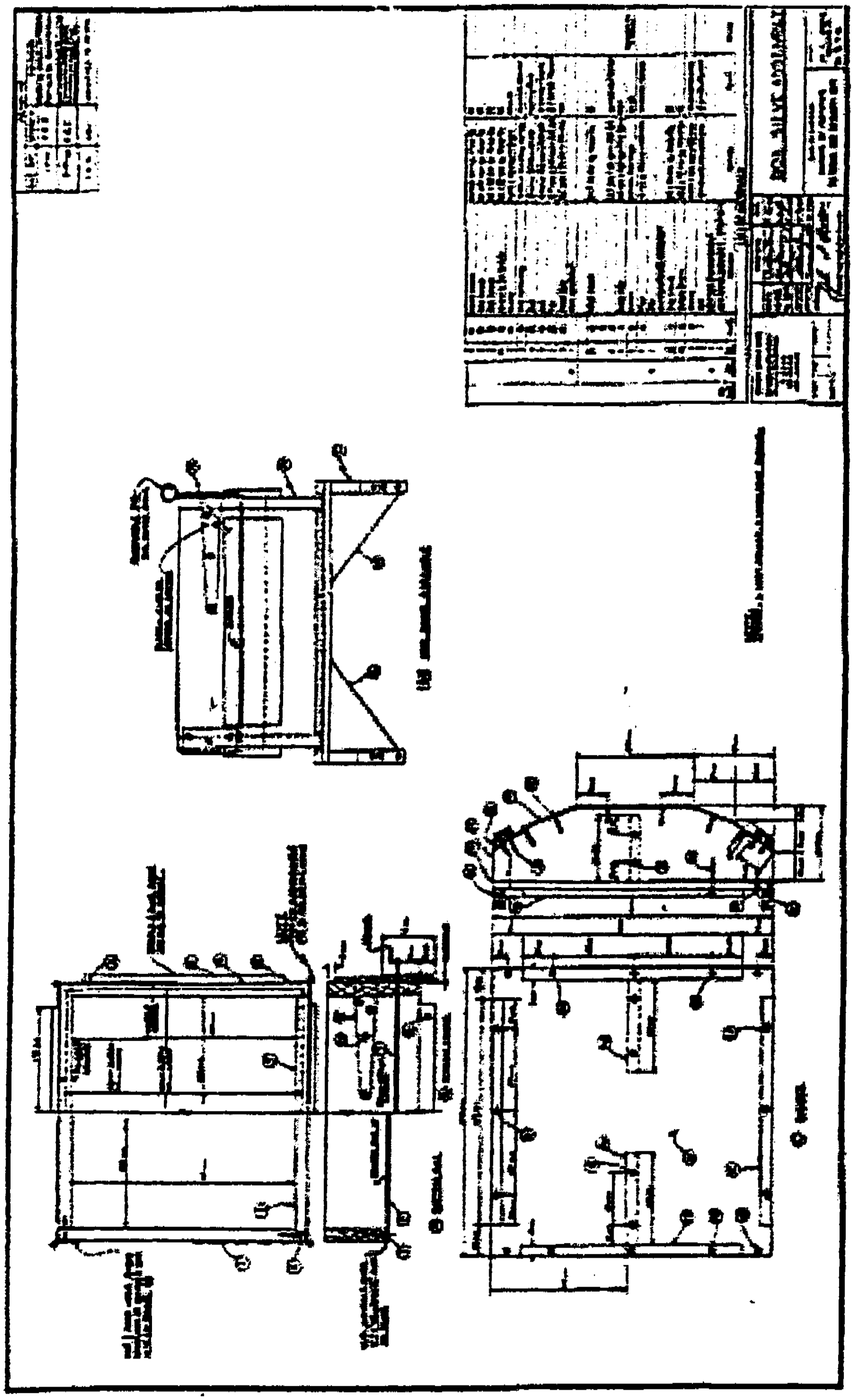


Figure 3

BOX SIEVE ASSEMBLY

State of Nevada
Department of Highways
Materials and Testing Division

METHOD OF TEST FOR DETERMINING THE PERCENT OF FRACTURED FACES

SCOPE

This test method describes a procedure for determining the percentage, by weight, of aggregate particles with at least one fractured face. A particle is defined to be fractured if it has a rough surface texture caused by natural or mechanical means.

A. APPARATUS

1. Balance. A balance or scales with a minimum capacity of 2 kg. and sensitive to 1 g. or less is required.
2. Sieves. The sieves shall be of the woven wire type with square openings, and shall conform to the Standard Specifications for Sieves for Testing Purposes. AASHTO Designation M92.
3. Splitter. Any device may be used which will divide the sample into representative portions. However, the riffle-type splitter is preferable to hand quartering.
4. Spatula. A spatula or similar tool to aid in sorting aggregate particles.

B. PREPARATION OF SAMPLE

1. Carefully quarter the test sample from the larger sample of aggregate that has been submitted to the laboratory for testing. The following table shows the minimum oven-dry weights for the different sizes of aggregates:

Aggregate size	Weight in grams
Pass 2 inch (50.8 mm)	4,000 ± 100 grams
Pass 1 inch (25.4 mm)	2,500 ± 50 grams
Screenings and open-graded plantmix	1,000 ± 50 grams

2. Dry the test sample to constant weight at a temperature not exceeding 230° F. (110° C.).
3. Separate the test sample into two portions by means of a No. 4 (4.75 mm) sieve. Waste the portion passing the No. 4 (4.75 mm) sieve.

C. TEST PROCEDURE

1. Weigh the portion retained on No. 4 (4.75 mm) sieve and record as "Total Weight of Sample".

2. Spread sample out on a worktable, using large enough area so that individual particles can be closely inspected.

3. Use knife edge of large spatula for separating particles with one or more fractured faces from those particles that have no fractured faces (it is faster to separate particles into two separate piles by sliding them with a spatula than it is to pick up individual particles with fingers).

4. Use spatula to slide pile of particles with one or more fractured faces into balance pan. Weigh and record as "Weight of Fractured Aggregate".

D. CALCULATIONS

$$\text{Percent fractured faces} = \frac{\text{Weight of fractured aggregate}}{\text{Total weight of sample}} \times 100$$

E. PRECAUTIONS

Wash dirty aggregate. This will facilitate inspection and detection of fractured particles.

F. REPORTING OF RESULTS

Report the percent of aggregate particles with fractured faces calculated to the nearest whole number.

State of Nevada
Department of Highways
Materials and Testing Division

METHOD FOR DETERMINATION OF COMPRESSIVE STRENGTH OF CEMENT TREATED BASE AND CEMENT TREATED SUBGRADE (FIELD METHOD)

SCOPE

This method covers the procedure for determining the compressive strength of cement treated material, and also provides a guide for maintaining optimum moisture conditions in the field.

FIELD METHOD

A. APPARATUS

1. Balance with capacity of 5,000 g, accurate to 1 g
2. Split compaction mold, 4-in. diam. x 11.5 in. as shown in Figure I.
3. One compression machine consisting of a 12-20 ton capacity hydraulic jack fitted with a spherically seated head and mounted in a 30-in. frame.
4. Tamper, rod, tin liners and bottom and upper plunger as shown in Figure I.
5. Measuring gauge and stand as shown in Figure II.
6. Special bench vise for holding compaction and mold as shown in Figure II.
7. 6 x 12-in. concrete cylinder cans with lids.
8. Two 6 x 6-in. glass plates for each specimen.
9. Miscellaneous items such as spoons, spatulas, scoops, scotch tape, etc.
10. Water tank 6-in. deep for use in submerging test specimens.
11. Sample splitter, riffle type, 3/4-in. openings.

B. MATERIALS

1. A supply of gypsum casting plaster.
2. Supply of 1/2-in. adhesive tape.

C. PROCEDURE FOR THE FABRICATION OF TEST SPECIMENS

1. Obtain representative samples of the freshly mixed materials daily. Normally, two samples should be taken, one from the mixing plant and one from the street immediately ahead of rolling operations. To protect against the loss of moisture, place all samples in 6 x 12-in. concrete cylinder cans and immediately cover.

2. Transport the cans to the point of fabrication and fabricate samples with the least possible delay. Protect against loss of moisture at all times.

3. Immediately upon arrival at the point of fabrication, remix the sample and screen through a 1-in. sieve. Only the minus 1-in. material is used in making test specimens.

4. Quarter out the approximate amounts required for the moisture determination and test specimen. The amount of material for moisture samples should be approximately 1,000 g. The amount of material needed for fabricating a test specimen is shown in Table II. It is of extreme importance that test specimens be fabricated as soon as possible after the mixing process. The hydration of the cement can cause a serious loss of compressive strength as well as a reduction in the density of the test specimen.

5. Weigh the material for both moisture samples and test specimens to the nearest gram, and weigh as rapidly as possible to avoid loss of moisture. Protect all material for test specimens against loss of moisture after weighing, and do not delay between weighing and fabricating.

6. Assemble the 4-in. mold with the tin liner in place and the plunger held one space from the bottom by means of the pin. (For some soils it may be necessary to hold the bottom plunger further from the end of the mold in order to prevent the rim of the mold from coming in contact with the shoulder of the plunger before compaction is completed. In such cases, insert the pin through successively higher holes until satisfactory results are secured).

7 Place the extension sleeve on top of the mold and add approximately one-half of the weighed sample with a scoop or large spoon. If the material contains rock particles larger than 1/4 in., rod 20 to 30 times with a 3/8 in. bullet-nosed rod during this operation, in order to prevent the formation of rock pockets at the bottom or sides of the specimen. Tamp the first layer of material 50 blows with the small end of the 6 lb. hand tamper. Physical exertion in tamping should be only sufficient to move the tamper over the entire surface of the specimen. The actual compactive effort should be provided only by the weight of the tamper, using the hand as a guide. Avoid having a smoothly compacted surface at this stage because it will result in a compaction plane in the specimen when the next layer is tamped, and this would prevent the two layers from being bonded together.

8. Place the remaining portion of the sample in the mold and rod if sample contains coarse aggregate. It is not necessary to rod fine material such as

sand. Tamp the second layer using 100 blows with the small end of the hand tamper. Level off the top of the compacted specimen by tamping lightly with the large end of the tamper in order to provide a smooth surface on an even plane at right angles to the axis of the mold. After tamping is completed, remove the extension sleeve.

9. Place the top plunger in position, then place the entire assembly on the hydraulic jack in the compression frame. If necessary, place one or more of the spacing rings between the top plunger and the top of the frame to prevent excessive travel of the jack. Remove the pin that holds the bottom plunger in place and gradually apply a total load of 25,000 lb.; use 1 min. to attain the first 20,000 lb., 1/2 min. for the next 5,000 lb. and hold the 25,000 lb. load for 1 min. Then release the load, place the mold in the vise, take out the plungers, open the mold, remove the specimen with its tin jacket and weigh.

10. Determine the height with the measuring gauge, by seating the circular measuring guide firmly on top of the cylinder. Care must be taken to seat the dial indicator tip properly in the center of the measuring guide. The height measurement is illustrated in Figure II.

11. If water is squeezed out of the specimen during compaction, a notation should be made of the amount as a guide in maintaining optimum moisture control in the field. This is done by taking the difference between the net weight of the specimen and the net weight of the sample used. Headquarters laboratory will normally make optimum moisture determination on preliminary samples which may serve to compare with field results. However, in applying optimum moisture control in the field, consideration must be given to evaporation losses in mixing and handling and allowances made accordingly.

12. Determine the moisture content of the sample by weighing the material set aside for this purpose (approx. 1,000 g.) to the nearest gram and drying on a hot plate to constant weight.

$$\text{Percent moisture} = \frac{\text{Wet Weight - dry weight}}{\text{Dry weight}} \times 100$$

13. After determining the height and weight of the compacted specimen, print the proper identifying marks on the side of the tin liner with an indelible pencil. Place tin caps on each end and seal with masking tape.

D. PROCEDURE FOR THE DETERMINATION OF COMPRESSIVE STRENGTH IN THE FIELD

1. If it is necessary that compressive strengths be determined on the job, the test specimens should be cured for 6 days. The curing shall be accomplished by placing lids on each end of the tin sleeve, sealing with adhesive tape and then storing in a cool place such as the shady side of a building. However, during cold weather the test specimens should be protected from freezing. At the end of the 6-day curing period, remove the caps and liners and transfer the identifying marks to the side of the specimen with an indelible pencil.

2. Immerse the specimens in water for 1 day in order to complete the 7-day curing period required for the compressive strength test.

3. Remove the specimens from the water bath, wipe the surfaces with a dry rag and cap both ends of each specimen with gypsum casting plaster as follows:

    a. Select two glass plates, approximately 6 x 6 in., for each specimen and lay them out on a table or bench.

    b. Oil the top of each glass with common motor lubricant.

    c. Measure out into a suitable container about a cup of gypsum casting plaster for each specimen to be capped.

    d. Add water and mix to a fairly thick paste.

    e. Place a tablespoonful of paste on top of each test specimen and immediately force one of the plates down on the paste on top of each specimen to form full caps.

    f. Place a tablespoonful of paste on each of the other glass plates and press each of the specimens firmly on a glass plate so as to form full caps.

    g. Allow the caps to harden for a minimum of 30 min. and then remove the glass plates by tapping the edges lightly with a piece of soft wood. If difficulty is experienced in removing the plates, apply warm water and continue tapping lightly.

4. The specimen may be tested for compressive strength as soon as the glass plates are removed. Center the specimen on the head of the hydraulic jack in the compression machine and apply the load at the rate of between 20 and 50 lb. per square inch per second. A convenient rate of loading when using the compression machine on a 4-in. diam. test specimen is 30,000 lb. per minute. This allows easy conversion in the field to desired load-time units (i.e., 500 lb. per second). Apply the load until ultimate fracture of the test cylinder occurs. An initial fracture will usually occur at approximately 80 percent of the load required for ultimate fracture.

5. Report the test results as compressive strength in pounds per square inch which equals the total compression load divided by the end area of the 4-in. dia. test specimen (12.57 sq. in.). Table I lists the unit compressive stress in increments of 500-lb. total load.

TABLE I

TABLE OF UNIT COMPRESSIVE STRENGTH 4-IN. DIAMETER CEMENT TREATED BASE SPECIMEN

Total Load (lbs.)	Compressive Strength (psi)	Total Load (lbs.)	Compressive Strength (psi)	Total Load (lbs.)	Compressive Strength (psi)
500	40	10,500	840	20,500	1,640
1,000	80	11,000	880	21,000	1,680
1,500	120	11,500	920	21,500	1,720
2,000	160	12,000	960	22,000	1,760
2,500	200	12,500	1,000	22,500	1,800
3,000	240	13,000	1,040	23,000	1,840
3,500	280	13,500	1,080	23,500	1,880
4,000	320	14,000	1,120	24,000	1,920
4,500	360	14,500	1,160	24,500	1,960
5,000	400	15,000	1,200	25,000	2,000
5,500	440	15,500	1,240	25,500	2,040
6,000	480	16,000	1,280	26,000	2,080
6,500	520	16,500	1,320	26,500	2,120
7,000	560	17,000	1,360	27,000	2,160
7,500	600	17,500	1,400	27,500	2,200
8,000	640	18,000	1,440	28,000	2,240
8,500	680	18,500	1,480	28,500	2,280
9,000	720	19,000	1,520	29,000	2,320
9,500	760	19,500	1,560	29,500	2,360
10,000	800	20,000	1,600	30,000	2,400

PROCEDURE FOR DETERMINING THE DENSITY OF TEST SPECIMENS

The density of the test specimen, based on the dry weight of material, is calculated from the data obtained in the Procedure for the Fabrication of Test Specimens using the following formula:

$$D = \frac{30.3\ Ww}{(100 + M)H}$$

Where:

D = Dry density of the test specimen in lb. per cu. ft.

Ww = Wet weight of the test specimen in grams.

M = Percent moisture of the sample.

H = Height of the test specimen in inches.

30.3 = Constant used to convert weight in grams to pounds per cubic foot for a 4-in. diam. specimen having the height measured in inches.

REFERENCE

Test Method Nev. 203
Test Method No. Calif. 901
Test Method No. Calif. 905

TABLE II

TABLE OF WEIGHTS FOR FABRICATING 4-IN. DIAMETER X 4-IN. HIGH TEST SPECIMENS OF VARIOUS WEIGHTS PER CU. FT.

Total Grams CTB

Density lbs./cu.ft.	6% moist.	7% moist.	8% moist.	9% moist.	10% moist.	11% moist.	12% moist.
115	1609	1624	1640	1655	1670	1685	1700
116	1623	1639	1654	1669	1684	1700	1715
117	1637	1653	1668	1684	1699	1714	1730
118	1651	1668	1682	1698	1714	1729	1745
119	1665	1681	1697	1712	1728	1744	1759
120	1679	1695	1711	1727	1743	1758	1774
121	1693	1709	1725	1741	1757	1773	1789
122	1707	1723	1739	1756	1772	1788	1804
123	1721	1737	1754	1770	1786	1802	1819
124	1735	1752	1768	1784	1801	1817	1833
125	1749	1766	1782	1799	1815	1832	1848
126	1763	1779	1796	1813	1829	1846	1863
127	1777	1793	1810	1827	1844	1860	1877
128	1791	1808	1825	1842	1859	1876	1893
129	1805	1822	1839	1856	1873	1890	1907
130	1819	1836	1853	1870	1888	1905	1922
131	1833	1850	1867	1885	1902	1919	1936
132	1847	1864	1881	1899	1916	1934	1951
133	1861	1879	1896	1914	1932	1949	1967
134	1875	1893	1911	1928	1946	1964	1981
135	1889	1907	1925	1942	1960	1978	1996
136	1903	1921	1939	1957	1974	1992	2010
137	1916	1935	1953	1971	1989	2007	2025
138	1931	1950	1968	1986	2004	2022	2041
139	1945	1963	1982	2000	2018	2037	2055
140	1959	1977	1996	2014	2033	2051	2070
141	1973	1992	2010	2029	2048	2066	2085
142	1987	2006	2025	2043	2062	2081	2100
143	2001	2020	2039	2058	2077	2095	2114
144	2015	2034	2053	2072	2091	2110	2129
145	2029	2048	2067	2087	2106	2125	2144
146	2043	2062	2082	2101	2120	2139	2159
147	2057	2076	2096	2115	2135	2154	2173
148	2071	2091	2110	2130	2149	2169	2188
149	2085	2105	2124	2144	2164	2183	2203
150	2099	2119	2139	2158	2178	2198	2218

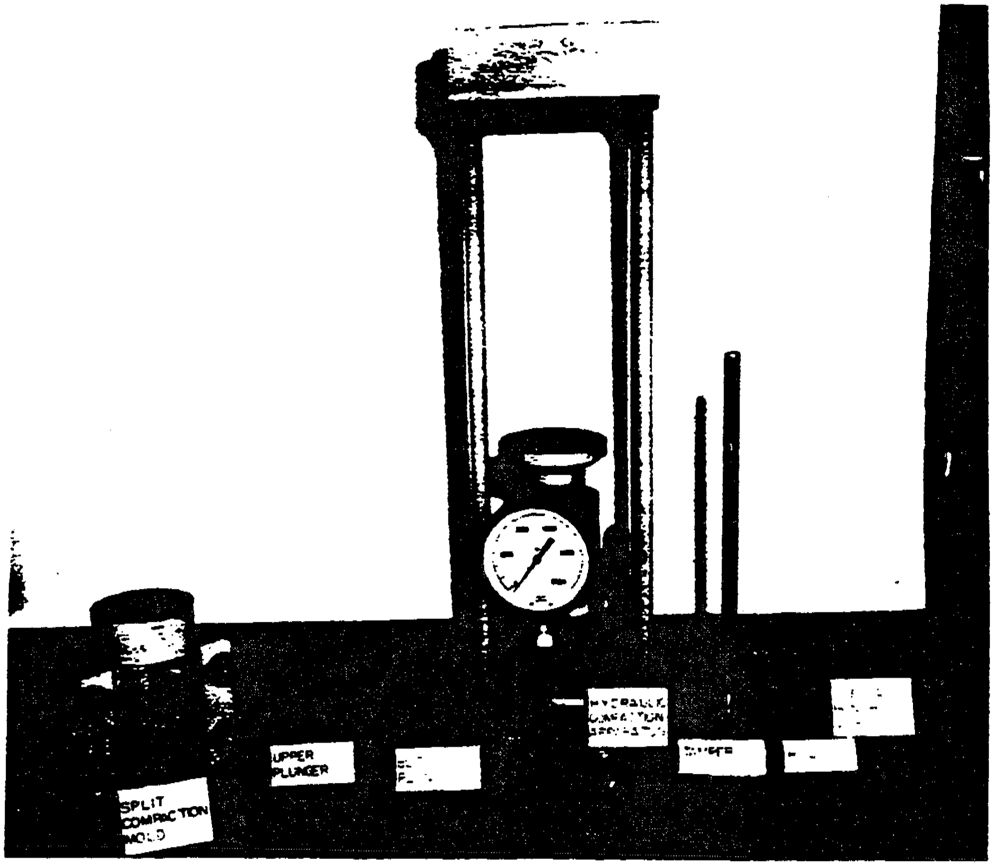

SPLIT COMPACTION MOLD
UPPER PLUNGER
HYDRAULIC COMPACTION APPARATUS

FIGURE 1

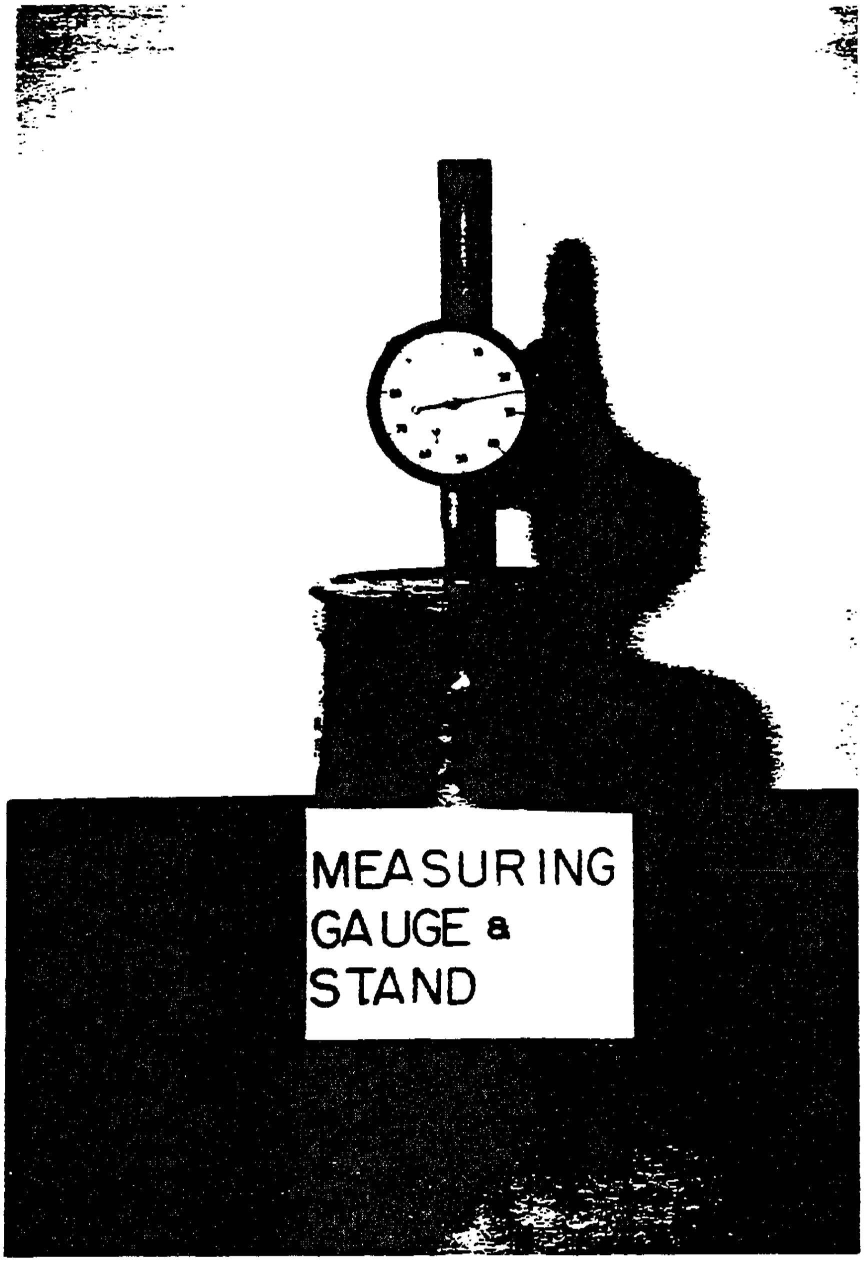


FIGURE 2

State of Nevada
Department of Highways
Materials and Testing Division

METHOD FOR DETERMINATION OF THE CEMENT CONTENT OF CEMENT TREATED BASE AND CEMENT TREATED SUBGRADE

SCOPE

This method describes the procedure for determining the cement content of cement treated materials by a rapid chemical analysis.

A. PRINCIPLE:

A 10% ammonium chloride solution is used as the solvent system for the calcium compounds present in Cement Treated Base Materials. The solution is titrated with the disodium salt of EDTA (ethylenedinitrilotetra-acetic acid) after adjustment of pH, using Hydroxynaphthol Blue as indicator. Cement content is determined from a standard graph after subtracting the aggregate blank.

B. EQUIPMENT: (For field use).

6 - 10 ml volumetric pipettes
2 - 25 ml burettes
1 - Magnetic Stirrer and Stirring Bar
1 - Burette Stand
6 - 250 ml Erlenmeyer flasks
6 - 2qt. Polyethylene Jugs (Fruit juice containers from any Variety Store have proven satisfactory and economical).
6 - Stainless Steel stirring rods (12 to 14 in.)
1 - Harvard Trip Balance with tared pan.
1 - 25 ml graduated cylinder
1 - 1,000 ml graduated cylinder
1 - Plastic funnel (12 in. diam.)
2 - 5 gal Polyethylene jugs for distilled water
1 - 5 gal Polyethylene jug for ammonium chloride
6 - Medicine droppers
1 - Pkg. pH indicator paper range 10 to 14.

C. REAGENTS:

1. EDTA, 0.1 M. Weigh 116.88 gms of EDTA (acid), A.C.S. Reagent grade, into a 3 L beaker. Add approximately 1.5 L of distilled water and place on stirrer. Add sodium hydroxide pellet by pellet until the acid is completely dissolved. Make up to exactly 4 L and transfer to a 1 gal. polyethylene bottle. This solution must be stored in plastic. (For field use this solution will be made up and distributed by Headquarters Laboratory.)

2. Ammonium chloride solution, 10%. Transfer 1893 gms of U.S.P. Granular Ammonium Chloride to a 5 gallon plastic bottle. Make up to 5 gallons with distilled water with thorough mixing.

3. Sodium Hydroxide, 50%. Dissolve 500 gms of sodium hydroxide pellets in distilled water and dilute to 1 L. Use caution, store in plastic when cool. Dilute 1 to 1 with distilled water for use. (For field use this solution will be made up and distributed by Headquarters Laboratory.)

4. Triethanolamine, 20%. Dilute 100 ml of triethanolamine to 500 ml with distilled water. (For field use this solution will be made up and distributed by Headquarters Laboratory.)

5. Hydroxynaphthol Blue. Obtain from Headquarters.

CAUTION: All equipment must be kept scrupulously clean and thoroughly rinsed with distilled water. All reagents must be stored in polyethylene containers.

D. PROCEDURE: Preparation of Curve:

Prepare three duplicate sets of samples as follows:

Set 1. Transfer two 300 gm samples of aggregate at the planned moisture con tent for the job, to separate plastic containers. (Note: The water used in bringing up the moisture to the correct amount should be the same as that used at the job site.)

Set 2. Prepare two samples as above containing 2.0 percent cement of the type to be used on the job.

Set 3. Repeat Set 1, preparing two samples containing 3.0 percent cement.

Proceed with each sample as with production samples described in Section E. Then construct a graph showing net mls.* EDTA vs. percent cement, using the average figures from Sets 1, 2, and 3. This should yield a straight line. Set 1 corresponds to the blank for the aggregate being used.

*Net mls. EDTA = Total mls. minus mls. for blank. Thence a new curve need not be prepared if only the blank changes.

E. PRODUCTION SAMPLES:

Make up a sample of exactly 300 grams, and place the sample into a 2 qt. plastic container, and add 600 mls of ammonium chloride solution. Stir EXACTLY 2 minutes with a stainless steel stirring rod, allow to settle EXACTLY 4 minutes and then pipette a 10 ml aliquot of the supernatant solution into a 250 ml Erlenmeyer flask. Add approximately 75 ml of distilled water and with thorough mixing add the diluted sodium hydroxide (NaOH) dropwise until a pH between 13.0 and 13.5 is obtained, using the pH indicator paper as a control. Add 4 drops of 20% Triethanolamine solution and then add the Hydroxynapthol Blue indicator. Titrate with EDTA to a pure blue endpoint.

Subtract the blank from your final reading and determine the cement content from the previously prepared graph.

Test Method Nev. T306C
March 1, 2006

State of Nevada
Department of Transportation
Materials Division

METHOD OF TEST FOR DETERMINING MOISTURE CONTENT OF ASPHALT MIXTURES OR MINERAL AGGREGATE USING MICROWAVE OVENS

SCOPE

This method provides a rapid field test procedure for determining the amount of moisture for asphaltic mixtures or mineral aggregate used in asphaltic mixtures.

APPARATUS

1. Microwave oven, capable of holding a 4000 g sample.
2. Sample containers, capable of holding 600 g (must be paper, glass or ceramic).
3. Balance, with 1000 g capacity, readable to 0.1 g.
4. Riffle splitter, having 37.5 mm (1 1/2 in.) wide riffles.
5. Spatula, approximately 25.4 mm (1 in.) wide and 254 mm (10 in.) long.
6. Heat resistant gloves.
7. Cylinder molds, complete with lids 152.4 mm (6 in.) diameter x 304.8 mm (12 in.) length.
8. Tape for sealing cylinder molds.
9. 600 mL beaker.

SAMPLE PREPARATION

1. Obtain approximately 2000 g of mineral aggregate or asphaltic mix.
2. Use the riffle splitter to obtain a 500 ± 50 g sample.

PROCEDURE

1. Place 600 mL beaker filled with water in microwave oven, keep beaker at least half full at all times.
2. Place the sample in a tared paper plate or glass container, and weigh to the nearest 0.1 g.
3. Put sample in microwave oven and turn oven on.
4. After 10 minutes, turn the oven off, remove the container and sample, weigh the sample and container to the nearest 0.1 g, and record the weight.
5. Place sample and container back in the oven. Turn oven on, and dry sample for 5 more minutes.
6. Remove sample and container from oven, weigh to the 0.1 g, and record weight.
7. Repeat steps 5 and 6 until a constant weight is obtained. Note: In most cases, with moisture contents of 1.0% or less, a 10 minute drying period is sufficient.

CALCULATIONS

After a constant weight has been obtained, calculate the moisture content of the samples as follows:

$$\% \text{ Moisture} = \frac{(\text{original weight}) - (\text{final weight})}{\text{final weight}} \times 100$$

REPORT

Moisture content shall be reported to the nearest 0.1.

PRECAUTIONS

1. Use gloves for handling hot mixtures during quartering and when placing in or removing from oven.
2. Do not use metal containers in oven at any time. Damage to the oven will occur.
3. Do not delay getting sample into oven after sampling. (If a delay of 15 minutes or more is anticipated, samples must be placed into and kept in sealed containers. For reliable results, all samples should be tested within 1 hour of sampling).
4. When weighing samples, do so as quickly as possible to avoid error in the balance due to heat transfer.

Test Method Nev. T324C
March 27, 2013

State of Nevada
Department of Transportation
Materials Division

METHOD OF TEST FOR THEORETICAL MAXIMUM SPECIFIC GRAVITY OF BITUMINOUS PAVING MIXTURES (FIELD METHOD)

SCOPE

This test method covers the determination of the theoretical maximum specific gravity of uncompacted bituminous paving mixtures.

APPARATUS

1. Pycnometer, 2 L (2 qt) glass.
2. Balance, 5000 g minimum capacity, sensitive to 0.1 g.
3. Stop watch, or suitable timing device.
4. Vacuum pump capable of 27.5 ± 2.5 mm H , and miscellaneous equipment necessary to evacuate air from the pycnometer.
5. Manometer, capable of 27.5 ± 2.5 mm Hg
6. Oven, capable of maintaining temperatures up to 110 ± 5°C (230 ± 9°F).
7. Thermometer, to measure and maintain a water bath temperature at 25 ± 3°C (77 ± 5°F).
8. Sieve, 6.3 mm (1/4 in.).
9. Water bath, a minimum of 20 L (5 gal) maintained at 25 ± 3°C (77 ± 5°F).

SAMPLE PREPARATION

1. Obtain sample of bituminous mixture per Test Method Nev. T200, under PROCEDURE number 10.
2. Obtain a representative sample of 1250 ± 50 g in accordance with Test Method Nev. T203.
3. Cool the sample to room temperature.

4. After the sample has sufficiently cooled, separate the particles of the paving mixture sample by hand over a 6.3 mm (1/4 in.) sieve, taking care to avoid fracturing the aggregate, so that the particles of the fine aggregate portions will not be larger than 6.3 mm (1/4 in.). If the sample of the paving mixture is not sufficiently soft to be separated manually, place it in a large flat pan and warm in an oven until it can be separated as described above.

PROCEDURE

1. If needed, clean and lightly lubricate the pycnometer gasket with petroleum jelly.

2. Fill the pycnometer with water at 25 ± 3°C (77 ± 5°F) to the top of the opening on the conical lid. Remove entrapped air by placing a finger over the opening on the pycnometer lid while turning the pycnometer to a horizontal position, then rotating in the hands. After removing the entrapped air, add water at 25 ± 3°C (77 ± 5°F) to refill the pycnometer, dry the outside of the pycnometer and place on a tared scale. Form a meniscus at the top of the opening of the conical lid. Weigh and record the mass of the pycnometer and water as “B” on NDOT form 040-030.

3. Mark the pycnometer lid with a marker to register its position relative to the jar. Return the lid to this position after it is removed and replaced.

4. Drain the pycnometer to approximately half full.

5. Place the partially drained pycnometer on the scale and tare. Place the room temperature sample in the tared pycnometer and record the sample weight as “A” on NDOT form 040-030. Fill with water at 25 ± 3°C (77 ± 5°F) to 25 mm to 50 mm (1 in. to 2 in.) above the sample and slightly below the jar rim. Replace and tighten the lid to the marked position.

6. Remove entrapped air by subjecting the contents to a partial vacuum of 27.5 ± 2.5 mm Hg absolute pressure for 15 ± 2 minutes. Agitate the pycnometer and contents manually by vigorously shaking at intervals of approximately 2 minutes, while evacuating, to aid in the removal of entrapped air.

7. Place the pycnometer (with sample) in the temperature controlled water bath for 10 ± 1 minute to stabilize any temperature changes caused during evacuation.

8. Dry the outside of the pycnometer. Place the pycnometer on a tared scale. Top off the pycnometer with water at 25 ± 3°C (77 ± 5°F), forming a meniscus at the top of the opening of the conical lid. Weigh and record the mass of the evacuated sample, pycnometer and water as “C” on NDOT form 040-030.

9. Care should be taken to maintain a constant water temperature throughout the test procedure.

10. All weights shall be recorded to the nearest 0.1 g.

CALCULATIONS

Calculate the apparent specific gravity of the sample as follows:

Apparent Specific Gravity = A / [(A + B) – C]

where:

A = Mass of sample in air
B = Mass of pycnometer and water
C = Mass of evacuated sample, pycnometer and water

REPORT

Apparent Specific Gravity shall be calculated and reported to the nearest 0.001.
Density shall be calculated and reported to the nearest 0.1.

Test Method Nev. T325A
January 1, 2014

State of Nevada
Department of Transportation
Materials Division

METHOD OF TEST FOR THE DETERMINATION OF THEORETICAL MAXIMUM SPECIFIC GRAVITY OF UNCOMPACTED BITUMINOUS PAVING MIXTURES (FIELD METHOD)

SCOPE

This test method covers the procedure to determine the theoretical maximum specific gravity of uncompacted bituminous paving mixtures using a vacuum pycnometer (Rice Pot) secured to a mechanical vibrating device. The theoretical maximum specific gravity determined by this test shall be used for determining relative percent compaction of bituminous paving mixtures in the field.

APPARATUS

1. Aluminum volumetric canister (pycnometer bowl) equipped with a solid lid, minimum 2000 g capacity 190 mm (7 1/2 in.) ID x 152 mm (6 in.) depth solid-wall cylinder.

2. Plexiglas vacuum lid, fitted with a rubber gasket, release valve and a connection for the vacuum line.

3. Mechanical vibrating device, equipped with a timer, vibration speed control and a detachable collar to which the vacuum pycnometer can be fastened.

4. Vacuum pump, capable of 27.5 ± 2.5 mm Hg and miscellaneous equipment necessary to evacuate air from the vacuum pycnometer.

5. Manometer, capable of 27.5 ± 2.5 mm Hg.

6. Balance, having a capacity of 12000 g and sensitive to 0.1 g.

7. Oven, capable of maintaining temperatures of 110 ± 5°C (230 ± 9 °F)

8. Thermometer, to measure and maintain a water bath temperature of 25 ± 5°C (77 ± 9°F)

9. Sieve, 6.3 mm (1/4 in.)

   NOTE: See Figure 1 for example of correct configuration of testing apparatus.

SAMPLE PREPARATION

1. Obtain a representative sample of bituminous paving mixture per Test Method Nev. T200.

2. Obtain a representative sample in accordance with Test Method Nev. T203. The size of the sample shall conform to the following requirements:

Table 1 – Minimum Sample Sizes

Nominal Maximum Aggregate Size, mm (in.)	Minimum Sample Size, g
19 to 25 (3/4 to 1)	2500
12.5 (1/2) or smaller	1500

3. Using a 6.3 mm (1/4 in.) sieve, separate the particles of the representative paving mixture sample by hand, taking care to avoid fracturing the aggregate, so that the finer aggregate portions will pass through the 6.3 mm (1/4 in.). If the paving mixture sample is not pliable enough to be separated manually, place the material in a large sample pan and warm it in an oven until it can be separated as described above.

4. Cool the sample to room temperature. Recombine the coarse and fine aggregate particles and record its weight to the nearest 0.1 g (Mass of dry sample in air).

PROCEDURE

1. As necessary, clean and lightly lubricate the Plexiglas vacuum lid gasket using petroleum jelly.

2. On a smooth and level surface, completely fill the pycnometer bowl with water at 25 ± 3 °C (77 ± 5 °F). Lightly place the pycnometer lid on the pycnometer bowl, allowing it to settle into place by its own weight. To remove any entrapped air, gently push the pycnometer lid down until water is ejected from the aperture on the top of the pycnometer lid. Thoroughly dry the outside of the pycnometer and record its weight to the nearest 0.1 g (Mass of pycnometer and water).

   NOTE: This weight should be verified periodically. Perform step 2 if parts of the pycnometer have been replaced or altered in any way.

3. Empty the pycnometer bowl.

4. Place the room temperature paving mixture sample into the empty pycnometer bowl and fill the pycnometer bowl with a sufficient amount of water 25 ± 3 °C (77 ± 5 °F) to completely submerge the sample. Place the bowl onto the mechanical vibrating device, affix the Plexiglas vacuum lid onto the pycnometer bowl and fasten the assembly together using the detachable collar.

5. Turn on the vacuum pump and close both the bleeder and monometer valves to remove the entrapped air in the sample by applying 27.5 ± 2.5 mm Hg of absolute pressure for 15 ± 2 minutes. Constantly agitate the container and sample using the mechanical vibrating device during the vacuum period.

   NOTE: The speed control adjustment should be closely monitored as to avoid over-agitation and stripping of asphalt in the sample and that water is not drawn into the vacuum line.

6. At the end of the vacuum period and before turning off the vacuum pump, open the bleeder valve located on the Plexiglas vacuum lid and the monometer valve to release the pressure in the pycnometer. Remove the Plexiglas vacuum lid from the pycnometer bowl.

7. Adjust the contents of the pycnometer bowl by filling the pycnometer bowl with a sufficient amount of water at 25 ± 3 °C (77 ± 5 °F). If the temperature of the pycnometer bowl is found to be above or below 25 ± 3 °C (77 ± 5 °F), carefully remove a small amount of water and repeat the process until the contents of the pycnometer have stabilized to within the required tolerance.

8. The pycnometer bowl shall be completely filled with water at the end of step 7. Lightly place the pycnometer lid on the pycnometer bowl, allowing it to settle into place by its own weight. To remove any entrapped air, gently push the lid down until water is ejected from the aperture on the top of the pycnometer lid. Thoroughly dry the outside of the pycnometer bowl and pycnometer lid and record its weight within 10 ± 1 minutes of completing the vacuum procedure to the nearest 0.1 g (Mass of evacuated sample, pycnometer and water)

CALCULATIONS

Calculate the theoretical maximum specific gravity of the uncompacted bituminous paving mixture as follows:

Specific Gravity = A / [(A+B)-C]

Where:

A = Mass of dry sample in air
B = Mass of pycnometer and water
C = Mass of evacuated sample, pycnometer and water

REPORT

Specific gravity shall be reported to the nearest 0.001.

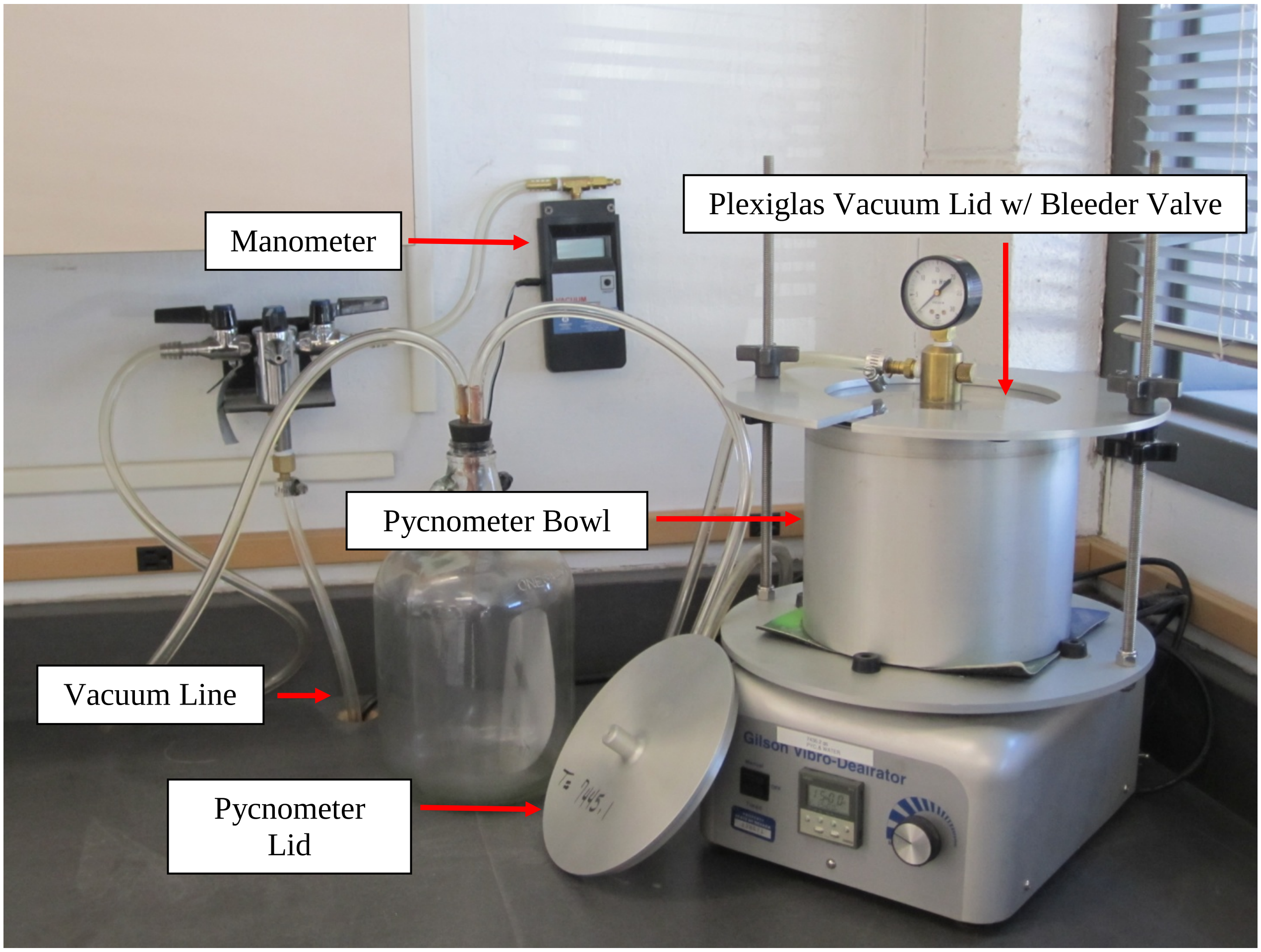

Manometer
Plexiglas Vacuum Lid w/ Bleeder Valve
Pycnometer Bowl
Vacuum Line
Pycnometer Lid
Gilson Vibro-Deairator

Figure 1

Test Method Nev. T335G
March 27, 2013

State of Nevada
Department of Transportation
Materials Division

METHOD OF TEST FOR RELATIVE COMPACTION OF PLANTMIX BITUMINOUS SURFACE USING A NUCLEAR DENSITY GAUGE

SCOPE

This test method is designed to measure the degree of compaction of plantmix base and surface mat and joint density, using a nuclear density testing device.

APPARATUS

1. Thin Layer Density Gauge, Troxler Model 4640-B or 3450.
2. Magnesium reference block.
3. Air gap spacer.

STANDARDIZATION

1. Warm up period: Turn the thin layer density gauge on and warm up for ten minutes. This allows the regulators and deflectors to stabilize.
2. At the start of each shift, standardize the thin layer density gauge to check equipment operation. This procedure can also be used as an operational check whenever test measurements are suspect.
3. The site chosen for standardization should remain the same throughout the contract. Outline the magnesium reference block with keil (lumber crayon) to ensure the same location is used.
4. Place the magnesium reference block on a solid surface having a density of 1600 kg/m^3 (100 lb/ft^3) or greater, preferably a plantmix or concrete surface approximately 10 cm (4 in.) thick. Ensure that the magnesium reference block is level and does not rock back and forth. This location should be at least 3 m (10 ft) away from any large object such as a vehicle, field lab, wall or any water source and at least 9 m (30 ft) from any other nuclear gauge**.**
5. Place the air gap spacer on the magnesium reference block and then place the thin layer density gauge on top of the air gap spacer. The handle end of the gauge should rest over the two posts on the air gap spacer. Verify that the “Standard Mode” is in multi-standard mode.
6. With the lock attached and the handle in the safe position, press the “STANDARD” key on the keypad. The screen will display “Standard Count XXXX XXXX Take a new standard count?” Press the “YES” key. The screen will then show “Place gauge on spacer and both on block, put the rod in safe position, press enter.” Check to make sure the thin layer density gauge does not rock, then

press the "START/ENTER" key. The thin layer density gauge will begin taking a four minute standard count.

7. When counting stops, at the end of the four minutes, screen will display "Standard # 1 XXXX X.XX% Pass Standard # 2 XXXX X.XX% Pass Use new standards?" If it shows a PASS/PASS, record the Standard #1 and Standard #2 in the gauge log book. Press the "YES" key. If you receive a PASS/PASS to the right of the percentages, it indicates that the standard counts are within the 1% maximum allowed variation for System 1 reference standard counts and 1.2% maximum allowed variation for System 2 standard counts.

8. If the standard counts for System 1 or System 2 fail, the screen will display "Do you want to use the new STD?" Press the "YES" key. Check the thin layer density gauge to make sure that the magnesium reference block does not rock, no other gauges are in the area and that the standard mode is in multi-standard mode. Then take another standard count.

9. It may take up to five standard counts before obtaining a PASS/PASS result. In the event that a PASS/PASS result is not obtainable, contact the Independent Assurance Lab for further assistance.

CORRELATION WITH DRILLED CORES

1. Perform correlation tests at seven locations within one test section. Thin layer density gauge correlation shall be performed on each mix design and on each different surface of paving (EX. Milled Surface, Second Lift, Type 1 Class B Base etc.). Take the thin layer density gauge shots first and record on NDOT form 040-017. Outline around the base of the thin layer density gauge with Kiel (lumber crayon). For each 1 minute test rotate the thin layer density gauge 90 degrees about the center of the thin layer density gauge for a total of four times at each location. Refer to Figure 1 for the correct positioning of the thin layer density gauge during correlation. Repeat this process at all seven locations.

2. Take the cores from the pavement after the mat has cooled enough to allow drilling without distortion or cracking of the cores. NOTE: Core area may be cooled with dry ice.

3. Determine the density of the cores as per Test Method Nev. T336 and document the results on NDOT form 040-017B.

4. Subtract the drilled core density from the corresponding nuclear density reading and discard the two cores with the biggest difference between the core density and the nuclear density.

EX.	Core Density	Nuclear Density	Difference
1-PM-1	142.3	140.9	1.4
1-PM-2	141.9	142.7	-0.8
1-PM-3	141.1	141.1	-0.0
1-PM-4	144.0	144.4	-0.4
1-PM-5	142.2	142.2	0.0
1-PM-6	140.6	140.4	0.2
1-PM-7	145.1	147.9	-2.8

The biggest difference would be 1-PM-1 and 1-PM-7. Use cores 1-PM-2 through 1-PM-6 for the gauge correlation, to achieve the most consistent correlation.

5. The average of five (5) drilled core densities will be correlated with the average of the five (5) nuclear densities taken at the same location as follows:

   a. If the difference between the two averages is less than ±1% of the average core density, the nuclear gauge readings shall be used without a correction factor.

      EX. Core Density Average x 0.01 = ±1% of Core Density Average
      147.7 x 0.01 = 1.477

      Core Density Average - Nuclear Density Average = Difference
      147.7 - 147.4 = 0.3

      The difference is less than 1.477; therefore there will not be a correction factor for this gauge correlation. (EX. Correction factor = 1.00)

   b. If the difference between the two averages exceeds the ± 1% of the average core density, a correction factor for the thin layer density gauge shall be determined as follows:

      EX. Core Density Average x 0.01 = ±1% of Core Density Average
      153.3 x 0.01 = 1.533

      Core Density Average - Nuclear Density Average = Difference
      153.3 - 149.4 = 3.9

      The difference is greater than the 1.533; therefore there will be a correction factor for this gauge correlation.

$$\frac{\text{Average of the five (5) core densities}}{\text{Average of the five (5) nuclear densities}} = \text{Correction Factor}$$

153.3 / 149.4 = 1.03

The correction factor is then multiplied by the average density on NDOT form 040-017, to obtain the corrected density. Use this correction factor for all future tests until another correlation is performed.

NOTES PERTAINING TO CORRELATION WITH DRILLED CORES

1. Allow core area to cool prior to coring so the cores do not break or become distorted during coring.

2. Take seven (7) core densities and seven (7) nuclear densities in one test section for the gauge correlation procedure. Obtain a core from each location for a total of seven (7) cores.
   Refer to Test Method Nev. T336 to determine each samples Bulk Specific Gravity

3. Thin layer density gauge correlation shall be documented on NDOT forms 040-017, 040-017A and 040-017B.

4. Correction Factor's shall be reported to the nearest 0.01.

5. Typically the correction factor should be within 0.96 to 1.04. If you are outside this range contact the Independence Assurance Lab for assistance.

6. The only time a gauge correlation should be labeled "informational tests" is if the correlation took place out of the contracts paving limits, then it will be labeled I1-PM-1 to I1-Pm-7 (EX. Paving a frontage dirt road, correlated on another contract etc.) document where the paving took place under remarks on NDOT form 040-017.

7. The gauge correlation section will be the only test section that has seven (7) tests for the test section, 1-PM-1to 1-PM-7, each test section that follows will have five (5) tests for the test section, 2-PM-1 to 2-PM-5, unless the gauge has to re-correlated then there will be another test section with seven (7) tests for the test section.

7. Re-correlate the gauge if the mix design changes, percent compaction decreases or increases drastically with no changes to the rolling pattern, when paving on different surfaces or lifts.

8. Refer to the PROCEDURE section to obtain the random numbers used for the thin layer density gauge correlation with the cores. In two of the subsections two additional shots shall be taken with two additional cores to obtain the seven drilled cores for the thin layer density gauge correlation.

PROCEDURE (3450 or 4640-B SERIES GAUGES)

1. Determine the target density per Test Method Nev. T324 or T750 and program it into the thin layer density gauge. After completion of the desired roller coverage, while the mix is still hot, a series of density tests are taken at locations according to the following:

2. Test Sections

   a. Divide the test section into five subsections of equal length. Four one minute mat density tests are to be taken for each subsection. If a joint or joints are present, two or four one minute joint density tests are to be taken. Refer to the Standard Specifications for the required size of the test sections.

      The exact station at which the mat densities will be taken, is determined from the table of random numbers by multiplying a random number (column A) times the length of each subsection, rounded to the nearest 10 m (25 ft).

      The exact distance in from the edge of the mat where the mat densities will be taken is determined from the table of random numbers (column B) times the width of the mat, rounded to the nearest 0.3 m (1 ft) for the distance in from the edge. NOTE: Do not take the mat density test any closer than 0.3 m (1 ft) from the edge of the mat.

The first four (4) one minute tests (rotated 90 degrees about the center of the thin layer density gauge) are to be taken in each subsection. If the mat was inlayed, perform two (2) one minute joint tests on each joint within 0.15 m (6 in.) of the joint (rotated 180 degrees) at the same station as determined in column A.

b. Random numbers are always used in a series of ten, five from column A and five from column B. Any random number block may be used as long as a different block is selected for each new test section.

EX.	Random Number Block = 15	Width of the entire mat = 13.8 ft
	Beginning Station “X” 413 + 12	Ending Station “X” 350 + 95

Note: One station equals 100 ft

(“X” 413 + 12) – (“X” 350 + 95) = 6217 ft

6217 ft (length of test section) / 5 (total subsections) = 1243.4 ft (length of each subsection)

Station – Length of Subsection = Station to Station for each Subsection

(“X”413 + 12) – 1243.4 = “X”400 + 68.6
(“X” 400 + 68.6) – 1243.4 = “X” 388 + 25.2
(“X” 388 + 25.2) – 1243.4 = “X” 375 + 81.8
(“X” 375 + 81.8) – 1243.4 = “X” 363 + 38.4
(“X” 363 + 38.4) – 1243.4 = “X” 350 + 95

Column A	x	Subsection Length	=	Distance for each Subsection Test Station
.698		1243.4		867.9
.796		1243.4		989.7
.348		1243.4		432.7
.358		1243.4		445.1
.698		1243.4		867.9

(“X”413+12) – 867.9 = “X”404+44.1 rounded to nearest 10 m (25 ft) = “X”404+50
(“X”400+68.6) – 989.7 = “X”390+78.9 rounded to nearest 10 m (25 ft) = “X”390+75
(“X”388+25.2) – 432.7 = “X”383+92.5 rounded to nearest 10 m (25 ft) = “X”384+00
(“X”375+81.8) – 445.1 = “X”371+36.7 rounded to nearest 10 m (25 ft) = “X”371+25
(“X”363+38.4) – 867.9 = “X”354+70.5 rounded to nearest 10 m (25 ft) = “X”354+75

Column B x	Mat Width =	Distance in from edge of Mat =	Rounded to nearest .5 m (1 ft)
.683	13.8	9.4	9.0
.996	13.8	13.7	13.0 (mat is only 13.8)
.743	13.8	10.3	10.0
.595	13.8	8.2	8.0
.539	13.8	7.4	7.0

1st density test is at “X” 404 + 50, 9.0 ft in from edge of mat
2nd density test is at “X” 390 + 75, 13.0 ft in from edge of mat
3rd density test is at “X” 384 + 00, 10.0 ft in from edge of mat
4th density test is at “X” 371 + 25, 8.0 ft in from edge of mat
5th density test is at “X” 354 + 75, 7.0 ft in from edge of mat

3. Density Testing

a. Program the target density from Test Method Nev. T324 or T750 into the thin layer density gauge. Input the target density for the Marshall and Voidless parameters into the thin layer density gauge. Select the "MA/VOIDLESS" key. The screen will display "MA: XXX.X pcf VD: XXX.X Do you want to change?" Press the "YES" key. Screen will display "Marshall XXX.X pcf " Input the target density and press the "START/ENTER" key. Screen will display "Voidless Density XXX.X pcf." Input the same target density and press the "START/ENTER" key. Thin layer density gauge will then go back to the main screen.

b. Select the proper depth by pressing the "THICK" key. The screen will display "Layer Thickness: X.XX in. Input and Press Enter." NOTE: Set the depth for the thin layer density gauge at 6 mm (0.25 in.) less than what is being placed. (EX. Paving 3 in. set the thin layer density gauge thickness at 2.75 in.) Thin layer density gauge will then go back to the main screen.

c. Set the count time for 1 minute by pressing the "TIME" key. The screen will show "Count Time XX min. Do you want to change?" Press the "YES" key. The screen will show "Sel: 1 – 0.5 min. 2 – 1 min. 3 – 2 min. 4 – 4 min." Press 2 for the 1 minute count time. Thin layer density gauge will then go back to the main screen. The 1 minute test is the only "TIME" allowed for density testing.

d. Do not utilize the "Average" function, verify that the average function is set at 1. The average of the 4 tests shall be hand calculated.

e. At each predetermined test site, place the thin layer density gauge on the mat. Check for rocking by placing a hand on opposite corners of the base. Outline the base of the thin layer density gauge with a piece of keil (lumber crayon). Place the source rod in the "Measure" position and press the "START/ENTER" key. At the end of the 1 minute count time the thin layer density gauge will display"Dens: X.X PCF %MA: X.XX% 100 - %MA: XX.XX% %VOID: X.XX". Write the density down on NDOT form 040-017, rotate the thin layer density gauge 90 degrees about the center of the thin layer density gauge and take another one minute density test at this location, refer to Figure 1 for thin layer density gauge positioning. Repeat this procedure for four (4), one minute density tests at this one test location.

f. Record each one minute density test and hand calculate the average of the four (4) tests on NDOT form 040-017. NOTE: Do NOT use the average mode in the thin layer density gauge.

g. The average of the four (4) density tests will constitute one test site density.

h. Repeat the above process at each of the 5 predetermined test site locations within the test section.

4. Joint Density Testing

a. Place the thin layer density gauge on the mat directly adjacent (within 6 in.) and parallel to the joint line at the same station that the four (4) one minute density tests were taken. Align one edge of the thin layer density gauge along the mat seam. The thin layer density gauge should be firmly seated on the new HOT mat and located as close to the joint as possible without extending any part of the gauge beyond the seam. Put the probe in the "Measure" position and press the "START/ENTER" key. At the end of the 1 minute count time the thin layer density gauge will display "Dens: X.X PCF %MA: X.XX% 100 - %MA: XX.XX% %VOID: X.XX." Write the joint density down on NDOT form 040-017. Take two (2) one minute density readings on the joint, rotating the gauge 180 degrees about its center after each reading, refer to Figure 1 for thin layer density gauge positioning. If the mat has been inlayed, it will require joint measurements on each HOT side of the mat.

b. Record each one minute joint density test and hand calculate the average of the two (2) tests on NDOT form 040-017.

c. The average of the readings for each individual joint (two one minute tests), will constitute one test site joint density.

d. Joint density tests will not be required on unconfined edges. Joint density tests are completed on the hot side of the mat.

PERCENT COMPACTION

1. Percent relative compaction of an individual test site or small test section:

   a. $$\% \text{ Relative Compaction} = \frac{((\text{Average Density}) \text{ or } (\text{Corrected Density}) \times (\text{Correction Factor}))}{\text{Target Density}}$$

   b. Record the percent relative compaction to the nearest whole percent.

2. Take the average of the five (5) corrected densities (Mean Test Section Density) and compute the Mean Percent Relative Compaction as follows:

   a. $$\text{Mean Percent Relative Compaction} = \frac{\text{Mean Test Section Density}}{\text{Target Density}}$$

   b. Record the percent compaction to the nearest whole percent.

3. Refer to Standard Specifications for the minimum and maximum density requirements.
   Note: Do not incorporate joint densities when calculating the Mean Test Section Density

ADDITIONAL ROLLING PROCEDURES

1. If an individual test either on the mat or on a joint does not meet the required minimum specifications for compaction, additional rolling may be required. After additional rolling, take another test by testing at a single location chosen at random within the same subsection. (This is not considered a re-test, since there are no re-tests on plantmix. The second test will be the one documented for the complete test section.) Note: Any changes from the original compaction must be documented under remarks.

2. If the mean test section compaction for the mat does not meet the required minimum specifications for compaction, additional rolling may be required on the entire test section. After additional rolling, take a series of five (5) tests using a new random block number, see Figure 2. (This is not considered a re-test, since there are no re-tests on plantmix). Note: Any changes from the original compaction must be documented under remarks.

3. No additional rolling will be performed if the surface temperature of the lift is below 68ºC (155ºF).

4. If additional compactive effort still results in a failing test, joint test or test section, the Resident Engineer must indicate under the remarks on NDOT form 040-017 what necessary steps are to take place if any pertaining to the failure in question.

GENERAL:

1. Under no circumstance is the thin layer density gauge (Troxler Model 4640-B) to be used for testing the compaction of concrete or dirt.

2. Do not leave the gauge on the hot plantmix surface any longer than absolutely necessary when taking the four, one minute counts. Long term exposure to high temperatures will reduce the service life of the components and temporarily effect the accuracy of the gauge.

3. If there is more than 1000 m^2 (1000 yd^2) (small section or miscellaneous test) of the mat to be tested it shall be made into a full test section even if it's less than the 5500 m^2 (6600 yd^2). There shall not be multiple small sections tested in a row. If paving approaches note that it is an approach under remarks.

4. The small sized area of 90% compaction per the Standard Specifications is not meant for mainline paving.

5. The mean percent relative compaction from NDOT form 040-017 is NOT applicable to partial test sections or joint densities.

6. For all coarses of 25 mm (1 in.) or less, use "Method A" from the Standard Specifications. No compactions per "Method B" shall be required since the thin layer density gauge detects underlying material for lifts of 25 mm (1 in.) or less.

Thin layer density gauge positioning for one density test location.

Thin layer density gauge positioning for one joint density test location.

FIGURE 1

TABLE OF RANDOM NUMBERS

A	B	A	B	A	B	A	B	A	B
1		2		3		4		5	
.576	.730	.430	.754	.271	.870	.732	.721	.998	.239
.892	.948	.858	.025	.935	.114	.153	.508	.749	.291
.669	.726	.501	.402	.231	.305	.009	.420	.517	.858
.609	.482	.809	.140	.396	.025	.937	.310	.253	.761
.971	.824	.902	.470	.997	.392	.892	.957	.640	.463
6		7		8		9		10	
.053	.899	.554	.627	.427	.760	.470	.040	.904	.993
.810	.159	.225	.163	.549	.405	.285	.542	.231	.919
.081	.277	.035	.039	.860	.507	.081	.538	.986	.501
.982	.468	.334	.921	.690	.806	.879	.414	.106	.031
.095	.801	.576	.417	.251	.884	.522	.235	.398	.222
11		12		13		14		15	
.509	.025	.794	.850	.917	.887	.751	.608	.698	.683
.371	.059	.164	.838	.289	.169	.569	.977	.796	.996
.165	.996	.356	.375	.654	.939	.815	.592	.348	.743
.477	.535	.337	.155	.767	.187	.579	.787	.358	.595
.788	.101	.434	.638	.021	.894	.324	.871	.698	.539
16		17		18		19		20	
.566	.815	.622	.548	.947	.169	.317	.472	.864	.466
.901	.342	.873	.964	.942	.985	.123	.086	.335	.212
.470	.682	.412	.064	.150	.962	.925	.355	.909	.019
.068	.242	.667	.356	.195	.313	.396	.460	.740	.247
.874	.420	.127	.284	.448	.215	.833	.652	.601	.326
21		22		23		24		25	
.897	.877	.209	.862	.428	.117	.100	.259	.425	.284
.875	.969	.109	.843	.759	.239	.890	.317	.428	.802
.190	.696	.757	.283	.666	.491	.523	.665	.919	.146
.341	.688	.587	.908	.865	.333	.928	.404	.892	.696
.846	.355	.831	.218	.945	.364	.673	.305	.195	.887
26		27		28		29		30	
.882	.227	.552	.077	.454	.731	.716	.265	.058	.075
.464	.658	.629	.269	.069	.998	.917	.217	.220	.659
.123	.791	.503	.447	.659	.463	.994	.307	.631	.422
.116	.120	.721	.137	.263	.176	.798	.879	.432	.391
.836	.206	.914	.574	.870	.390	.104	.755	.082	.939
31		32		33		34		35	
.636	.195	.614	.486	.629	.663	.619	.007	.296	.456
.630	.673	.665	.666	.399	.592	.441	.649	.270	.612
.804	.112	.331	.606	.551	.928	.830	.841	.602	.183
.360	.193	.181	.399	.564	.772	.890	.062	.919	.875
.183	.651	.157	.150	.800	.875	.205	.446	.648	.685

FIGURE 2

Test Method Nev. T336C
January 1, 2014

State of Nevada
Department of Transportation
Materials Division

METHOD OF TEST FOR BULK SPECIFIC GRAVITY AND DENSITY OF COMPACTED BITUMINOUS MIXTURES (FIELD METHOD)

SCOPE

This test method covers a rapid determination of bulk specific gravity and density of specimens of compacted bituminous mixtures. It will be used for drilled cores obtained from the field.

APPARATUS

1. Balance, 2000 g minimum capacity, sensitive to 0.1 g. Equipped with suitable suspension rod and holder to permit weighing of a specimen while suspended from the center of the balance pan into a water container.
2. Water container, for immersing the specimen in water while suspended under the balance. A 500 mm (20 in.) diameter watertight (plastic) garbage can, approximately 600 mm (24 in.) high is recommended.
3. Thermometer, for monitoring water and specimen temperatures, accurate to 1°C (2°F).
4. Oven, capable of maintaining a temperature of 110 ± 5°C (230 ± 9°F).
5. Microwave oven.
6. Water Bath, minimum 20 L (5 gal) maintained at 25 ± 3°C (77 ± 5°F).
7. Bench or table to support balance over water bath.
8. Wire basket with handle.
9. Towel

TEST SPECIMENS

1. Test specimens are to be drilled cores taken from the bituminous pavement mat.
2. Size of specimens – Core size shall be 100 mm (4 in.) in diameter. Thickness shall be as close to plan as possible or greater.

3. Pavement specimens shall be taken from bituminous pavement with a core drill taking care to avoid distortion, bending or cracking of specimens during and after removal from the pavement.

4. Specimens shall be free from foreign materials such as tack coat, seal coat, soil, etc.

5. Specimens may be separated from other pavement layers by sawing, chiseling, or other suitable means.

PROCEDURE

1. Maintain the water temperature at 25 ± 3°C (77 ± 5°F). While the wire basket is immersed in the water, adjust the water level until water flows from the overflow spout, allow water and basket to stabilize and tare the immersed basket. Place specimen in the wire basket, leave immersed in the water container for four minutes and record the immersed in water weight, "C" on NDOT form 040-017B.

2. Remove specimen from the water and bring it to a saturated surface dry condition by blotting the sample with a damp towel, determine the weight of the sample and record it as "B" on NDOT form 040-017B.

3. Place specimen in a large flat bottom drying pan (conventional oven); may also use paper plate, glass dish or ceramic dish (microwave oven). For microwave oven use, refer to Test Method Nev. T306. For conventional oven drying use, refer to Test Method Nev. T112. Place the specimen in conventional oven or microwave oven. Leave the specimen in the conventional oven or heat in microwave oven until it can be easily broken down. Place the separated specimen in the conventional oven or microwave oven and dry to a constant weight. When a constant dry weight is obtained, allow the sample to cool to 25 ± 3°C (77 ± 5°F), weigh and record the oven-dry condition weight, "A" on NDOT form 040-017B.

CALCULATIONS

1. Calculate the Bulk Specific Gravity as follows:

$$\text{Bulk S.G.} = \frac{A}{B - C}$$

where
A = Weight in grams in air (oven-dry condition)
B = Weight in grams (saturated surface-dry)
C = Weight in grams (immersed in water)

2. Core Density (lb/ft^3) = Bulk Specific Gravity x 62.4 lbs/ft^3. Round to the nearest 0.1.

3. Nuclear density obtained from the Average Density of the four (4) density readings from NDOT form 040-017.

4. Subtract the core density from the nuclear density to determine the difference of the two.
Discard the two cores with the biggest difference between the core density and the nuclear density.
Use five cores that are the most uniform, to obtain the "AVERAGE OF THE FIVE (5) CORES", report the bulk specific gravity, core density, and nuclear density on NDOT form 040-017A.

PRECAUTIONS

1. Maintain a constant water level for all weights obtained in the water bath
2. Do not overheat or burn samples. Note: If the sample is smoking the specimen has been burned.
3. To obtain the SSD condition, do not use paper towels to blot the specimen dry, paper towels will absorb too much moisture, affecting the SSD weight
4. Use the same scale for all weight measurements
5. Make sure the suspension apparatus is not in contact with the hole in the counter nor any other obstructions exist

REPORT

Bulk Specific Gravity to nearest 0.001

Core Density to the nearest 0.001 Mg/m^3 (0.1 lb/ft^3)

Nuclear Density to the nearest 0.001 Mg/m^3 (0.1 lb/ft^3)

Test Method Nev. T416B
September 16, 2013

State of Nevada
Department of Transportation
Materials Division

METHOD OF TEST FOR SAMPLING, DETERMINING UNIT WEIGHT, AIR CONTENT, AND MAKING AND CURING SPECIMENS OF HYDRAULIC-CEMENT SELF-CONSOLIDATING CONCRETE

SCOPE

This test method covers the procedure for obtaining representative samples of hydraulic-cement self-consolidating concrete from approved delivery equipment and modifications to procedures for determining unit weight, air content, and making and curing specimens of self-consolidating concrete (SCC).

SAMPLING

Sampling of freshly mixed SCC shall be performed in accordance with Test Method Nev. T425, except the time to obtain the representative sample shall not exceed 2 minutes.

UNIT WEIGHT, AIR CONTENT, AND MAKING AND CURING SCC SPECIMENS

1. The unit weight test shall be performed in accordance with Test Method Nev. T435, except the measure shall be filled in one lift without vibrating, rodding or tamping.

2. The air content test shall be performed in accordance with Test Method Nev. T431 or T432, except the bowl shall be filled in one lift without vibrating, rodding, or tamping.

3. Compressive strength and segregation test specimens shall be made in accordance with Test Method Nev. T428, except the specimen molds shall be filled in one lift without vibrating, rodding or tamping.

Test Method Nev. T417B
September 16, 2013

State of Nevada
Department of Transportation
Materials Division

METHOD OF TEST FOR UNOBSTRUCTED SLUMP FLOW AND STABILITY OF HYDRAULIC-CEMENT SELF-CONSOLIDATING CONCRETE

SCOPE

This test method covers the determination of the flow-ability and stability of fresh hydraulic-cement self-consolidating concrete using the slump cone. The average diameter of the unobstructed slump flow is a measure of the filling ability (flow-ability) of self-consolidating concrete (SCC). The Visual Stability Index (VSI) is a measure of the dynamic segregation resistance (stability) of SCC.

APPARATUS

1. Slump cone mold and tamping rod, shall conform to Test Method Nev. T438.
2. Base plate, smooth, rigid, nonabsorbent sealed or laminated plywood, rigid plastic or steel, and be at least 914 mm (36 in.) in diameter.
3. Trowel and hand scoop.
4. Measuring tape, having a minimum graduation of 10 mm (0.5 in.).
5. Stopwatch, accurate to the nearest .01 second.

SAMPLING

Sampling shall be performed in accordance with Test Method Nev. T416.

PROCEDURE

1. Place the base plate on level, stable ground. Dampen the slump cone mold and base plate. Wipe away any excess water with a moist cloth or damp sponge.
2. Center the slump cone mold on the base plate. The slump cone mold shall be placed with the smaller diameter opening facing down (See Figure 1).
3. Using a hand scoop, fill the slump cone mold in one lift without vibrating, rodding or tamping.

4. Strike off the surface of the concrete, level with the top of the slump cone mold using a trowel or by means of a screeding or rolling motion using a tamping rod. Remove excess concrete from around the base of the slump cone mold and base plate.

5. Raise the slump cone mold in a vertical direction, making sure the mold clears the top of the SCC in 3 ± 1 second without any lateral or torsional motion. Complete the test procedure from filling the slump cone mold to removal of the slump cone mold, without any interruption, and within 2.5 minutes.

6. *If specified in the contract documents:* From the time the slump cone mold is lifted, measure the time in seconds it takes for the concrete to reach a diameter of 500 mm (20 in.). This is the T_{50} time.

7. When the concrete has stopped flowing measure the maximum diameter of the resulting unobstructed slump flow and then measure the diameter perpendicular to the maximum diameter. If the difference between the two unobstructed slump flow diameters is more than 50 mm (2 in.), the test is invalid. Check to make sure the base plate is level and flat, and run the test again ensuring that the slump cone is raised in a vertical direction within 3 ± 1 seconds.

Example: 560 mm (22 in.) unobstructed slump flow – 510 mm (20 in.) unobstructed slump flow = 50 mm (2 in.), test is acceptable.

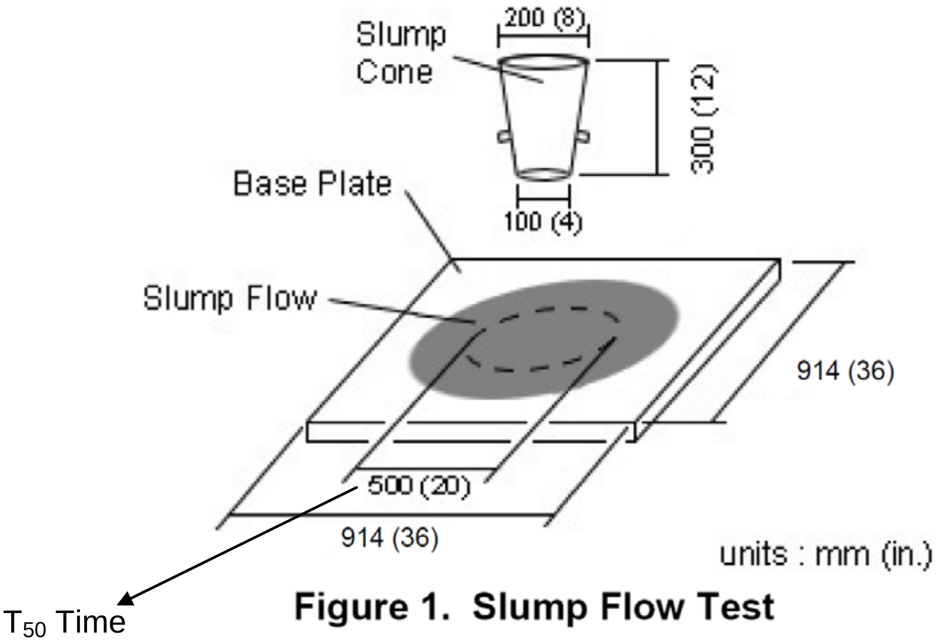


Figure 1. Slump Flow Test

CALCULATIONS

Calculate the average of the two measured diameters. This is the slump flow.

Example: 560 mm (22 in.) unobstructed slump flow + 510 mm (20 in.) unobstructed slump flow = 1070 mm (42 in.) / 2 = 535 mm (21 in.) = 530 mm (21 in.) unobstructed slump flow.

By visual examination, rate the Visual Stability Index (VSI) of the SCC using the criteria in Table 1 and photo illustrations shown in Figures 2 - 9.

Table 1 - Visual Stability Index (VSI) Rating Criteria

Rating	Criteria
0 Stable	No evidence of segregation or bleeding in slump flow area, mixer drum chute, or sampling receptacle (e.g. wheelbarrow, bucket, etc.)
1 Stable	No mortar halo or coarse aggregate heaping within the slump flow area, but slight bleeding and/or air popping is evident on the surface of the slump flow area on the concrete surface in the mixer drum chute or sampling receptacle.
2 Unstable	Slight mortar halo, # 10 mm (0.5 in.) wide within slump flow area, and/or coarse aggregate heaping in the slump flow area, and highly noticeable bleeding in the mixer drum chute or sampling receptacle.
3 Unstable	Clearly segregated by evidence of a large mortar halo, > 10 mm (0.5 in.) wide, and/or large coarse aggregate pile with the slump flow area. A thick layer of paste on the concrete surface in the mixer drum chute or sampling receptacle.

REPORT

1. Report the unobstructed slump flow to the nearest 10 mm (0.5 in.).
2. Report the VSI rating.
3. *If specified in the contract documents: R*eport the T_{50} time to the nearest 0.2 seconds.

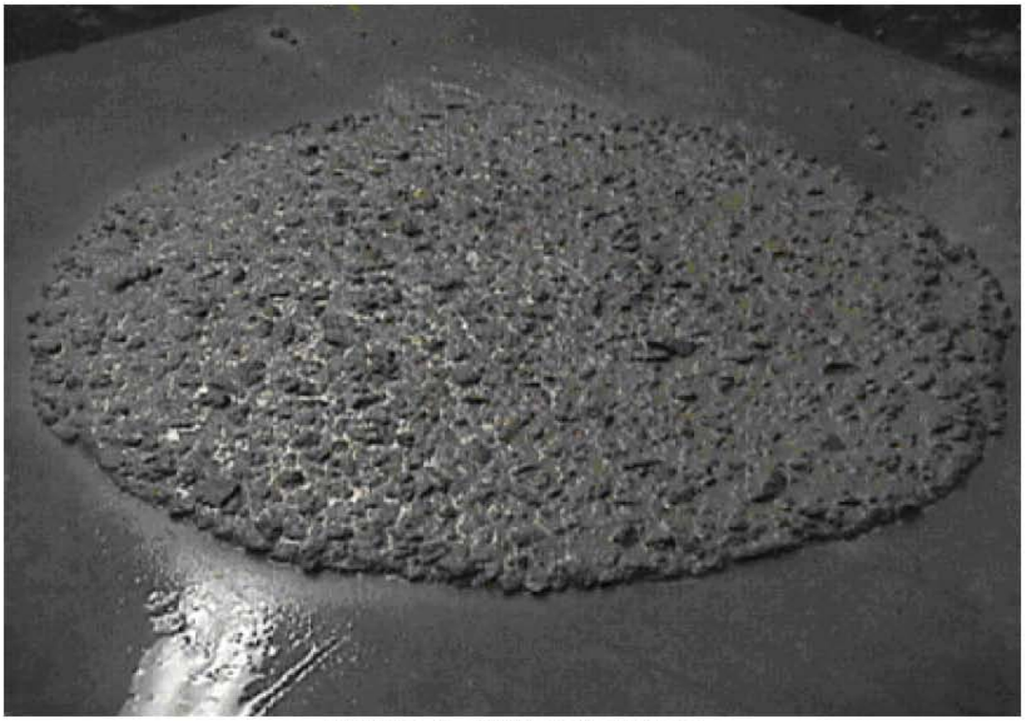


Figure 2. VSI = 0, stable

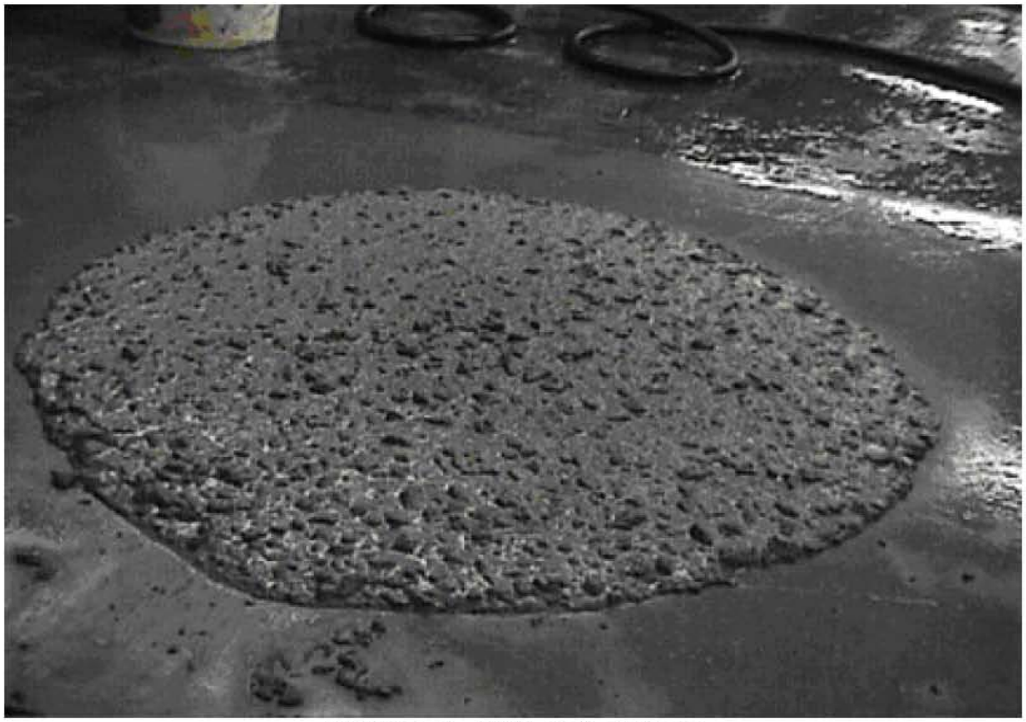


Figure 3. VSI = 0, stable

Figure 4. VSI = 1, stable

Figure 5. VSI = 1, stable

Figure 6. VSI = 2, unstable

Figure 7. VSI = 2, unstable

Figure 8. VSI = 3, unstable

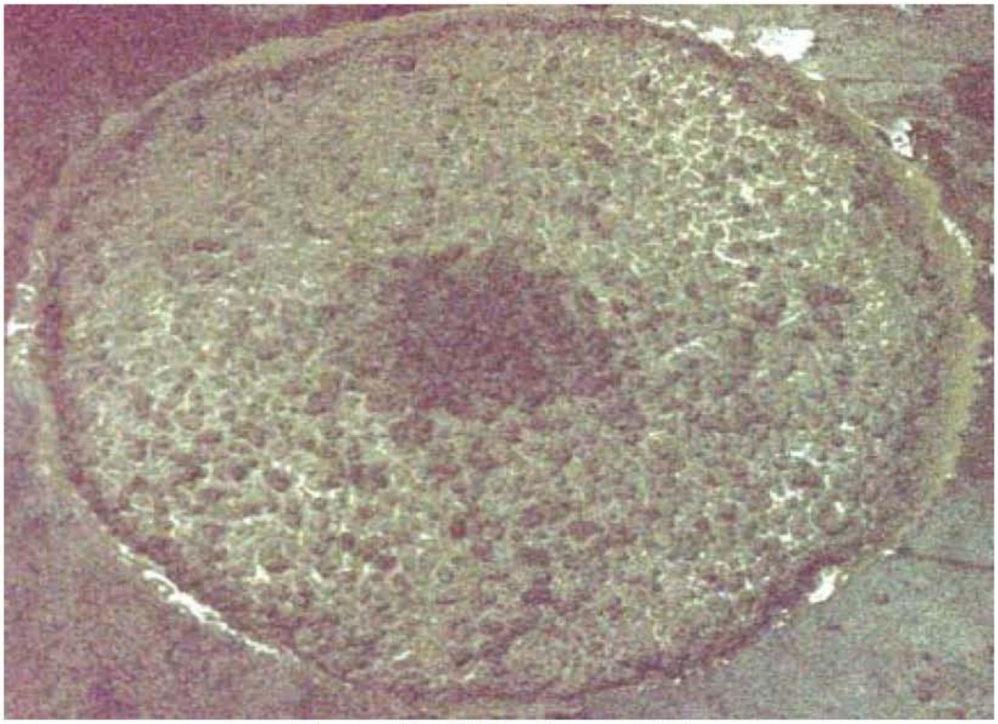


Figure 9. VSI = 3, unstable

Test Method Nev. T418C
January 1, 2015

State of Nevada
Department of Transportation
Materials Division

METHOD OF TEST FOR PASSING ABILITY OF HYDRAULIC-CEMENT SELF-CONSOLIDATING CONCRETE BY J-RING AND SLUMP CONE

SCOPE

This test method covers the determination of the flow-ability and stability of fresh hydraulic-cement self-consolidating concrete using the j-ring and slump cone. The diameter of the unobstructed slump flow versus the obstructed slump flow passing through the j-ring, is a measure of the j-ring value and the passing ability rating of self-consolidating concrete (SCC).

APPARATUS

1. J-Ring, with smooth bars (See Figure 1).
2. Slump cone mold and tamping rod, shall conform to Test Method Nev. T438.
3. Base plate, smooth, rigid, nonabsorbent sealed or laminated plywood, rigid plastic or steel, and be at least 914 mm (36 in.) in diameter.
4. Trowel and hand scoop.
5. Measuring tape, have a minimum graduation of 10 mm (0.5 in.).

SAMPLING

Sampling shall be performed in accordance with Test Method Nev. T416.

PROCEDURE

1. Place the base plate on level, stable ground. Dampen the j-ring, slump cone mold and base plate. Wipe away any excess water with a moist cloth or damp sponge.
2. Center the j-ring on the base plate. The slump cone mold shall be centered within the j-ring with the smaller diameter opening facing down (See Figure 2).
3. Using a hand scoop, fill the slump cone mold in one lift without vibrating, rodding or tamping.

4. Strike off the surface of the concrete, level with the top of the slump cone mold using a trowel or by means of a screeding or rolling motion using a tamping rod. Remove excess concrete from around the base of the slump cone mold and base plate.

5. Raise the slump cone mold in a vertical direction, making sure the mold clears the j-ring in 3 ± 1 second without any lateral or torsional motion. Complete the test procedure from filling the slump cone mold to removal of the slump cone mold, without any interruption, and within 2.5 minutes.

When the concrete has stopped flowing, with the j-ring still in place measure the maximum diameter of the resulting obstructed slump flow and then measure the diameter perpendicular to the maximum diameter. If the difference between the two obstructed slump flow diameters is more than 50 mm (2 in.), the test is invalid. Check to make sure the base plate is level and flat, and run the test again ensuring that the slump cone is raised in a vertical direction within 3 ± 1 seconds.

CALCULATIONS

1. Calculate the average of the two measured diameters. This is the j-ring flow.

   Example: 560 mm (22 in.) + 530 mm (21 in.) = 1090 mm (43 in.)
   1090 mm (43 in.) / 2 = 546 mm (21.5 in.) = 550 mm (21.5 in.) j-ring flow

2. Calculate the difference between the unobstructed slump flow (determined per Test Method Nev. T417) and the j-ring flow, of the same representative sample. This is the j-ring value. Rate the Passing Ability of SCC using the criteria in Table 1.

   Example: 535 mm (21 in.) unobstructed slump flow - 510 mm (20 in.) j-ring flow =
   25 mm (1 in.) j-ring value

Table 1 - Passing Ability Rating

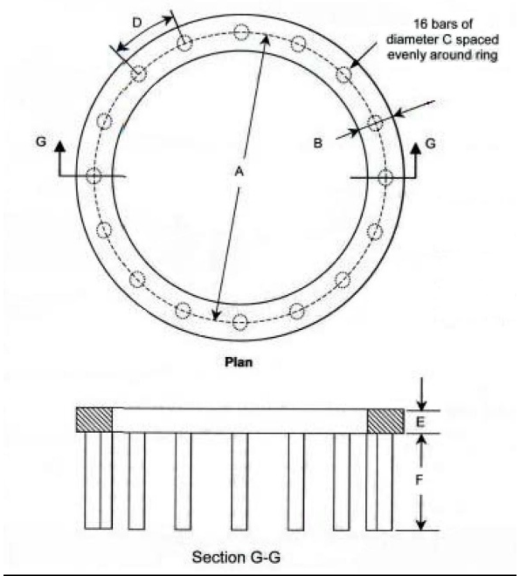
J-Ring Value	Passing Ability Rating	Remarks
0 to 25 mm (0 to 1 in.)	0	High passing ability
> 25 to 50 mm (> 1 to 2 in.)	1	Moderate passing ability
> 50 mm (> 2 in.)	2	Low passing ability

Example: 25 mm (1 in.) j-ring value = 0 (Passing Ability Rating) = High Passing Ability

REPORT

1. Report the j-ring flow and j-ring value to the nearest 10 mm (0.5 in.).

2. Report the j-ring flow value and corresponding passing ability rating on NDOT form 040-056.



Dimension	mm	in.
A	300 ± 3.3	12.0 ± 0.13
B	38 ± 1.5	1.5 ± 0.06
C	16 ± 3.3	0.625 ± 0.13
D	58.9 ± 1.5	2.36 ± 0.06
E	25 ± 1.5	1.0 ± 0.06
F	100 ± 1.5	4.0 ± 0.06

Figure 1. J-Ring

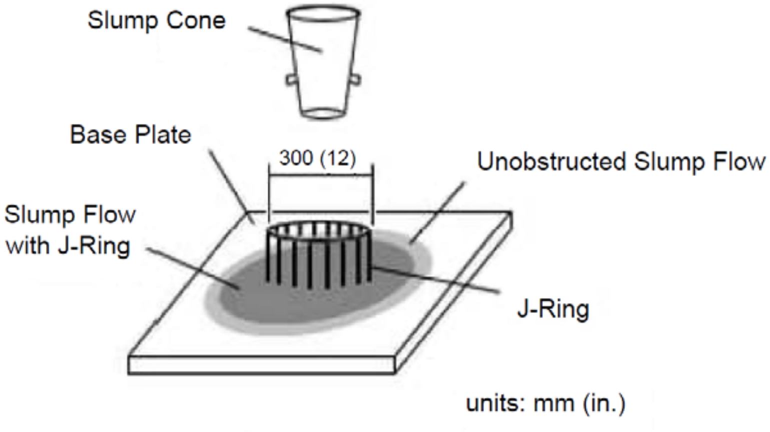


Figure 2. J-Ring Test

Test Method Nev. T425E
September 16, 2013

State of Nevada
Department of Transportation
Materials Division

METHOD OF TEST FOR SAMPLING FRESH CONCRETE

SCOPE

This test method covers the procedure for obtaining representative samples of fresh concrete as delivered to the project site, from stationary, paving and truck mixers, agitating and non-agitating equipment, or dump trucks.

SIZE OF SAMPLE

Make the sample size to be used for strength tests and unit weight tests a minimum of 0.028 m^3 (1 ft^3). Smaller samples may be permitted for routine temperature, slump test and air content.

SAMPLING CONCRETE USING RANDOM NUMBERS

Samples of concrete for test specimens shall be taken in accordance with the following:

When the testing frequency is based on volume, the location to be sampled shall be determined by the use of the Table of Random Numbers given in Figure 1. This method depends upon the volume of the material the sample represents and the capacity of the delivery vehicle. The vehicle to be sampled is determined by the following procedure:

From the table of random numbers select a number block 1 thru 35. Do not use the same number more than once per day. Multiply the random number by the volume of the material the sample will represent. Then divide the volume obtained by the volume of one delivery vehicle. This number will represent the vehicle to be sampled. Use standard practice for rounding off, unless the random number selected indicates the unit to be sampled to be less than one. Then the unit to be sampled will be considered to be number one.

Example: Sampling concrete using Ready mix delivery vehicles. Using random number block 1, column B, and random number .482. The sample frequency is one per 100 yd^3. Multiply .482 x 100 yd^3 = 48.2 yd^3. Ready Mix delivery vehicle’s capacity is 10 yd^3. Divide 48.2 yd^3/10 yd^3 = 4.82, 4.82 rounded = 5. Samples would be taken from the 5th ready mix delivery vehicle.

PROCEDURE

1. The elapsed time between obtaining the first and final portions of the composite samples shall be as short as possible, but in no instance shall it exceed 15 minutes.

    a. Fresh concrete tests such as temperature, slump, air content and unit weight are to be performed as close to the pour site as possible. The transporting of samples for these tests could alter the test results, and should be avoided. Samples for compressive strength cylinders may be transported, if deemed necessary, but must be remixed to ensure uniformity before using.

    b. Tests for temperature, slump or air content shall be started within 5 minutes after the sampling is complete. These tests should then be completed as expeditiously as possible after the composite sample has been fabricated. Tests for unit weight and cylinders for strength testing must be started within 15 minutes after the sampling is complete. The elapsed time between obtaining and using the sample shall be as short as possible and the sample should be protected from the sun, wind, other sources of rapid evaporation, and from contamination.

2. Sampling should be performed as the concrete is delivered from the mixer to the conveying vehicle used to transport the concrete to the forms; however, specifications may require other points of sampling. The procedures used in sampling shall include the use of every precaution that will assist in obtaining samples that are truly representative of the nature and condition of concrete sampled as follows:

    a. Sampling from Stationary Mixers (Except Paving Mixers) - Sample the concrete at two or more regularly spaced intervals during discharge of the middle portion of the batch. Take the samples, within the 15 minute time limit and composite them into one sample for test purposes. Do not obtain samples from the very first or last portions of the batch discharge. Perform sampling by passing a receptacle completely through the discharge stream, or by completely diverting the discharge into a sample container. If discharge of the concrete is too rapid to divert the complete discharge stream, discharge the concrete into a container or transportation unit sufficiently large enough to accommodate the entire batch and then accomplish the sampling in the same manner as given above. Take care not to restrict the flow of concrete from the mixer, container or transportation unit so segregation does not occur. These requirements apply to both tilting and nontilting mixers.

b. Sampling from Stationary Mixers used for portland cement concrete pavement (PCCP) - Sample the fresh concrete after the contents of the mixer have been discharged into the conveying vehicle and moved to the testing platform. Obtain samples from at least five different portions of the batch and composite them into one sample for testing purposes.

c. Sampling from Paving Mixers - Sample the concrete after the contents of the paving mixer have been discharged. Obtain samples from at least five different portions of the pile and composite them into one sample for test purposes. Avoid contamination with subgrade material or prolonged contact with an absorptive subgrade. To preclude contamination or absorption by the subgrade, sample the concrete by placing five shallow containers on the subgrade and discharging the concrete across the containers. Combine the samples obtained into one composite sample for test purposes. The containers shall be of a size that is in agreement with the maximum aggregate size. In some instances, the containers may have to be supported above the subgrade to prevent displacement during discharge.

d. Sampling from Revolving Drum Truck Mixers or Agitators - Sample the concrete during discharge of the middle portion of the batch. Repeatedly pass a receptacle through the entire discharge stream or by completely diverting the discharge stream into a sample container. Take the samples obtained within the 15 minute time limit and combine them into one composite sample for test purposes. Do not obtain samples until after all of the water and admixtures have been added to the mixer. Do not obtain samples from the very first or last portions of the batch discharge. Regulate the rate of discharge of the batch by the rate of revolution of the drum and not by the size of the gate opening.

e. Sampling from Open-top Truck Mixers, Agitators, Nonagitating Equipment, or Other Types of Open-top Containers - Take samples by whichever of the procedures described in a, b, c, or d is most applicable under the given conditions.

TABLE OF
RANDOM NUMBERS

A	B	A	B	A	B	A	B	A	B
1		2		3		4		5	
.576	.730	.430	.754	.271	.870	.732	.721	.998	.239
.892	.948	.858	.025	.935	.114	.153	.508	.749	.291
.669	.726	.501	.402	.231	.305	.009	.420	.517	.858
.609	.482	.809	.140	.396	.025	.937	.310	.253	.761
.971	.824	.902	.470	.997	.392	.892	.957	.640	.463
6		7		8		9		10	
.053	.899	.554	.627	.427	.760	.470	.040	.904	.993
.810	.159	.225	.163	.549	.405	.285	.542	.231	.919
.081	.277	.035	.039	.860	.507	.081	.538	.986	.501
.982	.468	.334	.921	.690	.806	.879	.414	.106	.031
.095	.801	.576	.417	.251	.884	.522	.235	.398	.222
11		12		13		14		15	
.509	.025	.794	.850	.917	.887	.751	.608	.698	.683
.371	.059	.164	.838	.289	.169	.569	.977	.796	.996
.165	.996	.356	.375	.654	.939	.815	.592	.348	.743
.477	.535	.337	.155	.767	.187	.579	.787	.358	.595
.788	.101	.434	.638	.021	.894	.324	.871	.698	.539
16		17		18		19		20	
.566	.815	.622	.548	.947	.169	.317	.472	.864	.466
.901	.342	.873	.964	.942	.985	.123	.086	.335	.212
.470	.682	.412	.064	.150	.962	.925	.355	.909	.019
.068	.242	.667	.356	.195	.313	.396	.460	.740	.247
.874	.420	.127	.284	.448	.215	.833	.652	.601	.326
21		22		23		24		25	
.897	.877	.209	.862	.428	.117	.100	.259	.425	.284
.875	.969	.109	.843	.759	.239	.890	.317	.428	.802
.190	.696	.757	.283	.666	.491	.523	.665	.919	.146
.341	.688	.587	.908	.865	.333	.928	.404	.892	.696
.846	.355	.831	.218	.945	.364	.673	.305	.195	.887
26		27		28		29		30	
.882	.227	.552	.077	.454	.731	.716	.265	.058	.075
.464	.658	.629	.269	.069	.998	.917	.217	.220	.659
.123	.791	.503	.447	.659	.463	.994	.307	.631	.422
.116	.120	.721	.137	.263	.176	.798	.879	.432	.391
.836	.206	.914	.574	.870	.390	.104	.755	.082	.939
31		32		33		34		35	
.636	.195	.614	.486	.629	.663	.619	.007	.296	.456
.630	.673	.665	.666	.399	.592	.441	.649	.270	.612
.804	.112	.331	.606	.551	.928	.830	.841	.602	.183
.360	.193	.181	.399	.564	.772	.890	.062	.919	.875
.183	.651	.157	.150	.800	.875	.205	.446	.648	.685

Figure 1

Test Method Nev. T426C
September 16, 2013

State of Nevada
Department of Transportation
Materials Division

METHOD OF TEST FOR FLOW OF GROUT MIXTURES
(Flow Cone Method)

SCOPE

This test method covers the procedure, used both in the laboratory and in the field, for determining the flow of grout mixtures by measuring the time of efflux of a specified volume of grout from a standardized flow cone.

APPARATUS

1. Flow Cone, with dimensions as shown in Figure 1. The discharge tube shall be stainless steel. The body can be stainless steel, cast aluminum, or other non-corroding metal.

2. Receiving container, minimum capacity of 2000 mL.

3. Ring stand or other suitable device, capable of supporting the flow cone in a vertical, steady position over the receiving container.

4. Level, carpenter's or similar.

5. Stop watch, accurate to the nearest 0.1 second.

6. Rubber stopper for grout cone.

7. Scale, minimum capacity of 45 kg (100 lb), sensitive to 0.1.

CALIBRATION OF APPARATUS

1. The flow cone shall be firmly mounted in such a manner that the top will be level and the cone free from vibration. The discharge tube shall be closed by placing a rubber stopper from the underneath side into the lower end. A quantity of water equal to 1725 ± 5 mL shall be introduced into the cone to indicate the grout level as per Figure 1. Calibrate the cone in accordance with the manufacturer’s recommendation.

SAMPLE

1. The test sample specimen shall consist of 1725 ± 5 mL of grout.

PROCEDURE

Moisten the inside surface of the flow cone. Place rubber stopper into the outlet of the discharge tube. Introduce grout into the cone until the grout surface rises into contact with the grout level as per Figure 1. Start the stopwatch and remove the rubber stopper simultaneously. Stop the stopwatch at the first break in the continuous flow of grout from the discharge tube. The time indicated by the stopwatch is the time of efflux of the grout. At least two tests shall be made for any grout mixture. Results from two properly conducted tests on the same material should not differ by more than 2 ½ seconds.

A recommended procedure for insuring that the interior of the cone is properly dampened, fill the cone with water and, one minute prior to adding the grout sample, allow the water to drain from the cone.

For the specifications on the time of efflux, refer to the Standard Specifications and Special Provisions.

REPORT

On the Daily Construction Report NDOT form 040-056 shall include:

1. Average time of efflux to the nearest 0.2 seconds
2. Temperature of grout sample at the time of test
3. Ambient temperature at the time of test
4. Composition of the sample

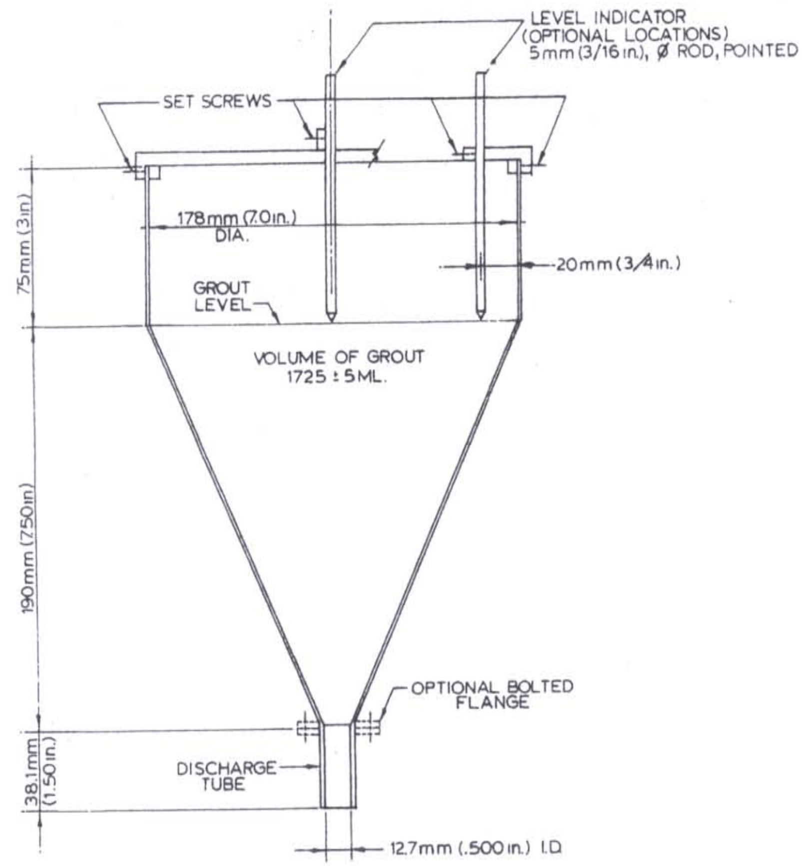


Figure 1 - Cross Section of Flow Cone

Test Method Nev. T427B
January 1, 2014

State of Nevada
Department of Transportation
Materials Division

STANDARD METHOD OF TEST FOR MAKING AND CURING GROUT OR MORTAR COMPRESSION TEST SPECIMENS IN THE FIELD

SCOPE

This test method covers the procedures for making and curing specimens of masonry grout or mortar in the field for compressive strength tests.

APPARATUS

1. Cylindrical molds, with non-absorbent surfaces, substantial enough to hold their shape during the molding of test specimens. The approved standard mold is 100 mm x 200 mm (4 in. x 8 in.).

2. Mallet, with a rubber or rawhide head weighing 0.60 ± 0.02 kg (1.25 ± 0.50 lb).

3. Shovel, pail, trowel, scoop, etc.

4. Suitable pan, wheelbarrow, or nonabsorbent mixing board of sufficient capacity to allow mixing of the entire sample.

SAMPLING

Obtain a representative sample per Test Method Nev. T425. The item being constructed shall be noted on NDOT form 020-017.

PROCEDURE

1. Specimens shall be molded on a level, rigid surface, free of vibration or other disturbances at a place as close as practicable to the location where they are to be stored. If it is not practicable to mold the specimens where they will be stored, they may be moved to the place of storage immediately after being struck off. All jarring, striking, tilting, or scarring the surface of the completed specimens shall be avoided when moving them to the storage area. Specimens shall be molded on site and brought to the storage place as soon as possible.

2. Thoroughly mix or agitate the grout to obtain a fully representative mix and place into a 4 in. x 8 in. mold using a scoop.

3. Grout/Mortar without coarse aggregate; fill the mold in one lift and tap the sides of the mold by hand or with the mallet, 10 – 15 times to release air bubbles.

   Grout/Mortar with coarse aggregate; prepare specimens according to Test Method Nev. T428.

4. Striking off and covering. The surface of the grout/mortar shall be struck off, without undue manipulation, using a wood float or trowel. All completed specimens shall be covered immediately using the lid provided with the mold, to prevent loss of moisture, seal the lid with duct tape. On the mold lid write the contract number, cylinder set number, quantity of cylinders (Ex. 1 of 3), mix design number and date.

NUMBER OF SPECIMENS

A minimum of three specimens shall be made for each test. These will be used to determine the 28-day strength. Additional specimens may be made for informational purposes if desired.

CURING SPECIMENS

During the first 48 hours of initial curing and after molding, store all test specimens in the same location under the same conditions that maintain the temperature immediately adjacent to the specimens in the range of 16°C to 27°C (60°F to 80°F) and prevent loss of moisture from the specimens. Storage temperatures may be regulated by means of ventilation or by evaporation of water from sand or burlap (temperature within damp sand and under wet burlap or similar materials will always be lower than the temperature in the surrounding atmosphere if evaporation takes place), or by using heating devices such as stoves, electric light bulbs, or thermostatically controlled heating cables. A temperature record of the specimens shall be established by means of maximum-minimum thermometer, record the high and low temperature on NDOT form 020-017 under remarks. Store specimens in tightly constructed, insulated, firmly braced wooden boxes, damp sand pits, temporary buildings at construction sites, under wet burlap in favorable weather, or in heavyweight closed plastic bags, or use other suitable methods, provided the foregoing requirements limiting specimen temperature and moisture loss are met. Remove specimens from storage and ship directly to the concrete laboratory as soon as possible after the initial field storage of 48 hours.

Test Method Nev. T428F
September 16, 2013

State of Nevada
Department of Transportation
Materials Division

METHOD OF TEST FOR MAKING AND CURING CONCRETE COMPRESSION TEST SPECIMENS IN THE FIELD

SCOPE

This test method covers the procedures for making and curing concrete compression test cylinders in the field.

APPARATUS

1. Cylindrical molds, with non-absorbent surfaces, substantial enough to hold their shape during the molding of test specimens. The approved standard mold is 100 mm x 200 mm (4 in. x 8 in.). When the nominal maximum size of the coarse aggregate exceeds 25 mm (1 in.), use 150 mm x 300 mm (6 in. x 12 in.) molds.

   The nominal maximum size is the smallest sieve opening through which the entire amount of aggregate passes.

2. Tamping rods, round, straight steel rod with the dimensions listed below. Having the tamping end or both ends rounded to a hemispherical tip of the same diameter as the rod.

   Tamping Rod Requirements:

Diameter of cylinder	Rod Dimensions	
	Diameter: ± 2 mm 1/16 in.	Length: ± 100 mm (4 in.)
100 mm (4 in.)	10 mm (3/8 in.)	300 mm (12 in.)
150 mm (6 in.)	16 mm (5/8 in.)	600 mm (24 in.)

3. Internal vibrators, with rigid or flexible shafts. The vibrator frequency shall be at least 7000 vibrations per minute while the vibrator is operating in the concrete. The diameter of the vibrator shall be no more than one-third the diameter of the cylinder mold and the combined length of the vibrator shaft and vibrating element shall exceed the depth of the section being vibrated by at least 75 mm (3 in.).

4. Mallet, with a rubber or rawhide head weighing 0.60 ± 0.02 kg (1.25 ± 0.50 lb).

5. Shovel, pails, trowel, scoop, etc.

6. Suitable pan, wheelbarrow or nonabsorbent mixing board of sufficient capacity to allow mixing of the entire sample.

SAMPLING

Obtain a representative sample per Test Method Nev. T425. The item being constructed shall be noted on NDOT form 020-017.

PROCEDURE

1. Begin the concrete cylinders within 15 minutes of obtaining the representative sample.

2. Specimens shall be molded on a level, rigid surface, free of vibration or other disturbances at a place as close as practicable to the location where they are to be stored. If it is not practicable to mold the specimens where they will be stored, they may be moved to the place of storage immediately after being struck off. All jarring, striking, tilting, or scarring the surface of the completed specimens shall be avoided when moving them to the storage area.

2. In 150 mm (6 in.) diameter molds, the concrete shall be placed, using a scoop, in three layers of approximately equal volume. In 100 mm (4 in.) diameter molds, the concrete shall be placed, using a scoop, in two layers of approximately equal volume. In placing each portion of concrete, the scoop or trowel shall be moved around the top edge of the mold as the concrete slides from it, in order to ensure a symmetrical distribution of the concrete and to minimize segregation of the coarse aggregate within the mold.

3. Preparation of satisfactory specimens may require different methods of consolidation. The methods of consolidation are rodding and internal vibration. Base the selection of the method of consolidation on the slump, unless the method is stated in the specifications under which the work is being performed. Rod concrete with a slump greater than 75 mm (3 in.). Rod or vibrate concrete with slump of 25 to 75 mm (1 to 3 in.). Vibrate concrete with a slump of less than 25 mm (1 in.).

   Rodding. Mold and rod in accordance with Table 1. Each layer shall be rodded 25 times. The strokes shall be distributed uniformly over the cross section of the mold. In rodding the first layer use sufficient force to penetrate the entire depth without denting or cracking the bottom of the mold. Each successive layer should be rodded enough to penetrate about 25 mm (1 in.) into the underlying layer. After each layer is rodded, tap the outside of the mold lightly 10 to 15 times with the mallet to close any holes left by rodding and to release any large air bubbles that may have been trapped. Avoid overfilling by more the 6 mm (0.25 in.) when adding the final layer.

Table 1
Molding Requirements by Rodding:

Diameter of Cylinder	Number of Layers	Number of Rods per Layer	Approx. Depth of Layer
100 mm (4 in.)	2	25	½ depth of specimen
150 mm (6 in.)	3	25	⅓ depth of specimen

Vibration. Mold and vibrate in accordance with Table 2. Place all the concrete, for each layer, in the mold before starting vibration of that layer. Allow the vibrator to penetrate through the layer being vibrated, and into the layer below, approximately 25 mm (1 in.). The vibrator shall not be allowed to rest on or touch the bottom or sides of the mold. Carefully withdraw the vibrator in such a manner as to avoid air pockets being left in the specimen. After vibration of each layer, tap the sides of the mold 10 to 15 times with a mallet to ensure removal of large entrapped air bubbles at the surface of the mold. When adding the final layer, avoid overfilling by more than 6 mm (0.25 in.). The duration of vibration required will depend upon the work ability of the concrete and the effectiveness of the vibrator. In most cases, sufficient vibration has been applied as soon as the surface of the concrete has become relatively smooth. Continue vibration only long enough to achieve proper consolidation of the concrete. Over vibration may cause segregation.

Table 2
Molding Requirements by Vibration:

Diameter of Cylinder	Number of Layers	Number of Vibrator Insertions per Layer	Approx. Depth of Layer
100 mm (4 in.)	2	1	½ depth of specimen
150 mm (6 in.)	3	2	⅓ depth of specimen

4. Striking off and covering. After consolidation, the surface of the concrete shall be struck off, without undue manipulation, using a wood float, trowel or the tamping rod where the consistency of the concrete permits. All completed specimens shall be covered immediately using the lid provided with the mold, to prevent loss of moisture, seal the lid with duct tape. On the mold lid write the contract number, cylinder set number, quantity of cylinders (Ex. 1 of 5), mix design number and date.

CURING SPECIMENS

Method A: Standard Curing (Specimens for determining compliance with ultimate strength specifications):

During the first 48 hours of initial curing and after molding, store all test specimens in the same location under the same conditions that maintain the temperature immediately adjacent to the specimens in the range of 16°C to 27°C (60°F to 80°F) and prevent loss of moisture from the specimens. Storage temperatures may be regulated by means of ventilation or by evaporation of water from sand or burlap (temperature within damp sand and under wet burlap or similar materials will always be lower than the temperature in the surrounding atmosphere if evaporation takes place), or by using heating devices such as stoves, electric light bulbs, or thermostatically controlled heating cables. A temperature record of the specimens shall be established by means of maximum-minimum thermometer, record the high and low temperature on NDOT form 020-017 under remarks. Store specimens in tightly constructed, insulated, firmly braced wooden boxes, damp sand pits, temporary buildings at construction sites, under wet burlap in favorable weather, or in heavyweight closed plastic bags, or use other suitable methods, provided the foregoing requirements limiting specimen temperature and moisture loss are met. Remove specimens from storage and ship directly to the concrete laboratory as soon as possible after the initial field storage of 48 hours.

Method B : Field Curing (Specimens for determining the earliest date a structure may be put into service):

After the initial 24-hour storage period per Method A, the specimens shall be placed in or on the structure as near to the point of sampling as possible, and shall receive, insofar as practicable, the same protection from the elements as is given to the portion(s) of the structure which they represent for another 24 hours. In simulating these conditions, the test specimens are relatively small and therefore more quickly affected by freezing or drying conditions than the much larger volume of concrete in the structure. The specimens must also be protected from injury while on the worksite. A temperature record of the specimens shall be established by means of maximum-minimum thermometer, record the high and low temperature on NDOT form 020-017 under remarks. These specimens are presumed to show the compressive strength of the portion(s) of the structure they represent at a given time and under field curing conditions. Therefore, such specimens should be kept in the field as long as possible, preferable right up to a day or two before being tested. Remove specimens from the field and ship directly to the concrete laboratory after 48 hour storage period and in time for necessary testing as specified.

Test Method Nev. T431D
September 16, 2013

State of Nevada
Department of Transportation
Materials Division

METHOD OF TEST FOR AIR CONTENT OF FRESHLY MIXED CONCRETE BY THE VOLUMETRIC METHOD (ROLL-A-METER)

SCOPE

This test method is for determining the air content of freshly mixed concrete. This method can be used for all classes of concrete.

APPARATUS

1. Air Meter, shall consist of a bowl for containing the fresh concrete, and a top section, both conforming to the requirements listed below: (See Fig. 1)

    a. Bowl, shall be sufficiently rigid to withstand normal field use and of such construction as to resist attack from the cement paste. The diameter of the bowl shall be 1 to 1.25 times the height. The bowl shall have a capacity of not less than 0.002 m^3 (0.075 ft^3) and be constructed with a flange at or near the top surface.

    b. Top Section, shall be sufficiently rigid to withstand normal field use and be resistant to chemical attack from the cement paste. The capacity of the top section should be approximately the same as the bowl. It shall be equipped with hooks or lugs and a flexible gasket that will form a watertight connection with the flanged end of the bowl. The top section shall be equipped with a glass or plastic lined neck, the neck must be graduated in increments not greater than 0.5 percent from 0 at the top to 9 percent or more of the volume of the bowl. The upper end shall be stoppered with a cap that forms a watertight seal.

2. Funnel, when inserted through the neck of the top section, will extend to a point just above the top of the bowl. The discharge end of the spout shall distribute the water added to the meter to cause a minimum disturbance to the concrete in the bowl.

3. Tamping Rod, a round straight steel rod, straight high density polyethylene or straight aluminum rod, with minimum dimensions of 16 mm (5/8 in.) in diameter and approximately 300 mm (12 in.) in length, having the tamping end rounded to a hemispherical tip of the diameter.

4. Strike-off Bar, a flat steel bar, flat high density polyethylene or flat aluminum rod, with minimum dimensions of 3 mm x 19 mm x 280 mm long (1/8 in. x 3/4 in. x 11 in. long),

5. Calibrated Measuring Cup, a metal or plastic cup having a capacity equal to 1.0 percent of the volume of the bowl of the air meter.

6. Syringe, small rubber bulb syringe having a capacity of at least that of the measuring cup.

7. Pouring Vessel, a metal, glass or plastic container of approximately 1 L (1 qt) capacity.

8. Mallet, with a rubber or rawhide head weighing 0.60 ± 0.02 kg (1.25 ± 0.50 lb).

9. Small Tools, trowel, small metal scoop.

10. 70% Isopropyl Alcohol.

CALIBRATION OF METER

1. The volume of the bowl of the air meter, in cubic meters or cubic feet, shall be determined by accurately weighing the amount of water at 25 ± 3ºC (77 ± 5ºF) required to fill it, and dividing this mass by 999.6 kg/m^3 (62.4 lb/ft^3). A cover plate (made of glass or acrylic) shall be used to cover the bowl to remove excess water and to insure that the container is full.

2. The accuracy of the graduations on the neck of the top section of the air meter shall be determined by filling the assembled measuring bowl and top section with water to the level of the mark for any air content. A quantity of water at 25 ± 3ºC (77 ± 5ºF) equal to 1.0 percent of the volume of the bowl, shall be added to the water already in the neck. The height of the water column shall increase by an amount equivalent to 1.0 percent of the air.

3. The volume of the measuring cup shall be checked by adding one cupful of water to the air meter in the manner described in paragraph 2, above. Such additions shall increase the height of the water column by an amount equivalent to 1.0 percent of air.

4. If the meter does not meet the calibration criteria, the meter needs to be repaired or replaced.

SAMPLING

1. Obtain a representative sample of fresh concrete per Test Method Nev. T425.

2. If the concrete contains coarse aggregate particles larger than 25 mm (1 in.), wet sieve a representative sample over a 25 mm (1 in.) sieve to obtain more than what is required to fill the bowl of the roll-a-meter. Place only enough concrete on the sieve at any one time so that after sieving, the thickness of the layer of retained aggregate is not more than one particle thick. Do not scrape mortar off of the coarse aggregate retained on the sieve, dispose of all aggregate retained on the sieve. Scrape mortar off of the sieve and add it to the material passing the 25 mm (1 in.) sieve. Once enough concrete has been obtained for the test, remix the concrete into a uniform sample and proceed with testing immediately.

PROCEDURE

1. This test shall be started within 5 minutes of obtaining the representative sample.

2. Dampen the inside of the bowl. Using the scoop, fill the measuring bowl with concrete in two equal lifts. Rod each lift 25 times with the tamping rod. Do not forcibly strike the bottom of the measuring bowl when rodding the first lift. When rodding the next lift, penetrate the previous lift approximately 25 mm (1 in.). After rodding each lift, tap the sides of the bowl 10 to 15 times with a mallet to close the voids left by the tamping rod.

3. After the top lift has been placed, tamped, and the voids rodded closed. Strike-off the excess concrete with the strike-off bar until a smooth surface is obtained. Clean the rim and flange of the measuring bowl with a damp sponge.

4. Clamp the top section tightly into position on the measuring bowl, insert the funnel into the neck and add 1 to 2 pints of Isopropyl Alcohol. Finish filling the top section with water until it appears in the neck. Remove the funnel and using the rubber syringe adjust the water level until the bottom of the meniscus is level with the zero mark. Attach and tighten the cap.

5. Invert and agitate the air meter until the concrete dislodges from the measuring bowl. Quickly invert the air meter, shake the base horizontally, and return the air meter to the upright position. To prevent the aggregate from lodging in the neck of the air meter, do not keep it inverted for more than 5 seconds at a time. Repeat the inversion and shaking process until the concrete has broken free and the aggregate can be heard moving in the air meter as it is inverted. Once, the concrete has been dislodged from the measuring bowl, place the air meter on the ground. Place one hand on the neck and the other hand on the flange and tip the air meter at a 45° angle while the base is still in contact with the ground. Vigorously roll the air meter a ¼ to ½ turn back and forth several times, while quickly starting and stopping the rolling process. Repeat this process until all the air appears to have been removed from the concrete. If at any time during this process, liquid leaks from the air meter, the test in invalid and a new test shall be started. Set the air meter upright, loosen the cap and tilt the air meter slightly at a 20° angle allowing the air to rise to the top and the liquid level to stabilize.

6. After all the air has been removed from the concrete allowing it to rise to the top of the neck, set the air meter flat on the surface and remove the cap.

7. Make a direct reading of the water level in the neck, reading to the bottom of the meniscus, and estimating to the nearest 0.25 percent. If a direct reading cannot be determined due to an unclear line of demarcation between the foam mass and the liquid, add in one calibrated measuring cup of Isopropyl Alcohol, add additional increments of Isopropyl Alcohol one at a time with the bulb syringe to dispel the foam mass on the surface of the water, once added stir the foam mass with a non-absorbent device, small enough to fit in the neck and until a line can be read. (One calibrated measuring cup of Isopropyl Alcohol is equivalent to 1.0 percent of air). When Isopropyl Alcohol is added, take the direct reading of the liquid and add the total cups of Isopropyl Alcohol to the direct reading to obtain the air content.

   No Additional Alcohol added: 4.5% = 4.5% Air Content

   Additional Alcohol added: Final reading with Isopropyl Alcohol 4.5% + 2 calibrated measuring cups of Isopropyl Alcohol added = 6.5% Air Content

8. Once the air content reading has been taken disassemble the meter. Dump the contents of the bowl out and verify that there are no undisturbed portions of tightly packed concrete in the bowl. If there are portions of undisturbed concrete in the bowl, the test is invalid and another test shall be ran.

REPORT

Report the air content to the nearest 0.25%. Results should be documented on NDOT form 020-017.

Brass Roll-A-Meter

Light Weight Roll-A-Meter

Test Method Nev. T432E
September 16, 2013

State of Nevada
Department of Transportation
Materials Division

METHOD OF TEST FOR AIR CONTENT OF FRESHLY MIXED CONCRETE BY THE PRESSURE METHOD

SCOPE

This test method describes the equipment and procedures used for determining the air content of freshly mixed concrete. This method is to be used with dense aggregate and normal weight concrete. This test method shall not be used with lightweight aggregates, air cooled blast furnace slag, or aggregates with high porosity. Test Method Nev. T431 shall be used for Air Content of Freshly Mixed Concrete by Volumetric Method with lightweight aggregates.

APPARATUS

1. Air Meter - Type B (See Figure 1).

    a. Measuring bowl, flanged or otherwise constructed cylindrical bowl made of hard metal resistant to corrosion by the cement paste. The diameter of the bowl shall be equal to 0.75 to 1.25 times the height and a capacity of at least $0.0057 m^3$ ($0.20 ft^3$).

    b. Cover assembly, shall be made of hard metal resistant to corrosion by the cement paste, smoothly machined interior surfaces contoured to provide an air space above the level of the top of the bowl and flanged or otherwise constructed such that the cover and the measuring bowl can be fitted together into a pressure-tight assembly. The cover shall be fitted with a gauge for obtaining a direct reading of air content. The graduations for a suitable range in air content shall be within 0.1%. The cover shall be fitted with an air bleeder valve for venting of the air chamber, a main air valve, and petcocks for bleeding off water as required. Suitable means of clamping the cover to the bowl shall be provided to make a pressure-tight seal without entrapping air at the joint between the flanges of the cover and bowl. A suitable hand pump shall be provided with the cover.

2. Scoop, large enough to obtain a representative sample of concrete.

3. Tamping rod, round, straight steel rod, 16 mm (5/8 in.) in diameter and not less than 400 mm (16 in.) in length, having the tamping end rounded to a hemispherical tip.

4. Internal vibrators, may have rigid or flexible shaft. The frequency of vibration shall be 7000 vibrations per minute or greater while in use. The outside diameter or the side dimensions of the vibrating element shall be at least 19 mm (3/4 in.) and not greater than 38 mm (1 1/2 in.). The length of the shaft shall be at least 600 mm (24 in.).

5. Rubber mallet, weighing approximately 0.60 ± 0.25 kg (1.25 ± 0.50 lb) for use with measuring bowl of 0.0142 m^3 (0.5 ft^3) or less, and a mallet weighing approximately 1.0 ± 0.25 kg (2.25 ± 0.50 lb) for use with measuring bowl larger than 0.0142m^3 (0.5 ft^3).

6. Strike-off bar, flat, straight steel bar or other suitable material which is at least 300 mm (12 in.) in length.

7. Strike-off plate, flat, rectangular metal plate at least 6 mm (1/4 in.) thick glass or acrylic plate at least 13 mm (1/2 in.) thick with a length and width at least 50 mm (2 in.) greater than the diameter of the measure with which it is to be used. The edges of the plate shall be straight and smooth within a tolerance of 1.5 mm (1/16 in.)

8. Syringe, small rubber bulb type.

9. Sponge or towel.

10. Calibration vessel, which represents 5% air by volume.

11. Calibration tubes, one bent tube and one straight tube.

CALIBRATION OF AIR METER

1. Calibrate the Air Meter - Type B daily prior to use.

2. Fill the measuring bowl with water at 25 ± 3°C (77 ± 5°F).

3. Strike the sides of the measuring bowl with a rubber mallet to remove excessive air bubbles from the water.

4. Thread the short piece of straight tubing into the threaded petcock opening on the underside of the cover assembly. Clamp the cover assembly on the measuring bowl with the tube extending down into the water.

5. Using the syringe provided, add water at 25 ± 3°C (77 ± 5°F) to the measuring bowl through the petcock with the threaded tube until all air is expelled through the opposite petcock.

6. Pump up the air pressure to just beyond the predetermined initial pressure line (I/P). Wait a few seconds for the gauge hand to stabilize, then add or release air as necessary to stabilize the gauge hand at the initial pressure line (I/P).

7. Close both petcocks and immediately press the main air valve to release air into the base. Tap the gauge lightly with your fingers while holding down the main air valve lever. The gauge hand should read zero. If two or more tests show a variation greater than 0.1% from zero, follow specification protocol to reestablish initial pressure line (I/P).

8. Screw the curved tube provided into the threaded outside opening of the petcock. By pressing on the main air valve lever and controlling the flow with the petcock lever, carefully fill the plastic calibration vessel exactly full of water.

9. Release air pressure by opening the petcock without the tubing. Open the other petcock and allow water from the tube to run back into the measuring bowl. There is now 5% air in the measuring bowl.

10. With both petcocks open, follow the procedure in step six to pressurize the gauge to the initial pressure line (I/P). Close the petcocks and immediately press the main air valve lever. Stabilize the gauge hand as before. The gauge should read 5.0%.

11. If two or more tests indicate a variation of more than 0.1%, reset the gauge hand to 5.0%. Retest to ensure settings are correct by following steps two through nine.

SAMPLING

Sample fresh concrete in accordance with Test Method Nev. T425.

PROCEDURE

1. Referee or dispute testing shall be performed using Test Method Nev. T431.

2. Dampen all equipment and place the measuring bowl on a rigid surface that is level and stable. There shall be no excessive water left standing inside the measuring bowl before testing.

3. Filling the measure and consolidating.

    a. Method of consolidation should be determined per the results of the slump test, unless the method is stated in the specifications under which the work is being performed. The methods of consolidation are rodding and internal vibration. Rod concrete with a slump greater than 75 mm (3 in.). Rod or vibrate concrete with a slump of 25 to 75 mm (1 to 3 in.). Vibrate concrete with a slump less than 25 mm (1 in.).

    b. Rodding - Place the concrete in the measure in three layers of approximately equal volume. Rod each layer with 25 strokes of the tamping rod. Rod the bottom layer throughout its depth but the rod shall not forcibly strike the bottom of the measure. Distribute the strokes uniformly over the cross section of the measure and for the top two layers, penetrate about 25 mm (1 in.) into the underlying layer. After each layer is rodded, lightly tap the sides of the measure 10 to 15 times with the appropriate mallet to close any voids left by the tamping rod and to release any larger air bubbles that may have been trapped. Add the final layer so as to avoid overfilling.

c. Internal Vibration - Fill and vibrate the measure in three layers of approximately equal volume. Place all of the concrete for each layer in the measure before starting vibration of that layer. Insert the vibrator at three different points for each layer. Throughout the consolidation process, do not allow the vibrator to rest on or touch the bottom or sides of the measure. The vibrator shall penetrate into the previous layer approximately 25 mm (1 in.). When withdrawing vibrator, take care to avoid any air pockets being left in the specimen. The duration of vibration required will depend upon the workability of the concrete and the effectiveness of the vibrator. Continue vibration just long enough to achieve proper consolidation of the concrete. Usually, sufficient vibration has been applied as soon as the surface of the concrete becomes relatively smooth. Over vibration may cause segregation and loss of appreciable quantities of entrained air.

4. After consolidating the concrete, strike off the excess concrete with the strike-off bar or the strike-off plate until the surface is flush with the top of the bowl. Clean the top flange of the measuring bowl to ensure a proper seal.

5. Clamp the top section onto the measuring bowl. Open both petcocks. Using the rubber bulb syringe, gently inject water through one petcock while jarring the air meter until water emerges from the opposite petcock and visible air bubbles have been expelled.

6. Close the air bleeder valve on the air chamber and pump air into the air chamber until the gauge hand is on the initial pressure line (I/P). Allow a few seconds for the compressed air to cool to normal temperature. Gently tap the gauge with one hand while slowly opening the air bleeder valve until the needle rests exactly on the initial starting point. If too much air is released, then add air again and repeat this step. Close both petcocks and open the main air valve while simultaneously hitting the measuring bowl with the mallet. Lightly tap the gauge to settle the needle. After the needle has stabilized, read the air content to the nearest 0.1 percent. After this reading has been obtained, release the main air valve.

   Note: Failure to close the main air valve before releasing the pressure from either the container or the air chamber will result in water being drawn into the air chamber. Open both petcocks to release the pressure in the measuring bowl, remove the cover and thoroughly clean the bowl and the cover. Release the remaining air in the pressure chamber only after cleaning the cover.

7. Subtract the aggregate correction factor percentage obtained from the Mix Design from the gauge reading. This will give you the corrected air content percentage. Report this to the nearest 0.1 percent.

   Example: Apparent Air Content - Aggregate Correction Factor = Air Content

   5.2% - 0.2% = 5.0%


Gauge
Pump
Main Air Valve
Bleeder Valve
Pressure Chamber
Petcock
Cover Assembly
Measuring Bowl

Figure 1

Test Method Nev. T435F
January 1, 2015

State of Nevada
Department of Transportation
Materials Division

METHOD OF TEST FOR DENSITY (UNIT WEIGHT) AND VOLUME OF CONCRETE

SCOPE

This test method describes the procedure for determining the density (unit weight) in kg/m^3 (lb/ft^3) of freshly mixed concrete and furnishes formulas for calculating the volume of concrete per batch (yield).

APPARATUS

1. Scale, minimum capacity of 45 kg (100 lb), sensitive to 0.1.

2. Measure, a cylindrical, watertight steel or aluminum measure having a nominal capacity of 14 L (0.5 ft^3) provided with handles, for maximum size aggregate up to 63 mm (2 ½ in.). It shall have an inside diameter of 254 mm (10 in.) and an inside height of 279 mm (11 in.). The top rim shall be machined to a plane surface. The measuring bowl from the Type B – Air Meter may be used as the measure, for maximum size aggregate up to 25 mm (1 in.).

3. Tamping rod, a round, straight, steel rod, 16 mm (5/8 in.) in diameter approximately 600 mm (24 in.) long, having one end rounded to a hemispherical tip of the same diameter.

4. Internal vibrators, may have rigid or flexible shafts, preferably powered by electric motors. The frequency of vibration shall be 7000 vibrations per minute or greater while in use. The outside diameter or the side dimensions of the vibrating element shall be at least 19 mm (3/4 in.) and not greater than 38 mm (1 1/2 in.). The length of the shaft shall be at least 600 mm (24 in.).

5. Strike-Off plate, made of metal, reinforced glass or acrylic, approximately 300 mm (12 in.) square, 6 mm to 12 mm (1/4 in. to 3/4 in.) thick.

6. Mallet, with a rubber or rawhide head, weighing approximately 0.60 ± 0.25 kg (1.25 ± 0.50 lb) for use with measure of 0.0142 m^3 (0.5 ft^3) or less, or a mallet weighing approximately 1.0 ± 0.25 kg (2.25 ± 0.50lb) for use with a measure larger than 0.0142 m^3 (0.5 ft^3).

7. Sponge or towel.

8. Large Scoop.

CALIBRATION OF MEASURE

The calibration factor (f), shall be verified at the start of each contract and any time there is reason to suspect a change. Weigh the empty, dry measure and strike-off plate to the nearest 0.1 kg (0.1 lb) to obtain the tare weight. Fill the measure up with water having a temperature of 25 ± 3ºC (77 ± 5º F). Place the strike-off plate firmly in contact with the rim of the measure and add water if necessary to eliminate bubbles under the glass. Wipe surplus water from the outside of the measure and strike-off plate, weigh to the nearest 0.1 kg (0.1 lb). Take the total mass of the measure, water and strike-off plate and subtract the tare weight. Take 999.6 kg/m^3 (62.4 lb/ft^3) / [Total Mass (measure, strike-off plate, and water) – Tare Weight (empty measure and strike-off plate)] to determine the calibration factor to the nearest 0.1 kg (0.001 lb).

> Example: 999.6 kg/m^3 (62.4 lb/ft^3) / [Total Mass (measure, strike-off plate, and water) – Tare Weight (empty measure and strike-off plate)] = f (calibration factor)

SAMPLING

Obtain a representative sample per Test Method Nev. T425.

TEST PROCEDURE

1. This test shall be started within 15 minutes of obtaining a representative sample.

2. Filling the measure and consolidating.

    a. Dampen the measure and place on a flat level surface.

    b. Method of consolidation should be determined per the results of the slump test, unless the method is stated in the specifications under which the work is being performed. The methods of consolidation are rodding and internal vibration. Rod concrete with a slump greater than 75 mm (3 in.). Rod or vibrate concrete with a slump of 25 to 75 mm (1 to 3 in.). Vibrate concrete with a slump less than 25 mm (1 in.).

    c. Rodding - Place the concrete in the measure in three layers of approximately equal volume. Rod each layer with 25 strokes of the tamping rod. Rod the bottom layer throughout its depth but the rod shall not forcibly strike the bottom of the measure. Distribute the strokes uniformly over the cross section of the measure and for the top two layers, penetrate about 25 mm (1 in.) into the underlying layer. After each layer is rodded, lightly tap the sides of the measure 10 to 15 times with the appropriate mallet to close any voids left by the tamping rod and to release any larger air bubbles that may have been trapped. Add the final layer so as to avoid overfilling.

d. Internal Vibration - Fill and vibrate the measure in three layers of approximately equal volume. Place all of the concrete for each layer in the measure before starting vibration of that layer. Insert the vibrator at three different points for each layer. Throughout the consolidation process, do not allow the vibrator to rest on or touch the bottom or sides of the measure. The vibrator shall penetrate into the previous layer approximately 25 mm (1 in.). When withdrawing the vibrator, take care to avoid any air pockets being left in the specimen. The duration of vibration required will depend upon the workability of the concrete and the effectiveness of the vibrator. Continue vibration just long enough to achieve proper consolidation of the concrete. Usually, sufficient vibration has been applied as soon as the surface of the concrete becomes relatively smooth. Over vibration may cause segregation and loss of appreciable quantities of entrained air.

3. Strike-off, cleaning and weighing

   a. After the last layer has been properly consolidated, use the tamping rod held horizontally to strike off the top surface to its approximately correct elevation. Work the rod back and forth across the top with a sawing motion until a reasonably plane surface is obtained with all particles of coarse aggregate well buried. Clean the rim of the measure for a distance of about 150 mm (6 in.). Place one side of the strike-off plate firmly in position on the cleaned portion of the rim. Advance the strike-off plate with a sawing motion across the measure using sufficient pressure to maintain tight contact with the rim. There should always be a slight surplus of mortar ahead of the strike-off plate. If particles of coarse aggregate appear in front of the advancing edge of the strike-off plate, use your hand to shove them down into the concrete. Using a cloth or damp sponge, clean off all the extra concrete or other material adhering to the outside of the measure and strike-off plate. Weigh the filled measure with the strike-off plate to the nearest 0.1 kg (0.1 lb.) and record the weight.

   b. Slide the strike-off plate off the measure using a sawing motion. Examine the surface for evidence of incomplete filling of the measure. A slight depression of the surface near one edge of the measure and shallow voids up to 19 mm (3/4 in.) in diameter with a depth no greater than 1.5 mm (1/16 in.) may be disregarded. Deeper voids are indications that the measure was incompletely filled. In case of uncertainty, add a small amount of concrete and repeat the operations of screeding with the rod and working the strike-off plate into position. Weigh again. If the new mass agrees within 0.1 kg (0.1 lb) of the first mass, the original mass may be taken as correct.

CALCULATIONS

1. Density (unit weight), W, in kg/m^3 (lb/ft^3). Calculate the density (unit weight) of the concrete in kg/m^3 (lb/ft^3) by multiplying the net weight of the concrete in the container by the calibration factor (f), determined for the measure used.

   Gross Weight (concrete, measure and strike-off plate) – Tare Weight (dry measure and strike-off plate) = Net Weight (concrete) x f (calibration factor) = W (Density (Unit Weight)) to the nearest 0.001 kg/m^3 (0.1 lb/ft^3).

2. The volume of concrete, S, per batch is calculated as follows:

$$S = \frac{Wa + W_1 + Wc + Ww}{W}$$

Where:

S = volume of concrete per batch in cubic feet (cubic meter).

Wa = total cement in the batch in pounds (kilograms).

W_1 = total fine aggregate, including moisture as batched, in pounds (kilograms).

Wc = total coarse aggregate, including moisture as batched, in pounds (kilograms).

Ww = total mixing water added during mixing per batch, in pounds (kilograms).

W = density (unit weight) of the fresh concrete as determined under (1) above, in pounds per cubic foot (kilograms per cubic meter).

NOTES

This Test Method Nev. T435, the 14 L (0.5 ft^3) measure shall be used for concrete containing up to 63 mm (2 1/2 in.) maximum size of aggregate. When testing for unit weight with concrete aggregate of 50 mm (2 in.) or larger, two tests shall be made from the same batch. The average of the two tests shall be reported as a single determination. The measuring bowl from the Type B – Air Meter may be used as the measure, for maximum size aggregate up to 25 mm (1 in.).

REPORT

Report W, Density (Unit Weight) to the nearest 0.001 kg/m^3 (0.1 lb/ft^3). Results should be recorded on NDOT form 020-017, 040-025 and/or 040-078. If not filling out NDOT form 040-025 then 040-078 should be utilized.

Test Method Nev. T438C
September 16, 2013

State of Nevada
Department of Transportation
Materials Division

METHOD OF TEST FOR SLUMP OF PORTLAND CEMENT CONCRETE (CONE METHOD)

SCOPE

This test method covers the procedure to be used for determining slump of concrete, both in the laboratory and in the field. This test is not considered applicable to nonplastic and noncohesive concrete, nor when there is coarse aggregate 50 mm (2 in.) in size or larger in the concrete.

APPARATUS

1. Mold, the test specimen shall be formed in a mold made of metal not readily attacked by the cement paste. The metal shall not be thinner than 1.5 mm (0.060 in.), and if formed by the spinning process, there shall be no point on the mold at which the thickness is less than 1.14 mm (0.045 in.). The mold shall be in the form of the lateral surface of a cone with the base 200 ± 3 mm (8 in. ± 1/8 in.) in diameter, the top 100 ± 3 mm (4 in. ± 1/8 in.) in diameter, and the height 300 ± 3 mm (12 in. ± 1/8 in.). The base and the top shall be open and parallel to each other and at right angles to the axis of the cone. The mold shall be provided with foot pieces and handles. The mold may be constructed either with or without a seam. The interior of the mold shall be relatively smooth and free from projections such as protruding rivets. The mold shall be free from dents. A mold that clamps to a nonabsorbent base plate is acceptable provided the clamping arrangement is such that it can be fully released without movement of the mold.

2. Tamping Rod, a round, straight steel rod 16 mm (5/8 in.) in diameter and approximately 600 mm (24 in.) in length, having the tamping end rounded to a hemispherical tip of the same diameter.

SAMPLING

Obtain a representative sample per Test Method Nev. T425.

PROCEDURE

1. This test shall be started within 5 minutes of obtaining the representative sample. The entire operation from the start of the filling with fresh concrete through the removal of the mold shall be carried out without interruption and shall be completed within an elapsed time of 2 ½ minutes.

2. Dampen the mold and place it on a flat, moist, non-absorbent (rigid) surface. The operator standing on the foot pieces shall hold it firmly in place during filling. Immediately fill the mold in three layers, each approximately one-third the volume of the mold. One-third of the volume of the mold fills it to a depth of 68 mm (2 5/8 in.); two-thirds of the volume fills it to a depth of 156 mm (6 1/8 in.).

3. Rod each layer with 25 strokes of the tamping rod. Uniformly distribute the strokes over the cross section of each layer. For the bottom layer, this will necessitate inclining the rod slightly and making approximately half of the strokes near the perimeter, and then progressing with vertical strokes spirally toward the center. Rod the bottom layer throughout its depth. Rod the second layer and the top layer each throughout its depth, so that the strokes penetrate into the previous layer by approximately 25 mm (1 in.).

   When filling and rodding the top layer, heap the concrete above the mold before rodding is started. If the rodding operation results in the concrete receding below the top edge of the mold, add additional concrete to keep an excess of concrete above the top of the mold at all times, continue the rod counts. After the top layer has been rodded, strike off the surface of the concrete by screeding and rolling motion of the tamping rod. Clean away all concrete spilled in the process of filling and rodding from around the base of the cone. Remove the mold immediately from the concrete by raising it carefully in a vertical direction. The operation of raising the mold shall be performed in 5 to 10 seconds by a steady upward lift with no lateral or torsional motion being imparted to the concrete.

4. Immediately measure the slump by determining the vertical difference between the top of the mold and the height of the displaced center of the top surface of the specimen. If a decided falling away or shearing off of concrete from one side or portion of the mass occurs, disregard the test and make a new test on another portion of the sample. If two consecutive tests on a sample of concrete show a falling away or shearing off of a portion of the concrete from the mass of the specimen, the concrete probably lacks necessary plasticity and cohesiveness for the slump test to be applicable.

REPORT

Record the slump to the nearest 6 mm (1/4 in.). Results should be documented on NDOT form 020-017.

Test Method Nev. T439C
September 16, 2013

State of Nevada
Department of Transportation
Materials Division

METHOD OF TEST FOR BALL PENETRATION IN FRESH PORTLAND CEMENT CONCRETE

SCOPE

This test method describes the procedure for determining the consistency of fresh concrete by measuring the depth of penetration of a metal weight.

APPARATUS

Ball penetration apparatus, consists of a 150 mm (6 in.) diameter steel cylinder with a height of 118 mm (4 5/8 in.) with a hemispherically shaped bottom that is machined to a smooth finish. The penetrator is attached to a shaft graduated to measure penetration to the nearest 6 mm (1/4 in.). The weight of the apparatus (ball, shaft, and handle), exclusive of the yoke, is 13.61 ± 0.05 kg (30 ± 0.1 lb). The handle shall be a metal rod, 13 mm (1/2 in.) in diameter and graduated in increments of 6 mm (1/4 in.), with each inch numbered from the zero point at the top of the yoke or sleeve. The handle may be T-shaped or a closed rectangle at the top to permit grasping by the hand.

For lightweight concrete, a modified ball is used for determining the consistency of fresh lightweight concrete. The modified ball is identical in shape and size to the 13.61 kg (30 lb) ball, but the weight of the lightweight apparatus (ball, shaft, and handle), exclusive of the yoke, is 9.1 ± 0.05 kg (20 ± 0.1 lb).

CALIBRATION

To calibrate, a zero reading is established by placing the ball and the feet of the yoke on a flat surface. The shaft is then adjusted by turning the threaded shaft in the ball penetrator to obtain a zero reading at the top of the yoke or sleeve. The lock nut at the top of the penetrator is then re-tightened.

PROCEDURE

1. The test may be performed on concrete in a wheelbarrow, buggy, other container, after it has been deposited in the forms or on the subgrade. The depth of the concrete above the bottom of the container or reinforcement shall be at least 150 mm (6 in.) for 25 mm (1 in.) maximum size aggregate or smaller, and 200 mm (8 in.) for larger maximum size aggregate.

2. The surface of the concrete to be tested is struck off level over an area of about three square feet. Do not tamp, vibrate or consolidate the concrete. Screed the minimum amount required to obtain a reasonably level surface. Overworking may flush excess mortar to the surface and cause erroneously high penetration readings.

3. Holding the device by the handle, lower it slowly over the prepared area until the feet of the yoke touch the surface of the concrete. Make certain the shaft is in a vertical position and free to slide through the yoke. Gradually lower the ball penetrator into the concrete, maintaining enough restraint on the handle so that penetration is due to the dead weight of the ball only and not to any force generated by dropping the ball. When the ball comes to rest, release the handle and read the penetration to the nearest 6 mm (1/4 in.). Penetration of the feet of more than 3 mm (1/8 in.) may indicate that the concrete has been overworked in screeding the surface, or that the yoke is binding on the shaft. Do not overwork the surface and re-test in another location.

4. For one penetration determination take three individual readings. Individual readings shall be at least 230 mm (9 in.) apart and at least 150 mm (6 in.) from a vertical edge. The reported penetration determination shall be the average of the first three individual readings.

   Ex. 25 mm (1 in.) + 30 mm (1 ¼ in.) + 25 mm (1 in.) = 80 mm (3.25 in.) / 3 = 25 mm (1 in.)

REPORT

Report the average of the three readings to the nearest 6 mm (1/4 in.) of penetration determination. Results should be recorded on NDOT form 020-017.

Test Method Nev. T440D
September 16, 2013

State of Nevada
Department of Transportation
Materials Division

METHOD OF TEST FOR MEASURING SURFACE TEMPERATURE OF IN-PLACE PORTLAND CEMENT CONCRETE

SCOPE

This test method describes the procedure for measuring the temperature of in-place portland cement concrete.

APPARATUS

Use a recording device approved by the Construction Division. The recorder must be capable of measuring and recording temperatures as specified in Subsection 501.03.10 of the Nevada Department of Transportation Standard Specifications for Road and Bridge Construction.

TEMPERATURE MEASUREMENT

Temperature shall be measured continuously, in increments of 1.1°C (2°F), immediately after placement and vibration. Surface temperature of the in place concrete shall be measured by placing the probe on the concrete surface at a point representing the mass of concrete placed, as approved by the Engineer. The unit shall be insulated from the influence of external temperature sources. The chart recorder shall be set to the correct time and actuated after installation. The Engineer will be responsible for maintenance and changing of charts.

REPORT

Record the contract number, date, time, stationing and type of placement on the back of the chart or the computer print out.

Test Method Nev. T441A
September 16, 2013

State of Nevada
Department of Transportation
Materials Division

METHOD OF TEST FOR MEASURING TEMPERATURE OF FRESH CONCRETE

SCOPE

This test method describes the procedure for measuring the temperature of fresh concrete.

EQUIPMENT

1. Thermometer, glass or metal, liquid or digital, capable of accurately measuring from 0°C to 50°C (30°F to 120° F) and allows for 75 mm (3 in.) or more of immersion into the fresh concrete.

2. Container, shall be large enough to provide 75 mm (3 in.) of concrete coverage in all directions around the sensor of the thermometer and be at least three times the nominal maximum size of the coarse aggregate.

CALIBRATION

The thermometer shall be calibrated annually or whenever there is a question of accuracy.

SAMPLING

Obtain a representative sample of fresh concrete per Test Method Nev. T425.

PROCEDURE

1. This test shall be started within 5 minutes of obtaining a representative sample.

2. Submerge the temperature sensing portion of the thermometer into the fresh concrete a minimum of 75mm (3 in.). Gently press the surface of the fresh concrete around the thermometer to close any voids created during the insertion of the thermometer and to prevent the ambient air temperature from affecting the reading.

3. Leave the thermometer in the fresh concrete for a minimum of 2 minutes but no more than 5 minutes, read and record the temperature of the fresh concrete to the nearest 0.5° C (1° F). Do not remove the thermometer from the fresh concrete while reading the temperature.

REPORT

Report the temperature to the nearest 0.5° C (1° F). Results should be documented on NDOT form 020-017.

Test Method Nev. T442G
January 1, 2014

State of Nevada
Department of Transportation
Materials Division

METHOD OF TEST FOR MAKING AND CURING CONCRETE BEAM SPECIMENS IN THE FIELD AND FOR DETERMINING FLEXURAL STRENGTH OF CONCRETE USING SIMPLE BEAM WITH THIRD-POINT LOADING

SCOPE

This test method describes the procedure for making and curing beam specimens from representative samples of fresh concrete and the procedure used for determining the flexural strength of concrete by the use of a simple beam with third-point loading.

APPARATUS

1. Beam breaking machine, machines having the capacity, in one continuous stroke, to complete a test without requiring replenishment are permitted and shall be capable of applying loads at a uniform rate without shock or interruption. The testing machine shall conform to the requirement of the section on Basis of Verification, Corrections, and Time Interval between Verifications of Practices, ASTM E4.

2. Beam molds, molds shall be made of steel, cast iron, or other nonabsorbent material that is not reactive with concrete containing Portland or other hydraulic cements. Molds shall hold their dimensions and shape under all conditions of use and shall be watertight. Molds shall produce specimens that are 150 mm (6 in.) x 150 mm (6 in.) in cross section and at least 500 mm (20 in.) in length. Maximum variation from the nominal cross section shall not exceed 3 mm (1/8 in.). The inside surface shall be smooth. The sides, bottom, and ends shall be at right angles to each other and shall be straight and true and free of warpage.

3. Tamping rod, rod shall be made of steel and be round and straight. The rod shall be approximately 16 mm (5/8 in.) in diameter and 600 mm ± 100 mm (24 ± 4 in.) in length, with both ends rounded to a hemispherical tip of the same diameter.

4. Internal vibrators, vibrators may have rigid or flexible shafts. The frequency of vibration shall be 7000 vibrations per minute or greater while in use. The outside diameter or the side dimensions of the vibrating element shall be at least 19 mm (3/4 in.) and not greater than 38 mm (1 1/2 in.). The length of the shaft shall be at least 600 mm (24 in.).

5. Small hand tools, such as wood floats, 150 mm (6 in.) blunt end stainless steel trowel, rubber head mallet with a mass of 567 ± 227 g (1.25 ± 0.50 lb) and measuring tape or ruler with at least 1 mm (1/16 in.) graduations.

SAMPLING

1. Obtain a representative sample per Test Method Nev. T425. In the case of concrete deposited in front of a “slip-form paver,” the sample shall be taken from random points throughout the dumped loads in front of the paving machine.

2. Transport samples obtained as described above in watertight containers to the place where the test specimens are to be molded. A minimum of three samples shall be molded. Samples must be remixed with a shovel on a non-absorbent surface to assure that there is no segregation of the coarse aggregate or mortar.

MOLDING TEST SPECIMENS

1. Place the concrete in lightly oiled molds using a scoop. The oil used shall be mineral oil. If using a vibrator for consolidation, place concrete in one lift. Place enough concrete such that the mold will be slightly overfilled after consolidation. If a vibrator is not used for consolidation, place concrete in two layers of approximately equal volume and rod each layer. Place enough concrete in the second layer such that the mold will be slightly overfilled after consolidation. In placing each portion of concrete, the scoop or trowel shall be moved around the top edge of the mold as the concrete slides from it in order to ensure a symmetrical distribution of the concrete and minimize segregation of the coarse aggregate within the mold. The concrete may be further distributed by use of a tamping rod prior to the start of consolidation.

2. Preparation of satisfactory specimens requires different methods of consolidation. Concrete with a slump equal to or greater than 25 mm (1 in.) can be rodded or vibrated. Concrete with a slump of less than 25 mm (1 in.) shall be vibrated.

3. The number of roddings per layer shall be based upon the top surface area of the beam. Provide one rodding for each 1400 mm^2 (2 $in.^2$) of surface area. Rod each layer throughout the depth without forcefully striking the bottom of the mold. After each layer is rodded, tap the outsides of the mold 10 to 15 times with a mallet to close any holes and to release any large air bubbles that may have been trapped.

4. Vibrate by inserting the vibrator at intervals not exceeding 150 mm (6 in.) along the centerline of the long dimension of the specimen. Place all concrete in the mold before starting vibration. Insert the vibrator slowly and do not allow the vibrator to touch the bottom or sides of the mold. Withdraw the vibrator slowly so no large air pockets are left in the specimen. Generally, no more than 5 seconds of vibration should be required for each insertion. Usually, sufficient vibration has been applied as soon as the surface of the concrete has become relatively smooth. Longer times may be needed for lower slump concrete. Once vibration is complete, tap the outsides of the mold 10 to 15 times with a mallet to close any holes and to release any large air bubbles that may have been trapped. After tapping, spade along the sides and ends of the beam molds with a trowel.

5. After consolidation, strike off excess concrete from the surface and float with a hand trowel. Finish with the minimum manipulation necessary to produce a flat even surface that is level with the rim of the mold and that has no depressions or projections larger than 3 mm (1/8 in.).

CURING TEST SPECIMENS

1. Place earth around the sides and ends of the molds to prevent excessive loss of heat generated by the chemical reaction in the concrete.

2. During the initial 24 hours, apply the same curing compound to the top surface of the test beam as is applied to the pavement. Apply the curing compound promptly to the surface of the beam or cover the beam immediately with a double thickness of burlap or other fabric that shall be kept thoroughly damp until the curing medium is applied. The objective sought in curing the beam is to provide the same temperature environment as that of the pavement.

3. At the end of the initial 24 hour cure time, remove from test site and transport the beam to the curing location. Then, carefully remove the beam from the mold and bury the beam in damp earth with at least 100 mm (4 in.) of cover over the top of the beam. Keep the earth surrounding the test beams damp at all times. Cover with a tarp or plastic sheeting to prevent excessive evaporation.

BEAM BREAKING PROCEDURE

1. Testing schedule

    a. Break one beam at 10 days of age and one at 28 days of age. Thus, there will be one spare beam to test in case of a faulty break or if it is desired to vary the breaking schedule. The breaking schedule may be varied, if necessary, to determine the strength of the concrete before opening the pavement to traffic.

    b. Keep beams thoroughly damp throughout the curing process until immediately prior to testing time. If beams are allowed to dry prior to testing, test results may be inaccurate.

    c. Test beams promptly upon removal from the curing bed.

2. Testing procedure

    a. Locate the testing machine on a firm foundation, away from the influence of vibrations. Break strength may be decreased if this step is disregarded.

    b. Follow the operation manual to prepare the beam breaking machine for testing.

    c. Brush the beam clean, place in the testing machine on its side with respect to its position as molded, and center it on the support blocks. Center the loading system in relation to the applied force. Bring the load-applying block in contact with the surface of the specimen at the third points and apply a load of between 3 and 6 percent of the estimated ultimate load. Use leather shims on the specimen contact surface to eliminate any gaps. Leather shims shall be of uniform 6 mm (1/4 in.) thickness, 25 to 50 mm (1 to 2 in.) in width, and shall extend across the full width of the specimen.

d. Apply the load to the specimen continuously and without shock. The load shall be applied at a constant rate to the breaking point. Apply the load at a constant rate between 0.86 and 1.21 MPa/min (125 and 175 psi/min) until rupture occurs. When the loading rate needs to be calculated use the following equation:

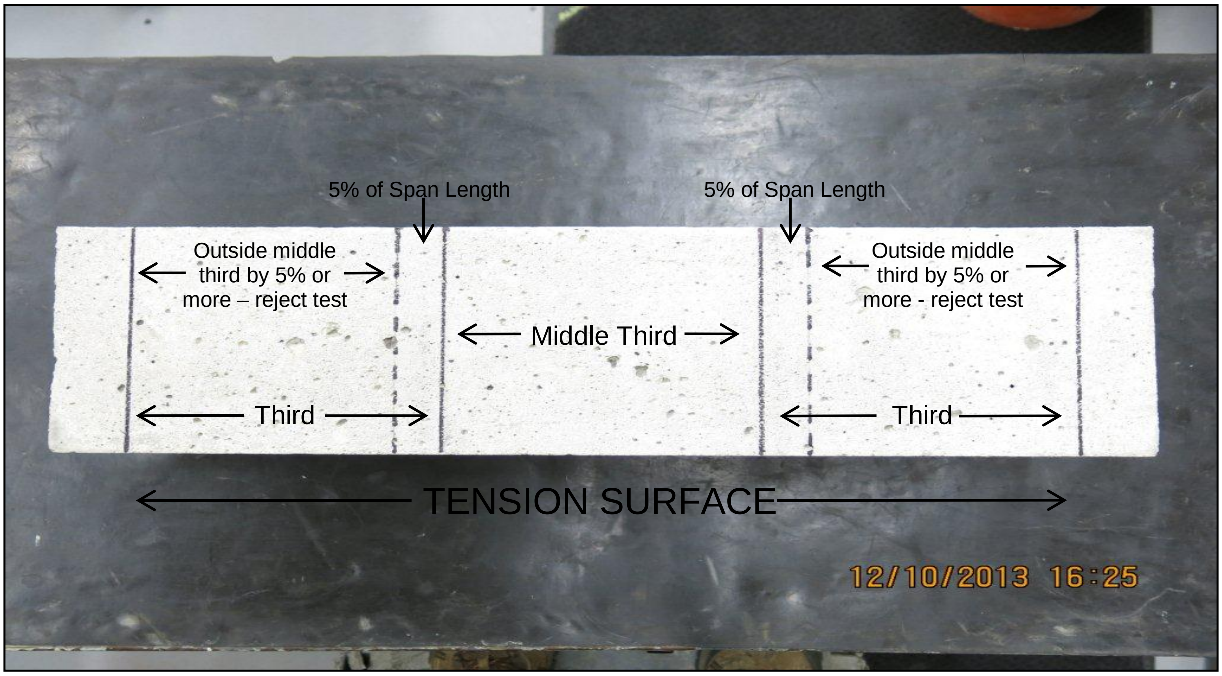
$$r = Sbd^2/L$$

where:
r = loading rate, MN/min (lb/min),
S = rate of increase in extreme fiber stress, MPa/min (psi/min),
b = average width of the specimen, mm (in.),
d = average depth of the specimen, mm (in.),
L = span length, mm (in.).

3. Measurement of Specimens after Test

   a. To determine the dimensions of the specimen cross section for use in calculating modulus of rupture, take measurements across one of the fractured faces after testing. For each dimension, take one measurement at each edge and one at the center of the cross section. Use the three measurements for each direction to determine the average width and the average depth. When necessary, calculate the average distance between the line of fracture and the nearest support measured on the tension surface of the beam by measuring from the nearest support to the fracture along both edges of the beam and along the centerline of the tension surface, and average the three measurements. Take all measurements to the nearest 1 mm (1/16 in.).

CALCULATIONS



1. If the fracture initiates in the tension surface within the middle third of the span length and the testing machine supplies modulus of rupture (R), record results per the REPORT section.

   If the fracture initiates in the tension surface within the middle third of the span length and the testing machine supplies maximum applied load (P), calculate the modulus of rupture (R) as follows:

$$R = PL/bd^2$$

where:
R = modulus of rupture, MPA (psi),
P = maximum applied load indicated by the testing machine, N (lbf),
L = span length, mm (in.),
b = average width of specimen, mm (in.) at the fracture,
d = average depth of specimen, mm (in.) at the fracture.

2. If the fracture occurs in the tension surface outside of the middle third of the span length by not more than 5% of the span length, and the testing machine supplies modulus of rupture (R), calculate maximum applied load (P) as follows:

$$P=Rbd^2/L$$

where:
P = maximum applied load, calculated, N (lbf),
R = modulus of rupture supplied by testing machine, MPA (psi),
L = span length, mm (in.),
b = average width of specimen, mm (in.) at the fracture,
d = average depth of specimen, mm (in.) at the fracture.

Then calculate an adjusted modulus of Rupture, (R) as follows:

$$R= 3Pa/bd^2$$

where:
R = adjusted modulus of rupture, MPA (psi),
P = maximum applied load calculated above, N (lbf),
a = average distance between the line of fracture and the nearest support measured on the tension surface of the beam, mm (in.),
b = average width of specimen, mm (in.) at the fracture,
d = average depth of specimen, mm (in.) at the fracture.

If the fracture occurs in the tension surface outside of the middle third of the span length by not more than 5% of the span length and the testing machine supplies maximum applied load (P), calculate the modulus of rupture, (R) as follows:

$$R = 3Pa/bd^2$$

where:
R = modulus of rupture, MPA (psi),
P = maximum applied load indicated by the testing machine, N (lbf),
a = average distance between the line of fracture and the nearest support measured on the tension surface of the beam, mm (in.),
b = average width of specimen, mm (in.) at the fracture,
d = average depth of specimen, mm (in.) at the fracture.

3. If the fracture occurs in the tension surface outside of the middle third of the span length by more than 5% of the span length, discard the results of the test.

REPORT

Report the modulus of rupture to the nearest whole number. Record the results on NDOT form 040-016.

Test Method Nev. T446E
December 1, 2008

State of Nevada
Department of Transportation
Materials Division

METHOD OF TEST FOR EVALUATION OF PAVEMENT PROFILES - ENGLISH

SCOPE

This test method describes the procedure used for determination and verification of the Profile Index from a pavement profile made with the California type profilograph (See Figure 8). This method also describes the procedure used to locate individual high points (must grinds).

The profile trace is recorded on a scale of 1 in. is equal to 25 ft longitudinally and 1 in. is equal to 1 in. (full scale) vertically. Determination of the Profile Index involves measuring scallops that appear outside a 0.2 in. wide shaded area of a blanking band. Determination of individual high points involves the use of a bump template as described in Section II of this test method.

EQUIPMENT

Profilograph, California type 25 ft wheel base. (Refer to Subsection 402.03.03 of the specifications for equipment requirements). Alternative equipment may be allowed if approved by the Engineer.

EQUIPMENT CALIBRATION

The profilograph should be checked for calibration of longitudinal distance and vertical height each time the profilograph is assembled, or at any time the Engineer deems necessary. The longitudinal distance calibration is to be performed by operating the profilograph at walking speed (approximately 3 mph) over a measured distance of 528 ft. The actual distance shown by the computer display must be within 0.5 ft. The vertical height calibration is to be performed by placing the center recording wheel of the profilograph on a flat surface. Two plates, each measuring 0.5 in. thick, are then placed under the center recording wheel, one at a time and the change in height noted. The two plates are then removed, one at a time and the change in height noted. Each step in this process shall show a change in height of 0.5 in. +/- 0.01 in. If the longitudinal distance or vertical height calibration is out of specification tolerance, follow the manufacturer's instructions to adjust the profilograph settings and recalibrate until the profilograph meets the specified tolerances. Provide the Engineer with a computerized printout to verify the profilograph calibration and parameter settings before testing pavement smoothness (See Figure 7). The tire pressure of the center recording wheel must be set and maintained at 25 psi unless the manufacturer specifies a different tire pressure setting. The tire pressure must be checked prior to the start of calibration.

SECTION 1 - VERIFICATION OF THE PROFILE INDEX

PROCEDURE

The pavement profile trace is produced and calculated by a computerized profilograph. The pavement profile trace shall be checked for accuracy using a plastic blanking band, 1.70 in. wide and 21.12 in. long (See Figure 1). The blanking band represents a pavement length of 528 ft or 0.1 mi at a scale of 1 in. = 25 ft. At the center of the blanking band is a 0.2 in. wide shaded area that extends the entire length of the blanking band. Each side of the 0.2 in. shaded area has scribed lines 0.1 in. apart and parallel to the 0.2 in. shaded area. These lines serve as a convenient scale to measure deviations of the graph above or below the 0.2 in. shaded area. These are called scallops (See Figure 4). A blanking band may be obtained from the Construction Division, Quality Assurance Section.

Place the blanking band over the profile in such a way as to “blank out” as much of the profile as possible. Usually when this is done, scallops above and below the 0.2 in. shaded area are equally balanced (See Figure 2). Starting at the left end of the blanking band, measure and total the height of all the scallops appearing both above and below the 0.2 in. shaded area. Measure each scallop to the nearest 0.01 in. Write this total on the profile sheet near the left end of the blanking band. Mark the right end of the blanking band in the center of the 0.2 in. shaded area. This will align the scale when moving onto the next 0.1 mi, or fraction thereof.

When scallops occurring in the first 0.1 mi are totaled, slide the blanking band to the right, aligning the left side of the blanking band with the small mark previously made and proceed with counting in the same manner. The last section counted may or may not be an even 0.1 mi. If not, its length in miles needs to be calculated. The readings should be rounded to the nearest 0.001 mi. Each 0.1 mi section, or portion thereof, must be recorded on Form No. 040-073 and checked for conformance with the specifications. The specifications indicate which pavement smoothness type to use when computing the Profile Index.

The computerized profile trace may move from a generally horizontal appearance when going around super elevated curves and through rapid changes in elevation such as dips or humps. These changes will make it nearly impossible to blank out the middle portion of the trace without shifting the scale. When these changing conditions occur, the computerized profile trace should break into short sections to balance the scallops (See Figure 3).

LIMITATION OF MEASUREMENT

When counting profiles, a day's production of pavement surface is considered to include the last portion of the previous work, which includes the take off joint. The last 30 ft of pavement surface cannot usually be obtained until the following day. If a line break, station equation, or exception (bridge deck, cattleguard, etc.) is encountered, the profilograph should be stopped at the point of the line break, station equation, or exception so that the ending station can be recorded. The profilograph should resume the run using the new station as the beginning point of the next section.

Example for in./0.1 mi Index:

	Section length, miles		in./0.1 mi
	0.100	------------------------------0.21 + 0.03 + 0.01 + 0.26 + 0.13 =	0.64
	0.100	------------------------------0.11 + 0.02 + 0.01 + 0.12 =	0.26
	* 0.071	------------------------------0.03 + 0.41 + 0.21 + 0.37 + 0.08 =	1.10
Totals	0.271		2.00

* A calculation will need to be made to determine a corrected measurement for short sections less than a 0.1 mi. This amount of roughness in each "one-tenth mile section" is converted to a relative profile. This calculation should be recorded in the remarks area on Form No. 040-073 "Report of Profilograph Test", but should not be used for the overall Profile Index.

Using the example above:

Short Section: Station 111+08 - 107+32 = 376 ft ÷ 5280 ft = 0.071 mi
Total count must be based on 0.1 mile section: 0.1/.071 x 1.10 =1.55 in./0.1 mi

Each section must be "weighted" according to its length. This is most easily done by totaling the tenths of an inch for each 0.1 mi section of a given line or lines and using the total length of the line (up to 1 mi) in the computation for determining the Profile Index for a mile.

Example for in./mi Index:

Using the 0.271 and 2.00 totals from the above example:

Inch Per Mile Index = (1 ÷ 0.271) x 2.00 = 7.380

REPORT

Report each in./0.1 mi to the nearest 0.01 in. and each 0.1 mi section to the nearest 0.001.

SECTION II - VERIFICATION OF HIGH POINTS (MUST GRINDS)

EQUIPMENT

Special equipment needed includes a plastic bump template, having a line 1 in. long scribed on one face with a small hole at either end, and a slot 0.3 in. (PCCP), 0.25 in. (Bridge Decks), 0.3 in. (Dense Graded Plantmix) or 0.4 in. (Open-Graded Plantmix) from and parallel to the scribed line (See Figure 5).

PROCEDURE

At each prominent peak or high point (must grinds) of the profile trace, place the template so that the small holes at each end of the scribed line intersect the profile trace to form a chord across the base of the peak or indicated bump. The line on the template does not need to be longitudinal. With a sharp pen or pencil, draw a line using the narrow slot in the template as a guide. Any portion of the trace extending above this line will indicate the approximate length and height of the deviation in excess of the specification value. Do not subtract the 0.2 in. wide shaded area when measuring high points. There may be instances where the distance between easily recognizable low points is less than 1 in. (25 ft). For such cases, a shorter chord length shall be used in making the scribed line on the template tangent to the trace at the low points (See Figure 6). However, it is the intent of this requirement that the baseline for measuring the height of bumps will be as nearly 1 in. (25 ft) as possible, but in no case shall exceed this value. When the distance between prominent low points is greater than 1 in. (25 ft), make the ends of the scribed line intersect the profile trace when the template is in a near horizontal position. The location of any high point that exceeds specification limits for bump height should be marked on the pavement. The station of that bump must be recorded on Form No. 040-073 in the remarks section so that the bump can be located for possible remediation at a later date.

SECTION III – FIGURES

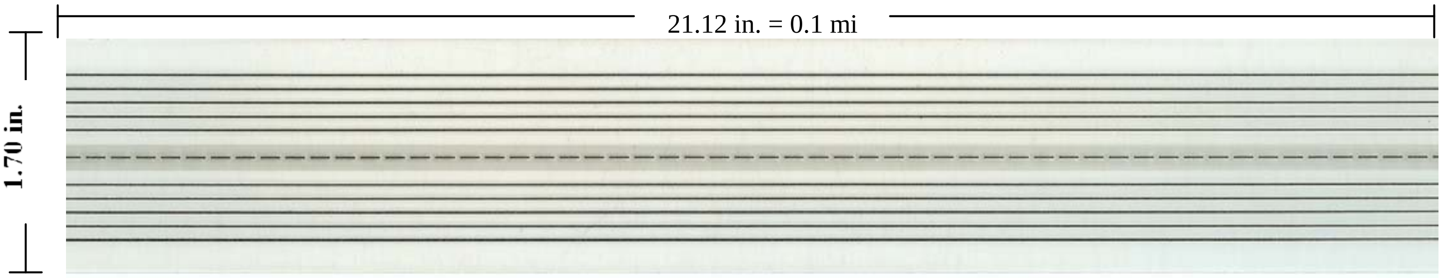


Figure 1: Plastic Scale (Blanking Band)

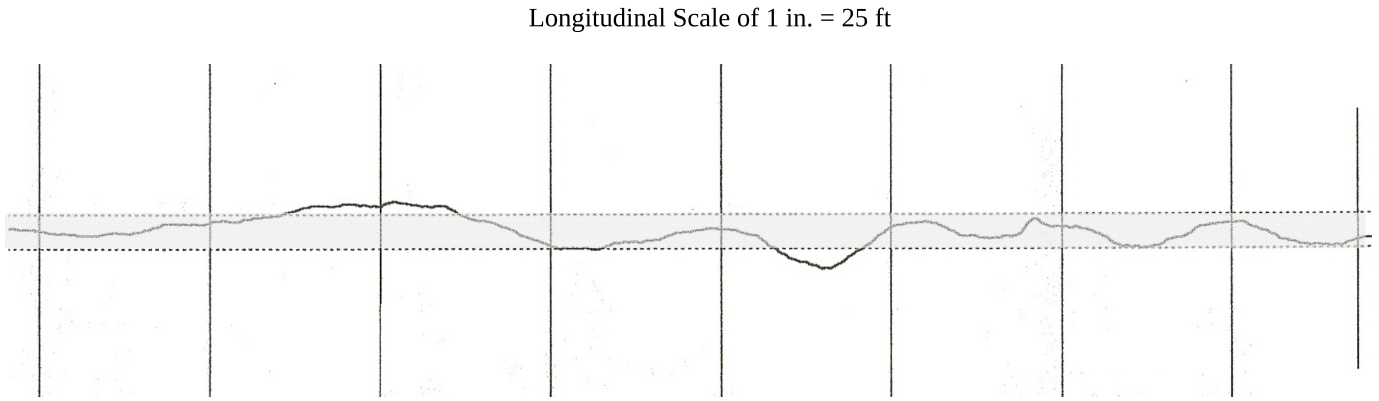
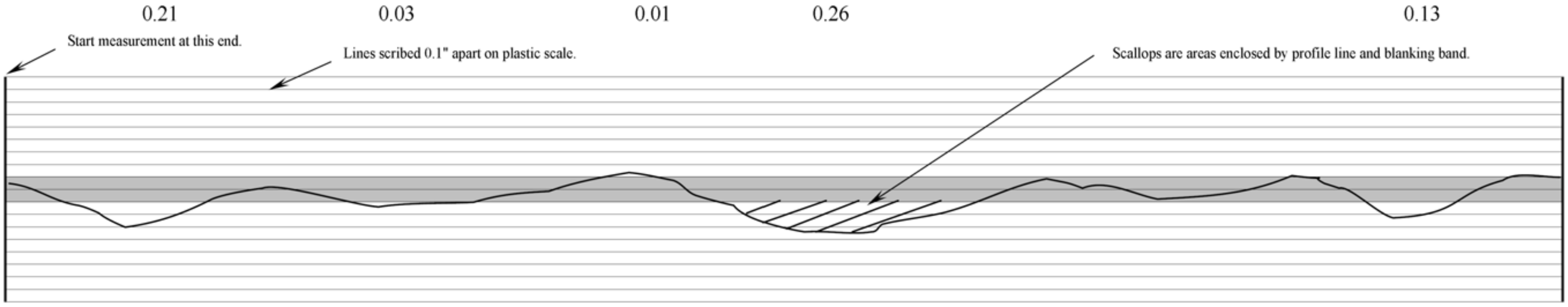


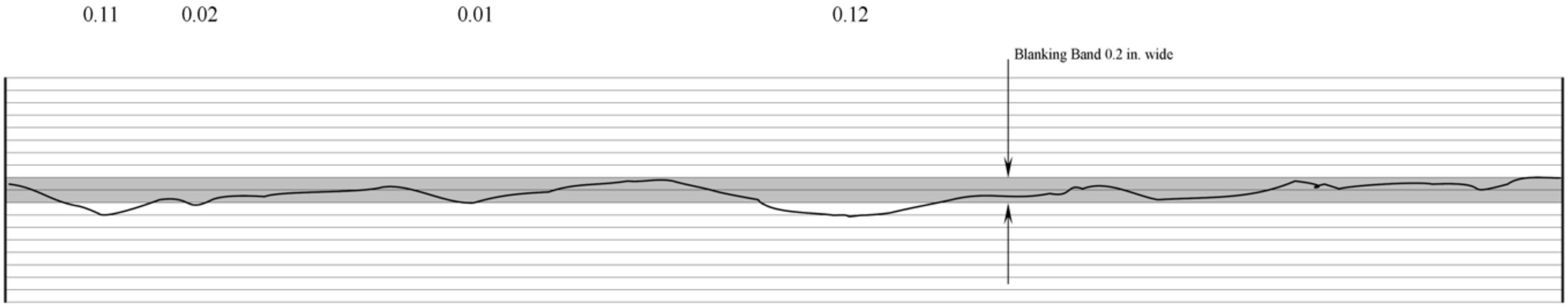
Figure 2: Balanced Blanking Band

Incorrect placement of blanking band for shifting profile

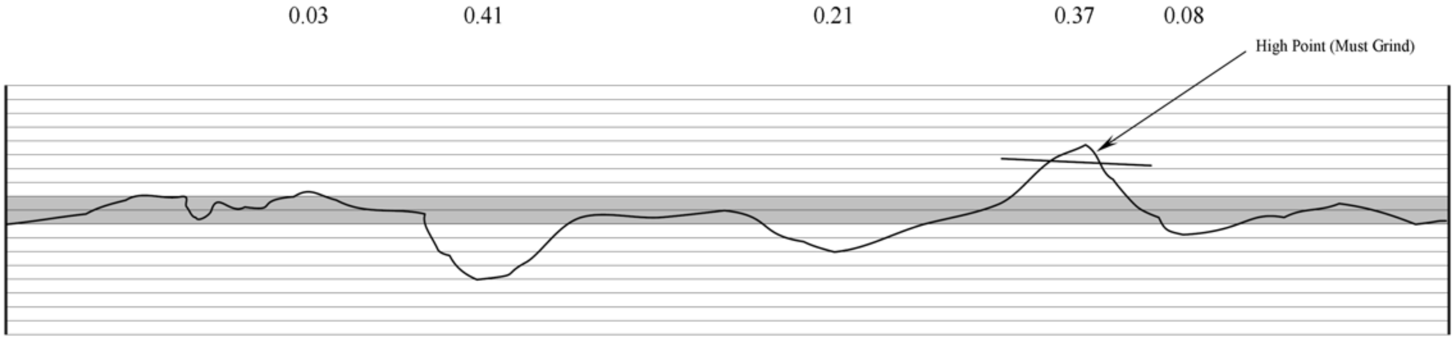
Figure 3: Correct placement of blanking band for shifting profile



Total measurement for this 0.1 mi section is 0.64 tenths of an in.



Total measurement for this 0.1 mi section is 0.26 tenths of an in.



Total measurement for this 0.071 mi section is 1.55 tenths of an in. Total count must be based on 0.1 mile section. .1/.071 X 1.1 = 1.55

Figure 4: Typical 0.1 (tenth) mi sections

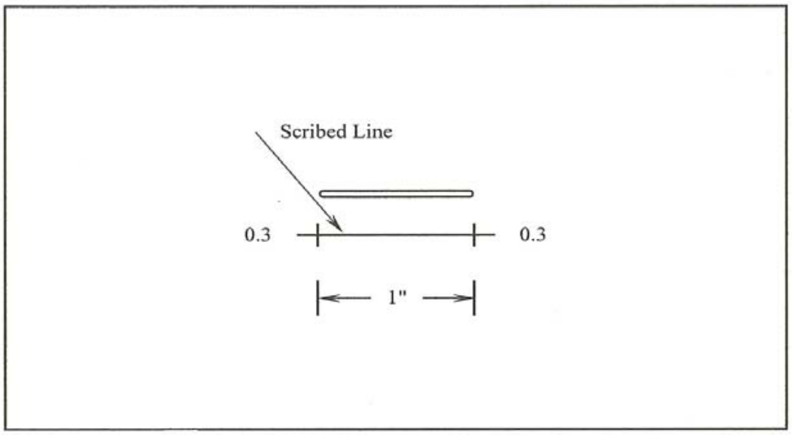
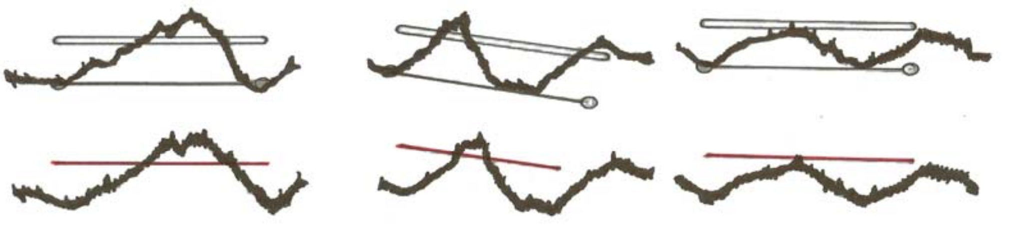


Figure 5: A typical 0.3 in. bump template



Baseline 25'

Baseline less than 25'

Height of peak is less 0.3"

Baseline more than 25′

Figure 6: Bump template positions for varying conditions

```
Profiler System V1.53
Licensed to: Joe Contractor
Date Paved: 6/01/08  6:00 AM
Date Tested: 6/01/08  2:00 PM
File C:\My Documents\3400
1 Seg 1 Stn: 620 + 00 to 625 + 28
Height Cal – 109 counts in 1.00 in
Distance Cal – 119 counts per ft
Filter (Moving Average, Width = 1.90, Gain = 1.000)
Scallop:
    minimum height                      0.01 in.
    minimum width (300:1)               2.00 ft
    resolution                          0.01 in.
    blanking band                       0.20 in.
    defect bump template height         0.40 in.
    defect bump template length         25.0 ft

                        Track 1
PRI (in./mi/0.1mi)   0.00
No Defects Found:  0.00
```

Figure 7: Parameters for a California type profilograph

Figure 8: California type profilograph

State of Nevada
Department of Transportation
Materials and Testing Division

METHOD OF TEST FOR BULK SPECIFIC GRAVITY (S.S.D.) AND ABSORPOTION OF COARSE AGGREGATE FOR CONCRETE

(FIELD METHOD)

SCOPE

This test method, which is a modification of AASHTO Designation T85, describes a rapid procedure used in the field for determining the bulk specific gravity (saturated surface dry condition) and absorption of coarse aggregate. The bulk specific gravity is the value desired for calculations in connection with portland cement concrete.

A. APPARATUS

1. A balance having a capacity of 20,000 grams and sensitive to 1 gram. A satisfactory balance is an "Ohaus" Metric Solution Balance.

2. A galvanized water pail of 12- to 14-quart (11.35 to 13.24 litres) sizes.

3. A suitable container for the immersion of the pail and sample in water. A 20-inch (508.0 mm) diameter garbage can about 24 inches (609.6 mm) high may be used.

4. A brass or galvanized rod about 3/16 inch (4.76 mm) in diameter with open hooks on each end. The rod should preferably be made in two detachable sections; the upper section is attached to the center of the balance pan and becomes part of the tare weight. This upper section is of such length that its lower end remains above the surface of the water in the container, and it is in a convenient position for attaching and removing the lower section from which the pail is suspended when weighing in water.

5. A bench or table to support the balance over the water container. Sufficient clearance between the table bottom and the top of the water container should be allowed to permit insertion of the pail into the water container. An opening shall be made in the bench to permit suspension of the hooked rod from the center of the balance pan.

6. A spoon, rod, or other suitable device for stirring and removing trapped air from the sample, when it is inundated in the pail. (The hand may be used if desired.)

7. A 3-square-yard (91.44 cm x 91.44 cm) piece of toweling.

B. PREPARATION OF SAMPLE

Select approximately a 4,000-gram sample representative of the coarse aggregate. If the sample is not visibly wet, cover with water at room temperature overnight.

C. PROCEDURE

1. Make all weighings to the nearest gram.

2. Water temperature in the container should be maintained between 65° and 75° F. (18.3° to 23.9° C.). Submerge the empty pail in the water container. Exercise care when immersing to see that no air is trapped under the pail. Adjust the water level in the container to intersect the straight portion of the lower section of the rod with the water surface. Adjust to this same water level (± 1 inch) (25.4 mm) for all future "in water" weighings. Weigh and record as weight in water of pail and rod. Remove pail and lower hooked rod from water container.

3. After the test sample has absorbed overnight, pour off all excess water. Care should be taken to avoid anv loss of aggregate particles.

4. Place the wet sample in the toweling, roll and pat to remove additional water. S.S.D. condition has been reached when all visible films of water are removed, although the surfaces of the particles may still appear to be damp. The larger fragments or particles may be individually wiped. Avoid as much as possible, evaporation of absorbed water during the operation of surface drying.

5. Place the sample (S.S.D.) on the balance and weigh immediately in air.

6. Remove the sample from the balance and place in the pail. Add enough water to the pail to completely inundate the sample. Stir the inundated sample with a spoon, rod or the hand in order to remove any air trapped between the aggregate particles.

7. Add enough water to almost fill the pail and attach the pail to the balance by means of the hook-ended rods. Lower and immerse the pail and sample into the water container and adjust the water level to within ± 1 inch (25.4 mm) of the same reference level as determined in paragraph 2 above. Exercise care when immersing to see that no air is trapped under the pail. Weigh and record as weight in water of the pail, rod and sample.

8. The weight in water of the sample is equal to the weight in water of the pail, rod and sample minus the weight in water of the pail and rod.

9. Pour sample into suitable drying pan, dry sample to constant weight, cool to room temperature, pour sample into balance pan, use suitable tare weight and weigh to nearest gram. Record as dry weight for calculating the percent absorption.

D. CALCULATIONS

Bulk Specific Gravity

1. Calculate the bulk specific gravity (saturated surface-dry basis) from the following formula:

   Bulk specific gravity (saturated surface-dry basis)=

$$\frac{Wa}{Wa - Ww}$$

   Where:

   Wa = Weight in grams, in air, of the sample in a saturated surface-dry condition, and

   Ww = Weight in grams, in water, of the sample in a saturated condition.

2. Duplicate determinations should check to within ± 0.02 from t.e average specific gravity.

Absorption:

3. Calculate the absorption from the following formula:

$$\text{Percent absorption} = \frac{Wa-A}{A} \times 100$$

   Where:

   A = Weight in grams of the sample in dry condition.

   Wa = Weight in grams, in air, of the sample in a saturated surface-dry condition.

4. Duplicate determinations should check to within ± 0.31 from the average percent absorption 95 percent of the time.

REFERENCE

AASHTO Designation T85
Test Method No. Calif. 224

Test Method Nev. T493D
November 1, 2007

State of Nevada
Department of Transportation
Materials Division

METHOD OF TEST FOR BULK SPECIFIC GRAVITY AND ABSORPTION OF FINE AGGREGATE

SCOPE

This test method describes the procedure used for determining the bulk specific gravity (saturated surface-dry condition) and absorption of fine aggregate.

APPARATUS

1. Balance, having a capacity of 12000 g and sensitive to 0.1 g.

2. Pycnometer, a volumetric flask of 500 mL capacity or a (1 L) 1 qt fruit jar fitted with a pycnometer top.

3. Mold, conical metal mold 40 ± 3 mm (1 1/2 ± 1/8 in.) inside diameter at the top, 90 ± 3 mm (3 1/2 ± 1/8 in.) inside diameter at the bottom and 75 ± 3 mm (3 ± 1/8 in.) in height.

4. Tamper, metal tamper having a mass of 340 ± 15 g and having a flat circular tamping face 25 ± 3 mm (1 ± 1/8 in.) in diameter.

5. Rubberized Cloth, approximately 0.9 x 0.9 m (3 x 3 ft).

6. Electric Fan (optional).

SAMPLING

Sampling shall be accomplished in accordance with Test Method Nev. T200.

PREPARATION OF SAMPLE

Obtain a representative sample of the fine aggregate, by quartering, weighing approximately 1200 g. Do not dry the fine aggregate prior to testing. Add at least 6 percent water to the fine aggregate, thoroughly mix, and permit to stand in a sealed container for 15 to 24 hours.

PROCEDURE

1. Record Weight (B) of the pycnometer filled to its calibration level with water between 18.3 and 23.9°C (65 and 75°F), to the nearest 0.1 g.

2. Partially fill the pycnometer with water. Water temperature in the pycnometer should be maintained between 18.3 and 23.9°C (65 and 75°F).

3. Decant excess water from the fine aggregate sample container, take care to avoid loss of fines. Spread the fine aggregate on a flat nonabsorbent surface (rubberized cloth) and stir frequently to ensure homogeneous drying. If desired, mechanical aids such as tumbling or stirring, or an electric fan may be employed to assist in achieving the saturated surface-dry condition. As the fine aggregate begins to dry sufficiently, it may be necessary to work it with the hands in a rubbing motion to break up any conglomerations, lumps, or balls of material that develop. Continue this operation until the fine aggregate approaches a free-flowing condition. Follow the Cone Test for Surface Moisture, as shown below, to determine whether or not surface moisture is present on the fine aggregate particles. The first trial of the cone test will be performed at a moisture content above the saturated surface-dry condition. Continue drying with constant stirring, and if necessary, work the fine aggregate with a hand rubbing motion, and test at frequent intervals until the test indicates that a saturated surface-dry condition has been reached. If the first trial of the surface moisture test indicates that moisture is not present on the surface, it has been dried past the saturated surface-dry condition. In this case, thoroughly mix a few milliliters of water with the fine aggregate and permit it to stand in a sealed container for 30 minutes. Resume the process of drying and testing at frequent intervals, until a saturated surface-dry condition is achieved.

   Cone Test for Surface Moisture - Hold the mold firmly on a smooth nonabsorbent surface (rubberized cloth) with the large diameter down. Place a portion of the partially dried fine aggregate loosely in the mold by filling until overflow occurs and heaping additional fine aggregate above the top of the mold by holding it with the cupped fingers of the hand holding the mold. Lightly tamp the fine aggregate into the mold with 25 light drops of the tamper (cup fingers around the top edge of the mold to prevent damage to mold). Each drop should start about 5 mm (0.2 in.) above the top surface of the fine aggregate. The tamping force shall not be more than that applied by the weight of the tamping rod. Adjust the starting height to the new surface elevation after each drop and distribute the drops over the surface. Do not add additional fine aggregate after the tamping is completed. Remove loose sand from around the base and lift the mold vertically. If surface moisture is still present, the fine aggregate will retain the molded shape. When the fine aggregate slumps slightly, it indicates that it has reached a saturated surface-dry condition.

4. Remove one 500 ± 0.2 g portion of fine aggregate from the saturated surface-dry sample and dry to a constant weight as described in Test Method Nev. T112, cool to room temperature and record Weight of dry sample (A), to the nearest 0.1 g.

5. Immediately introduce into the pycnometer a 500 ± 0.2 g portion of the remaining saturated surface-dry fine aggregate as prepared above. Record the Weight of saturated surface-dry sample (S), to the nearest 0.1 g. Fill with additional water to approximately 90 percent of capacity. Manually roll, invert, and

agitate the pycnometer to eliminate all air bubbles (see Note 1). Fill the pycnometer to its calibrated level with water between 18.3 and 23.9°C (65 and 75°F).

Note 1: It normally takes about 15 to 20 minutes to eliminate air bubbles. Dipping the tip of a paper towel into the pycnometer has been found to be useful in dispersing the foam that sometimes builds up when eliminating the air bubbles, or adding a few drops of isopropyl alcohol after removal of air bubbles and just prior to bringing the water to its calibrated level, has also been found useful.

6. Record the Weight of the pycnometer with fine aggregate and water filled to calibration level (C), to the nearest 0.1 g.

CALCULATIONS

1. Calculate bulk specific gravity (saturated surface-dry basis) as follows:

   Bulk specific gravity (saturated surface-dry basis) = S / (B + S - C)

   A = Weight of dry sample

   B = Weight of pycnometer filled with water to calibration level

   C = Weight of pycnometer with fine aggregate and water filled to calibration level

   S = Weight of saturated surface-dry sample

2. Calculate the percentage of absorption as follows:

   Absorption, percent = [(S - A) / A] x 100

   A = Weight of dry sample

   S = Weight of saturated surface-dry sample

REPORT

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

Test Method Nev. T510A
Effective March 21, 2003

State of Nevada
Department of Transportation
Materials Division

METHOD FOR DETERMINATION OF DRY FILM THICKNESS OF EPOXY OR WATERBORNE PAVEMENT MARKING MATERIALS

SCOPE

This test method is an adaptation of ASTM D 1005-95, and covers the measurement of dried film thickness of pavement marking materials using hand-held micrometers.

APPARATUS

The measuring apparatus shall consist of a hand-held anvil type micrometer. The anvils of the micrometer shall be circular and approximately 1/4 in. (6 mm) in diameter, with flat bottoms. The micrometer shall have a resolution of at least 0.0001", 0.1 mil (0.0025 mm, 2.5 micron).

Test panel made of aluminum with dimensions of approximately 3" x 12" x 0.075" (75mm x 300mm x 2mm). Obtain the panels from the District Progress Labs.

Black permanent marker (Sharpie)

PROCEDURE

Follow the manufacturers recommendations for the initial setup and operation of the micrometer. Prior to making any measurements, verify the data display reads 0 when anvils are fully closed.

Using the marker, outline the area of the plate to be covered by striping material on the back of the test panel. Then mark and sequentially number 6 evenly spaced points in a grid pattern within the area enclosed by the outlined limits. Measure the plate thickness using the micrometer at each location and record the measured thickness value on the plate next to the corresponding numbered location.

Secure the aluminum test panel to the pavement just prior to the application of the striping material, perpendicular to the striping line at the designated sample location with the numbered points and thickness values facing down. Align the plate so the approximate area of material outlined above will match the actual application. Use duct tape to secure each end of the panel to the pavement, keeping the tape away from the area of the plate that will receive the paint.

Note: Paint thickness is determined on samples without reflective beads. Ensure that the striping vehicle operator sees the plate and stops the application of beads prior to passing over the test panel.

Once the striping applicator has passed and applied the striping material to the plate, allow the material to sufficiently dry so that the paint will not run or smear. Remove the test panel from the roadway. The panel should be placed in a location that allows the paint material to further dry and be protected from damage during transportation back to the field office or to the location where the thickness measurements will be taken.

MEASURING PROCEDURE

Using the micrometer, measure the thickness of the test panel and paint material at each of the 6 areas previously marked and measured. Record the results on the plate next to the corresponding point with the permanent marker. Subtract the two values recorded at each point and then average the results of each of the 6 locations to determine the overall paint thickness. Record the average overall paint thickness to the nearest mil or micron on Form # 040-021.

Conversion: 1 mil = 0.001 inch
1 micron = 0.001 mm

Example:	Plate Thickness:	Micrometer Reading = 0.07670 in
	Paint and Plate Thickness:	Micrometer Reading = 0.09570 in

Paint and Plate Thickness – Plate Thickness = 0.019 in

0.019in / 0.001inches per mil = 19 mil

Paint Thickness = 19 mil**

** Average with the 5 remaining values to determine reported value for paint thickness.

Refer to Section 632 of the contract specifications for minimum thickness values.

Test Method Nev. T511A
April 1, 2005

State of Nevada
Department of Transportation
Materials Division

METHOD OF TEST FOR DETERMINING RETROREFLECTIVE PROPERTIES FOR PAVEMENT STRIPING

SCOPE

This method describes the procedure used for determining the minimum retroreflective properties for temporary and permanent applied waterborne, epoxy, and polyurea painted pavement striping.

EQUIPMENT

Use an approved retroreflectometer from NDOT's Qualified Products List (QPL). Retroreflectometers need to be calibrated and serviced by the manufacturer every two years and calibrated prior to each use as required by manufacturers recommendations.

METHOD OF MEASUREMENT

1. Prior to taking retroreflectivity readings, the roadway shall be dry and free from any debris.

2. Take retroreflective measurements one to two weeks after installation of pavement striping.

3. Measurement locations will be randomly determined by the Engineer.

4. Test frequencies will be in accordance with the "Testing Frequency Schedule - **Minimum** Required Samples and Tests - Project".

5. All measurements will be taken in the direction of traffic flow, except on the centerline of two-lane roads where the required number of measurements will be made in each direction. Both single and double lines are to be measured and the acceptance criteria shall be followed for each line in both directions.

6. One test location is defined as taking the average of five readings, approximately 3 m (10 ft.) apart. If the average of five readings meet specifications, then record the average on Form No. 040-041 (Retroreflectivity Measurements). If the average of the five readings is below the required retroreflectivity requirement, take the average of three additional readings, which are outside of the original five readings, to verify retroreflectivity failure. If the average of the additional three readings still do no meet specification requirements, then record the average of the five original readings and the average of the three additional readings on Form No. 040-041 (Retroreflectivity Measurements). This procedure will complete one test location.

   For example, if you have a two-lane roadway, there would be three stripes total - two edge stripes, and a centerline stripe. (See Standard Specifications and Special Provisions for project retroreflectivity requirements).

REPORTING:

1. Form No. 040-041
2. Date Tested
3. Date and Time of Pavement Marking Application
4. Station of Test
5. Description of Equipment Used
6. Equipment Calibration / Service Date
7. Material Description - epoxy, waterborne, polyurea, etc.
8. Line Type - skip, solid, double solid, skip w/solid, etc.
9. Color of Stripe
10. Retroreflectivity Measurements
11. Specification Requirement

NOTES:

1. One test location per lane kilometer or three test locations per lane mile per stripe are required.
2. Centerline stripes must be tested in each direction as results may vary.
3. Review Retroreflectometer Operating Manual to familiarize yourself with the equipment that will be used.

Test Method Nev. T512A
November 1, 2007

State of Nevada
Department of Transportation
Materials Division

METHOD OF TEST FOR PAVEMENT MARKING FILM ADHESION

SCOPE

This method describes the procedure used for determining the minimum adhesion for pavement marking film.

APPARATUS

1. Scale, 13.6 kg (30 lb) minimum capacity, accurate to the nearest .02 kg (oz).
2. Clamp, any suitable device that will attach to the scale and sufficiently clamp and hold the pavement marking film firmly in place.

PROCEDURE

1. Prior to taking adhesion measurements, the roadway shall be dry and free from any debris.
2. Adhesion measurements will be taken within the time limits specified in the Standard Specifications and Special Provisions.
3. Measurement locations will be randomly determined by the Engineer.
4. Test frequencies will be in accordance with the "Testing Frequency Schedule - Minimum Required Samples and Tests - Project".
5. Both single and double lines are to be measured and the acceptance criteria shall be followed for each line. Miscellaneous markings such as arrows, onlys, crosswalks, stopbars, etc. will be at the discretion of the Engineer.
6. Randomly select area to be measured. Avoid testing the first and last 100 mm (4 in.) of any stripe. Cut a 25 mm (1 in.) strip transversely through the material. Lift approximately 25 mm (1 in.) of the strip material from the substrata to enable gripping in the clamp, which is attached to a spring-loaded scale (see Figures 1 and 2). Once the scale and clamp are attached to the end of the 25 mm (1 in.) strip, continue to pull until the remaining test strip begins to separate from the substrata. The material shall resist the minimum pull applied at an angle of 90° relative to the surface of the adhered marking film strip. (Refer to Section 634 of the Standard Specifications and Special Provisions for minimum adhesion requirements). If the material does not meet the minimum requirements, randomly select another location, which is within the original area represented by that test, and repeat

this procedure. If the second test passes, the area represented by that test will be accepted. If the second test fails, the area represented fails to meet minimum requirements.

CALCULATIONS

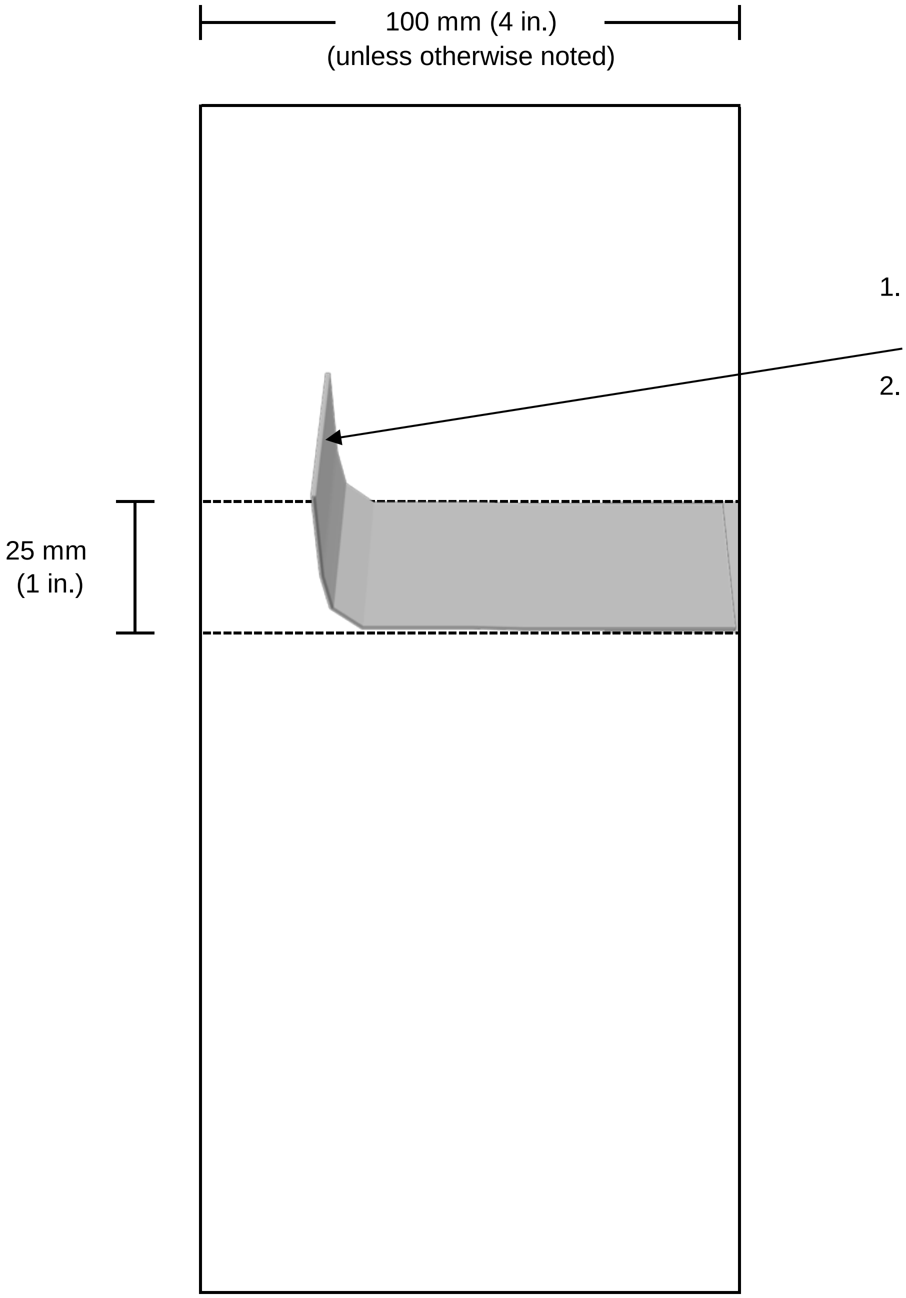
If using a metric scale in kilograms, the following formula shall apply:

kilograms x 9.81 = N

REPORT

Report adhesion results to the nearest N (lb)

Typical 100 mm (4 in.) Pavement Marking Film Application



NOTES:

1. Attach clamp and spring-loaded scale
2. Pull up at 90° angle from road surface

Figure 1


Hanging Scale
160393
0 0
CAPACITY : 33lb.
GRADUATION : 1oz.
OFF
ON
TARE
EXTECH
INSTRUMENTS

Figure 2

Test Method Nev. T723F
April 20, 2012

State of Nevada
Department of Transportation
Materials Division

METHOD OF TEST FOR SAMPLING BITUMINOUS MATERIAL

SCOPE

This method applies to sampling bituminous materials at the point of manufacture, storage, or delivery. Samples may be taken from tanks, vehicles, or containers used for storage or shipping of bituminous materials.

SIGNIFICANCE

Sampling is as important as testing and every precaution shall be taken to obtain samples that will show the true nature and condition of the materials. Samples are taken to represent an average of the bulk of the materials sampled.

SELECTION OF SAMPLES

Samples shall be taken in accordance with Section 106.04 of the Standard Specifications.

SIZE OF SAMPLES

The sample size of asphalt cement and liquid asphalt refinery samples submitted for mix designs shall be as specified in Section 401.02.02 of the Standard Specifications. The sample size of emulsified asphalt refinery samples submitted for pre-approval shall be 3.75 L (1 gal). The sample size of asphalt cement, liquid asphalt, and emulsion samples submitted for acceptance testing shall be 1 L (1 qt), unless otherwise specified. Sample containers shall be filled to within 25 to 50 mm (1 to 2 in.) of the top of the container.

CONTAINERS

1. Asphalt Cements - Wide mouth metal paint-can type containers.

2. Liquid Asphalts (MC-70, MC-250, MC-800, SC-800, etc.) - Metal cans with screw caps having an inside diameter of approximately 45 mm (1 3/4 in.).

3. Emulsified Asphalts - Wide mouth plastic bottles with screw caps.

PROTECTION AND PRESERVATION OF SAMPLES

1. All sample containers shall be new, clean and dry. Sample containers shall not be washed or rinsed with solvents. Sample containers shall not be wiped with an oily or solvent-saturated cloth. Do not use sample containers if they contain evidence of solder flux.

2. Immediately after filling, the lid shall be tightly affixed to the container. Care shall be taken to prevent contamination of samples by solvents, other types of bituminous materials, water, dust, or any other substance foreign to the material being sampled.

3. The filled sample container shall not be submerged in solvent, nor shall it be wiped with a solvent-saturated cloth. If cleaning is necessary, use a clean dry cloth.

4. Samples of emulsions shall be protected from freezing.

5. Transferring samples from one container to another shall not be permitted except where required by the sampling procedure. Characteristics of materials could be altered during transfer. Contamination is also a possibility.

6. After filling, installing the lids, and cleaning the containers (if necessary), the transmittal shall be completely and legibly filled out, signed, and affixed to the sample container. All samples will use the Transmittal for Asphalt Samples, NDOT Form No. 020-016. Masking tape shall be used to affix the transmittal to the container. Hot samples should be allowed to cool sufficiently before affixing the transmittal so that the tape will not melt to the can. In case of inclement weather, the transmittal will be sealed in a plastic envelope for protection. Strapping (fiber) tape, scotch tape, or duct tape should not be used for this purpose as they can damage the transmittal upon removal from the container.

7. Samples of all bituminous materials shall be forwarded to the Materials Division for testing as soon as possible.

SAMPLING PROCEDURES

Sampling will be performed by the contractor, asphalt supplier, shipper, or their representative. NDOT personnel should observe the procedure to ensure conformance to this specification. Sample containers will be provided by NDOT.

Sampling from a sample valve in a storage tank, vehicle tank, railroad tank car, or distributor truck:

1. Sample valves shall conform to AASHTO T 40.

2. Sample valves shall provide a sample from the approximate midpoint of the load.

3. Before the sample is taken, approximately 4 L (1 gal) of material will be drawn from the valve and discarded in order to ensure a representative sample.

Sampling from transfer lines:

1. Sampling will be accomplished by bleeding through a sample valve or drain-cock in the transfer line.

2. Sample valves shall conform to AASHTO T 40.

3. Before the sample is taken, approximately 4 L (1 gal) of material will be drawn from the valve and discarded in order to ensure a representative sample.

4. If sampling a vehicle tank during the unloading process, take the sample after one-third of the load has been removed and before two-thirds of the load has been removed.

5. A detachable fitting, containing a sampling valve, may be used on the truck outlet in front of the discharge. When the detachable fitting is used continuously for sampling the same product, it shall be allowed to drain between shipments while being protected from dust or accumulation of dirt, but shall not be cleaned with solvents. Threads of the collar and opposite end of the fitting shall be wiped clean with a cloth while the metal is warm and the bituminous material is still in a liquid condition. When the detachable fitting is used alternately for the sampling of different products, it shall be washed thoroughly with an appropriate solvent, followed by a second wash with an appropriate volatile solvent. The volatile solvent shall be removed by a warm air current or by drying in an oven before the next sampling.

Sampling from a bituminous hot-plant:

1. Sampling will be accomplished by bleeding through a sample valve or drain-cock in the transfer line.

2. Sample valves shall conform to AASHTO T 40.

3. Before the sample is taken, approximately 4 L (1 gal) of material will be drawn from the valve and discarded in order to ensure a representative sample.

4. Sampling will conform to the requirements of Section 106.04 of the Standard Specifications.

Sampling by the dip method:

1. This method is not suitable for asphalt cements.

2. Samples will be taken with an NDOT approved sampling device.

3. Samples shall be taken from the approximate midpoint of the load by lowering the approved sampling device into the bituminous material and opening the device at the appropriate level.

4. After sampling, the bituminous material will be transferred to an appropriate container as specified in the CONTAINERS section above.

5. The contractor, supplier, shipper, or their representative shall provide, handle and clean the sampling device. The Department will accept no responsibility for the cleanliness of the sampling device or for the representative nature of the sample.

6. A separate sampling device shall be provided for each delivery truck or trailer that is not equipped with a sampling valve.

7. Waste material, solvents, and residues from cleaning sampling devices shall not be deposited on state property.

Sampling by the spray bar method:

1. This method may be used for emulsions and liquid asphalts when it is not feasible to sample with a sample valve.

2. Samples shall be taken from a nozzle in the spray bar following complete circulation of the material. Take the sample after one-third of the load has been removed and before two-thirds of the load has been removed.

Test Method Nev. T750D
March 27, 2013

State of Nevada
Department of Transportation
Materials Division

METHOD OF TEST FOR RELATIVE COMPACTION OF PLANTMIX BITUMINOUS SURFACE AND COLD IN PLACE RECYCLE USING CONTROL STRIPS AND TEST SECTIONS WITH A NUCLEAR DENSITY GAUGE

SCOPE

This test method is designed to measure the degree of compaction of plantmix surface using a portable nuclear density testing device. Results may be obtained rapidly during the compaction process, allowing time for additional compactive effort if required.

APPARATUS

1. Thin Layer Density Gauge, Troxler Model 4640-B or 3450.
2. Magnesium reference block.
3. Air gap spacer.

STANDARDIZATION

1. Warm up period: Turn the thin layer density gauge on and warm up for ten minutes. This allows the regulators and deflectors to stabilize.
2. At the start of each shift, standardize the thin layer density gauge to check equipment operation. This procedure can also be used as an operational check whenever test measurements are suspect.
3. The site chosen for standardization should remain the same throughout the contract. Outline the magnesium reference block with keil (lumber crayon) to ensure the same location is used.
4. Place the magnesium reference block on a solid surface having a density of 1600 kg/m^3 (100 lb/ft^3) or greater, preferably a plantmix or concrete surface approximately 10 cm (4 in.) thick. Ensure that the magnesium reference block is level and does not rock back and forth. This location should be at least 3 m (10 ft) away from any large object such as a vehicle, field lab, wall or any water source and at least 9 m (30 ft) from any other nuclear gauge**.**

5. Place the air gap spacer on the magnesium reference block and then place the thin layer density gauge on top of the air gap spacer. The handle end of the gauge should rest over the two posts on the air gap spacer. Verify that the "standard mode" is in multi-standard mode.

6. With the lock attached and the handle in the safe position, press the "STANDARD" key on the keypad. The screen will display "Standard Count XXXX XXXX Take a new standard count?" Press the "YES" key. The screen will then show "Place gauge on spacer and both on block, put the rod in safe position, press enter." Check to make sure the thin layer density gauge does not rock, then press the "START/ENTER" key. The thin layer density gauge will begin taking a four minute standard count.

7. When counting stops, at the end of the four minutes, screen will display "Standard # 1 XXXX X.XX% Pass Standard # 2 XXXX X.XX% Pass Use new standards?" If it shows a PASS/PASS, record the Standard #1 and Standard #2 in the gauge log book. Press the "YES" key. If you receive a PASS/PASS to the right of the percentages, it indicates that the standard counts are within the 1% maximum allowed variation for System 1 reference standard counts and 1.2% maximum allowed variation for System 2 standard counts.

8. If the standard counts for System 1 or System 2 fail, the screen will display "Do you want to use the new STD?" Press the "YES" key. Check the thin layer density gauge to make sure that the magnesium reference block does not rock, no other gauges are in the area and that the standard mode is in multi-standard mode. Then take another standard count.

9. It may take up to five standard counts before obtaining a PASS/PASS result. In the event that a PASS/PASS result is not obtainable, contact the Independent Assurance Lab for further assistance

CONTROL STRIP

Control strips are to be rolled with specified rolling equipment until "no appreciable gain of 1.0 lb or less in density is obtained by additional roller coverage's". Do not allow excessive rolling as this may result in cracking or other damage to the mat. In order to determine the number of roller passes required, density tests are made after each pass (one pass equals down and back) of the rollers at three (3) preselected locations. The average density for the three (3) locations is plotted on a chart of density versus number of roller passes. Rolling is discontinued when the curve levels off, and/or by an appreciable gain of 1.0 lb. Tests are then taken at seven (7) additional locations throughout the control strip. The average density at these ten test locations is the Mean Control Strip Density.

1. Tests during rolling

   a. In order to assure that material throughout the entire control strip is effectively represented, divide the control strip (350 m^2 (400 yd^2)) into three (3) subsections of equal length, taking density tests diagonally across the mat. Select the site for testing. Mark the outline of the gauge on the material being compacted so that the gauge may be returned to the same spot after each roller pass (one pass equals down and back). Take the one-minute density test and record the results on NDOT form 040-048, TESTS DURING ROLLING. Rotate the gauge 180 degrees about its center and take the second one-minute density test and record the result on NDOT form 040-048, TESTS

DURING ROLLING. After each pass of the roller (at the three site locations), average the three "Average Test Site Density" values, and plot on NDOT form 040-048, Density Plot. See Figure 2 for an example. Repeat this process until "no appreciable gain of 1.0 lb or less in density is obtained by additional roller coverage". Do not allow excessive rolling as this may result in cracking or other damage to the mat. Repeat this process for each roller that will be utilized in this control strip.

2. After the rolling pattern has been established.

   a. Take seven additional Average Test Site Density tests at various locations chosen at random throughout the established control strip. Average these seven Average Test Site Density results together with the three Average Test Site Density tests taken after the maximum number of roller passes, and record this average as the Mean Control Strip Density on NDOT form 040-048. Refer to Figure 3 for an example.

   b. This control strip "Mean Control Strip Density" shall be used for the next ten test sections unless one of the following occurs:

      1. A new control strip shall be constructed, at the beginning of work on each lift of each roadway course, every twenty test sections, if results from compaction tests become erratic or significant change in composition of material.

      2. The maximum number of roller passes shall be noted on NDOT form 040-048 under Rolling Pattern, for each control strip. See Figure 3 for an example.

PROCEDURE (3450 or 4640-B SERIES GAUGES)

1. Determine the target density per Test Method Nev. T750 and enter the value into the thin layer density gauge. After completion of the desired roller coverage, a series of material density tests are to be taken at locations according to the following:

2. Test Sections

   a. Divide the test section into five subsections of equal length. Four one minute mat density tests are to be taken for each subsection. If a joint or joints are present, two or four one minute joint density tests are to be taken. Refer to the Standard Specifications for the required size of the test sections.

   The exact station at which the mat densities will be taken, is determined from the table of random numbers by multiplying a random number (column A) times the length of each subsection, rounded to the nearest 10 m (25 ft).

   The exact distance in from the edge of the mat where the mat densities will be taken is determined from the table of random numbers (column B) times the width of the mat, rounded to the nearest 0.3 m (1 ft) for the distance in from the edge of the mat. NOTE: Do not take the mat density test any closer than 0.3 m (1 ft) from the edge of the mat.

The first four (4) one minute tests (rotated 90 degrees) are to be taken in each subsection. If the mat was inlayed, perform two (2) one minute joint tests on each joint within 0.15 m (6 in.) of the joint (rotated 180 degrees) at the same station as determined in column A.

b. Random numbers are always used in a series of ten, five from column A and five from column Any random number block may be used as long as a different block is selected for each new test section. The same random number block shall not be used in the same shift.

EX. Random Number Block = 15 Width of the entire mat = 13.8 ft
Beginning Station “X” 413 + 12 Ending Station “X” 350 + 95

(“X” 413 + 12) – (“X” 350 + 95) = 6217 ft

6217 ft (length of test section) / 5 (total subsections) = 1243.4 ft (length of each subsection)

Station – Length of Subsection = Station to Station for each Subsection

(“X” 413 + 12.0) – 1243.4 = “X” 400 + 68.6
(“X” 400 + 68.6) – 1243.4 = “X” 388 + 25.2
(“X” 388 + 25.2) – 1243.4 = “X” 375 + 81.8
(“X” 375 + 81.8) – 1243.4 = “X” 363 + 38.4
(“X” 363 + 38.4) – 1243.4 = “X” 350 + 95

Column A	x	Subsection Length	=	Distance for each Subsection Test Station
.698		1243.4		867.9
.796		1243.4		989.7
.348		1243.4		432.7
.358		1243.4		445.1
.698		1243.4		867.9

(“X” 413+12.0) – 867.9 = “X” 404+44.1 rounded to nearest 10 m (25 ft) = “X” 404+50
(“X” 400+68.6) – 989.7 = “X” 390+78.9 rounded to nearest 10 m (25 ft) = “X” 390+75
(“X” 388+25.2) – 432.7 = “X” 383+92.5 rounded to nearest 10 m (25 ft) = “X” 384+00
(“X” 375+81.8) – 445.1 = “X” 371+36.7 rounded to nearest 10 m (25 ft) = “X” 371+25
(“X” 363+38.4) – 867.9 = “X” 354+70.5 rounded to nearest 10 m (25 ft) = “X” 354+75

Column B	x Mat Width	= Distance in from edge of Mat	= Rounded to nearest .5 m (1 ft)
.683	13.8	9.4	9.0
.996	13.8	13.7	13.0 (mat is only 13.8)
.743	13.8	10.3	10.0
.595	13.8	8.2	8.0
.539	13.8	7.4	7.0

1st density test is at “X” 404 + 50, 9.0 ft in from edge of mat
2nd density test is at “X” 390 + 75, 13.0 ft in from edge of mat
3rd density test is at “X” 384 + 00, 10.0 ft in from edge of mat
4th density test is at “X” 371 + 25, 8.0 ft in from edge of mat
5th density test is at “X” 354 + 75, 7.0 ft in from edge of mat

3. Density Testing

a. Program the target density from Test Method Nev. T324 or T750 into the thin layer density gauge. Input the target density for the Marshall and Voidless parameters into the thin layer density gauge. Select the “MA/VOIDLESS” key. The screen will display “MA: XXX.X pcf VD: XXX.X Do you want to change?” Press the “YES” key. Screen will display “Marshall XXX.X pcf " Input the target density and press the “START/ENTER” key. Screen will display “Voidless Density XXX.X pcf.” Input the same target density and press the “START/ENTER” key. Thin layer density gauge will then go back to the main screen.

b. Select the proper depth by pressing the “THICK” key. The screen will display “Layer Thickness: X.XX in. Input and Press Enter.” NOTE: Set the depth for the thin layer density gauge at 6 mm (0.25 in.) less than what is being placed. (EX. Paving 3 in. set the thin layer density gauge thickness at 2.75 in.) Thin layer density gauge will then go back to the main screen.

c. Set the count time for 1 minute by pressing the “TIME” key. The screen will show “Count Time XX min. Do you want to change?” Press the “YES” key. The screen will show “Sel: 1 – 0.5 min. 2 – 1 min. 3 – 2 min. 4 – 4 min.” Press 2 for the 1 minute count time. Thin layer density gauge will then go back to the main screen. The 1 minute test is the only “TIME” allowed for density testing.

d. Do not utilize the “Average” function, verify that the average function is set at 1. The average of the 4 tests shall be hand calculated.

e. At each predetermined test site, place the thin layer density gauge on the mat. Check for rocking by placing a hand on opposite corners of the base. Outline the base of the thin layer density gauge with a piece of keil (lumber crayon). Place the source rod in the “Measure” position and press the “START/ENTER” key. At the end of the 1 minute count time the thin layer density gauge will display“Dens: X.X PCF %MA: X.XX% 100 - %MA: XX.XX% %VOID: X.XX”. Write the density down on NDOT form 040-017, rotate the thin layer density gauge 90 degrees about the center of the thin layer density gauge and take another one minute density test at this location, refer to Figure 1 for thin layer density gauge positioning. Repeat this procedure for four (4), one minute density tests at this one test location.

f. Record each one minute density test and hand calculate the average of the four (4) tests on NDOT form 040-017. NOTE: Do NOT use the average mode in the thin layer density gauge.

g. The average of the four (4) density tests will constitute one test site density.

h. Repeat the above process at each of the 5 predetermined test site locations within the test section.

PERCENT COMPACTION

1. Percent compaction of an individual test site or small test section:

   a. $$\text{\% Relative Compaction} = \frac{\text{Average Density}}{\text{Target Density}}$$

   b. Record the percent relative compaction to the nearest whole percent.

2. Take the average of the five (5) corrected densities (mean test section densities) and compute the Mean Percent Relative Compaction as follows:

   a. $$\text{Mean Percent Relative Compaction} = \frac{\text{Mean Test Section Density}}{\text{Target Density}}$$

   b. Record the Mean Percent Relative Compaction to the nearest whole percent.

3. Refer to Standard Specifications for the minimum and maximum density requirements.

ADDITIONAL ROLLING PROCEDURES

1. If an individual test either on the mat or on a joint does not meet the required minimum specifications for compaction, additional rolling may be required. After additional rolling, take another test by testing at a single location chosen at random within the same subsection (This is not considered a re-test, since there are no re-tests on plantmix or cold-recycle. The second test will be the one documented for the complete test section). Note: Any changes from the original compaction must be documented under remarks.

2. If the mean test section compaction for the mat does not meet the required minimum specifications for compaction, additional rolling may be required on the entire test section. After additional rolling, take a series of five (5) tests using a new random block number, see Figure 2. (This is not considered a re-test, since there are no re-tests on plantmix or cold-recycle. If the section continues to fail a new control strip may have to be established). Note: Any changes from the original compaction must be documented under remarks.

3. If the compactive effort still gives a failing test, joint test or test section, the Resident Engineer must indicate under the remarks on NDOT form 040-017 what necessary steps are to place if any pertaining to the failure in question.

TABLE OF RANDOM NUMBERS

A	B	A	B	A	B	A	B	A	B
1		2		3		4		5	
.576	.730	.430	.754	.271	.870	.732	.721	.998	.239
.892	.948	.858	.025	.935	.114	.153	.508	.749	.291
.669	.726	.501	.402	.231	.305	.009	.420	.517	.858
.609	.482	.809	.140	.396	.025	.937	.310	.253	.761
.971	.824	.902	.470	.997	.392	.892	.957	.640	.463
6		7		8		9		10	
.053	.899	.554	.627	.427	.760	.470	.040	.904	.993
.810	.159	.225	.163	.549	.405	.285	.542	.231	.919
.081	.277	.035	.039	.860	.507	.081	.538	.986	.501
.982	.468	.334	.921	.690	.806	.879	.414	.106	.031
.095	.801	.576	.417	.251	.884	.522	.235	.398	.222
11		12		13		14		15	
.509	.025	.794	.850	.917	.887	.751	.608	.698	.683
.371	.059	.164	.838	.289	.169	.569	.977	.796	.996
.165	.996	.356	.375	.654	.939	.815	.592	.348	.743
.477	.535	.337	.155	.767	.187	.579	.787	.358	.595
.788	.101	.434	.638	.021	.894	.324	.871	.698	.539
16		17		18		19		20	
.566	.815	.622	.548	.947	.169	.317	.472	.864	.466
.901	.342	.873	.964	.942	.985	.123	.086	.335	.212
.470	.682	.412	.064	.150	.962	.925	.355	.909	.019
.068	.242	.667	.356	.195	.313	.396	.460	.740	.247
.874	.420	.127	.284	.448	.215	.833	.652	.601	.326
21		22		23		24		25	
.897	.877	.209	.862	.428	.117	.100	.259	.425	.284
.875	.969	.109	.843	.759	.239	.890	.317	.428	.802
.190	.696	.757	.283	.666	.491	.523	.665	.919	.146
.341	.688	.587	.908	.865	.333	.928	.404	.892	.696
.846	.355	.831	.218	.945	.364	.673	.305	.195	.887
26		27		28		29		30	
.882	.227	.552	.077	.454	.731	.716	.265	.058	.075
.464	.658	.629	.269	.069	.998	.917	.217	.220	.659
.123	.791	.503	.447	.659	.463	.994	.307	.631	.422
.116	.120	.721	.137	.263	.176	.798	.879	.432	.391
.836	.206	.914	.574	.870	.390	.104	.755	.082	.939
31		32		33		34		35	
.636	.195	.614	.486	.629	.663	.619	.007	.296	.456
.630	.673	.665	.666	.399	.592	.441	.649	.270	.612
.804	.112	.331	.606	.551	.928	.830	.841	.602	.183
.360	.193	.181	.399	.564	.772	.890	.062	.919	.875
.183	.651	.157	.150	.800	.875	.205	.446	.648	.685

FIGURE 1

Test Method Nev. T759H
September 9, 2011

State of Nevada
Department of Transportation
Materials Division

METHOD OF TEST FOR EMULSIFIED ASPHALT

Follow AASHTO T 59 in its entirety with the following exceptions:

SAMPLE CONDITIONING FOR TESTING

Replace this section with the following:

> All emulsions with viscosity requirements of 50ºC (122ºF) should be heated to 50 ± 3ºC (122 ± 5ºF) in the original sample container in an oven or water bath set at a temperature not exceeding 71 ± 3ºC (160 ± 5ºF). The sample containers should be tightly sealed, especially if testing solvent-based emulsions. Open the containers slowly to relieve pressure. After the sample reaches 50 ± 3ºC (122 ± 5ºF), stir the sample to achieve homogeneity. Samples of solvent-based emulsions, such as CMS-2, CMS-2h and CMS-2s, should not be maintained at a temperature of 50 ± 3º (122 ± 5ºF) for more than three hours.

RESIDUE AND OIL DISTILLATE BY DISTILLATION - PROCEDURE

Add to this section the following:

> Polymer modified emulsions will not be sieved prior to pouring into the test molds and containers.
>
> It may not be possible to determine the volume of the oil distillate to the nearest 1/2 mL due to the lack of a clear line of demarcation between the water, emulsifier and the oil distillate. In this case, seal the graduated cylinder and place it in a freezer at a temperature of –18 ± 3ºC (0 ± 5ºF) until separation between water and oil is established, but no more than three hours. Afterwards, allow the sample to thaw completely in the graduated cylinder and then record the oil distillate volume.

EMULSIFIED ASPHALT RESIDUE BY EVAPORATION - APPARATUS

Replace the beakers and the glass rods in this section with the following:

> Containers, 355 mL (12 oz) covered cylindrical seamless metal containers, with an approximate diameter of 86 mm (3 3/8 in.) and depth of 57 mm (2 1/4 in.).
>
> Glass Rods, with flame-polished ends, having an approximate diameter of 6.4 mm (1/4 in.) and length of 152.4 (6 in.) for use with the 355 mL (12 oz) metal containers.

RESIDUE BY EVAPORATION - PROCEDURE

Replace this section with the following:

Determine the mass of each container with a glass rod and cover to the nearest 0.1 g. Pour 50 ± 0.1 g of thoroughly mixed, emulsified asphalt into each of three containers. Place the containers containing the rods and sample in the oven, the temperature of which has been adjusted to 163 ± 2.8ºC (325 ± 5ºF), for two hours. The containers shall be loosely covered to avoid loss of material. At the end of this period remove each container and stir the residue thoroughly. Replace the containers in the oven for one hour and then remove the containers from the oven. Allow the containers to cool to room temperature. Determine the mass of each container, with the rods and covers.

When tests on the residue from the emulsion are required, replace the containers in the oven until the asphalt residue is sufficiently fluid to pour. Pour the residue into suitable containers and molds for making such tests as desired. If there is foreign matter in the residue, the material shall be poured through a No. 50 (300 μm) sieve prior to pouring into the test molds and containers. Polymer modified emulsions will not be sieved.

Note: Care must be taken to prevent loss of asphalt from the container through foaming or spattering or both.

Note: As the method for residue by evaporation tends to give an asphaltic residue lower in penetration and ductility than the distillation method, material may be accepted but shall not be rejected as failing to meet specifications on data obtained by evaporation. If residue from evaporation fails to meet the requirements for properties specified for residue from distillation, tests shall be rerun using the distillation method.

RESIDUE BY EVAPORATION - CALCULATION AND REPORT

Replace this section with the following:

Calculate the percentage of residue on each container as follows:

$$\text{Residue, percent} = 2(M_{brr} - M_{br})$$

where:

M_{brr} = mass of container, rod, cover and residue, g, and

M_{br} = tare mass of container, rod, and cover, g.

Report the percentage of residue by evaporation as the average of the three results.

PARTICLE CHARGE OF CATIONIC EMULSIFIED ASPHALTS - PROCEDURE

Replace the section specifying sample conditioning procedure with the following:

> Heat the emulsion to be tested to 50 ± 3ºC (122 ± 5ºF) in an oven or water bath set at a temperature not exceeding 71 ± 3ºC (160 ± 5ºF). Stir the emulsion thoroughly to ensure uniformity of temperature.

VISCOSITY (SAYBOLT FUROL) - APPARATUS

Replace the specification for sieve with the following:

> Sieve, 850 µm (No. 20) sieve of wire cloth, with a diameter of 1 1/2 ± 1/8 in., framed to fit into the top of the viscometer tube.

Add the following to the specification for thermometers:

> An equivalent thermometric device that has been calibrated in accordance with ASTM E 220 may be used. ASTM mercury thermometers shall be used for referee testing.

Replace the specification for water bath with the following:

> Oven or Water Bath capable of maintaining temperatures to 71 ± 3ºC (160 ± 5ºF).

VISCOSITY (SAYBOLT FUROL) - PROCEDURE

Replace the procedure for testing at 50ºC (122°F) with the following:

> Test at 50ºC (122ºF) - Clean and dry the viscometer and insert the cork. Heat the emulsion sample to a temperature of 51.4ºC to 60ºC (124.5ºF to 140ºF) in an oven or water bath set at a temperature not exceeding 71 ± 3ºC (160 ± 5ºF). The temperature is dependent on the material being tested and will be selected to achieve a temperature of approximately 50ºC (122ºF) after the emulsion has been poured into the viscometer. Stir the sample thoroughly without incorporating bubbles. Immediately pour the emulsion through the No. 20 sieve into the viscometer until it is above the overflow rim. Stir the emulsion in the viscometer at 60 rpm with the thermometer until the test temperature is attained, avoiding bubble formation. Adjust the bath temperature until the emulsion temperature remains constant for 1 minute at 50 ± 0.05ºC (122 ± 0.1ºF). Withdraw the thermometer. Quickly remove the excess emulsion from the gallery with a suction pipet. Determine the viscosity as prescribed in AASHTO T 72. Report the results to the nearest full second.
>
> During field testing, the material may be received at a temperature exceeding 60ºC (140ºF). In this case, the sample may be cooled by pouring approximately 100 mL into a 400 mL beaker, or other suitable container. Stir the emulsion with a wide circular motion at approximately 60 rpm with a thermometer

until a temperature of 51.4ºC to 60ºC (124.5ºF to 140ºF) is obtained.

If sufficient material to fill the viscometer tube will not pass through a single sieve due to excess particulates, the viscosity will be considered unobtainable by this procedure.

Note: The Saybolt Furol viscometer is satisfactory for testing emulsified asphalt when the viscosity is not less than 20 seconds.

DEMULSIBILITY- PROCEDURE AND CALCULATION

Change this section to use the percentage of residue by either distillation or evaporation as per Test Method Nev. T759 or Nev. T756.

SIEVE TEST - PROCEDURE

Change the mass of emulsified asphalt required for testing from 1000 g to 500 g.

SIEVE TEST - CALCULATION

Replace this section with the following:

Calculate the percentage of sample retained on the sieve as follows:

Sample retained, percent = $(M_{spr} - M_{sp}) / 5$

where:

M_{sp} = mass of sieve and pan, g, and

M_{spr} = mass of sieve, pan, and residue, g.

Test Method Nev. T761G
June 1, 2007

State of Nevada
Department of Transportation
Materials Division

METHOD OF TEST FOR DETERMINING BITUMEN RATIO OR ASPHALT CONTENT IN HOT MIX ASPHALT BY THE IGNITION METHOD

SCOPE

This test method covers the determination of bitumen ratio or asphalt content of hot mix asphalt (HMA) paving mixtures and pavement samples by ignition of the asphalt cement in a muffle furnace at 482°C or 538°C (900°F or 1000°F).

Aggregate obtained by this method may be used for sieve analysis using Test Method Nev. T206 (Field Method) or AASHTO T 30 in their entirety except for the following changes:

Test Method Nev. T206 (Field Method)

1. PREPARATION OF TEST SAMPLES, delete 2.
2. CALCULATIONS, delete NOTE adjusting gradation for mineral filler.

AASHTO T 30

1. Delete section entitled SAMPLE.
2. Delete first paragraph of section entitled PROCEDURE.

REFERENCED DOCUMENTS

Test Method Nev. T200 - Standard Methods of Sampling Stone, Gravel, Sand, and Paving Mixtures for use as Highway Materials (Field Method)

Test Method Nev. T206 - Method of Test for Sieve Analysis of Coarse and Fine Aggregate (Field Method)

Test Method Nev. T306 - Method of Determining Moisture Content of Asphalt Mixtures or Mineral Aggregate using Microwave Ovens (Field Method)

AASHTO T 30 - Mechanical Analysis of Extracted Aggregate

AASHTO T 329 - Moisture Content of Hot-Mix Asphalt (HMA) by Oven Method

SIGNIFICANCE AND USE

This method can be used for the determination of bitumen ratio or asphalt content of hot mix asphalt paving mixtures and pavement samples for quality control, specification acceptance, and mixture evaluation. Bitumen ratio is the ratio of the weight of asphalt to the dry weight of aggregate in an asphalt mixture. Asphalt content is the ratio of the weight of the asphalt to the total weight of the asphalt mixture.

Note 1: Although bitumen ratio will be used throughout this test procedure, it is also valid for determining asphalt content. However, the calibration factor will not be the same. Therefore, bitumen ratio and asphalt content cannot be interchanged. One or the other must be selected and used exclusively throughout the calibration and testing process.

SUMMARY OF TEST METHOD

Two samples with a known bitumen ratio are prepared, burned by ignition, and bitumen ratios calculated. The difference between the actual and the measured bitumen ratio is calculated for each sample. The average difference is determined and recorded as a calibration factor. This calibration factor is then used to calculate a corrected bitumen ratio on HMA paving mixtures and pavement samples.

APPARATUS

1. Furnace - Forced air ignition furnace capable of maintaining temperatures to 538 ± 5.5°C (1000 ± 10°F), with an internal balance thermally isolated from the furnace chamber accurate to 0.1 g. The balance shall be capable of weighing a 3000 g sample in addition to the sample baskets. A data collection system will be included so that the weight can be automatically determined and displayed during the test. The furnace shall have a built-in computer program to calculate the change in mass of the sample baskets and provide for the input of a calibration factor to account for aggregate loss or incomplete asphalt combustion. The furnace shall provide a printed ticket with the initial sample mass, sample mass loss, temperature compensation, calibration factor, corrected asphalt content (%), corrected bitumen ratio (%), test time, and test temperature. The furnace chamber dimensions shall be adequate to accommodate a sample size of 3000 g. The furnace shall provide an audible alarm and visible indicator when the sample mass loss does not exceed 0.01 percent of the total sample mass for three consecutive minutes. The furnace door shall be equipped so that the door cannot be opened during the ignition test. A method for reducing furnace emissions shall be provided. If the furnace uses filters, they must be self-cleaning ceramic filters. The furnace shall be vented into a hood or to the outside and shall have no noticeable odors escaping into the laboratory. The furnace shall have a fan with the capability to pull air through the furnace to expedite the test and to reduce the escape of smoke into the laboratory.

2. Balance - Readable to 0.1 g and capable of measuring the appropriate sample sizes. Balance must meet the requirements of AASHTO M 231, Class G2.

3. Sample Baskets - Two or more nested sample baskets will be used that allow the samples to be thinly spread and allow air to flow up through and around the sample particles. The sample shall be completely enclosed with screen mesh or perforated steel plate with maximum and minimum openings of No. 6 (3.35 mm) and No. 30 (600 μm), respectively.

4. Catch Pan - Sufficient size to hold the sample baskets so that aggregate particles falling through the screen mesh are caught. Wire guards will be provided to attach the sample baskets firmly to the catch pan.

5. Retriever - Capable of safely moving the sample baskets in and out of the heated furnace.

6. Oven - Capable of maintaining temperatures to 135°C (275°F) for drying samples.

7. Safety Equipment - Face shield or safety glasses to provide eye protection when loading and unloading furnace. Gloves capable of withstanding temperatures up to 538°C (1000°F). A protective cage to surround the sample baskets during cooling.

8. Miscellaneous Equipment - Pans for holding samples. Spatulas and brushes for removing asphalt mixtures and aggregate from baskets and pans.

9. Microwave Oven - For drying samples.

SAMPLE PREPARATION

1. Obtain samples of the paving mixture in accordance with Test Method Nev. T200 (Field Method).

2. By the method of splitting, obtain representative samples with sufficient material for the ignition procedure. The size of the test sample shall be governed by the nominal maximum aggregate size of the mixture and conform to the mass requirements of Test Method Nev. T206 (Field Method) or as listed below in Table 1. (Table 1 is for Materials Division use only).

Table 1

Size of Sample

Nominal Maximum Aggregate Size	Minimum Mass of Sample
37.5 mm (1 1/2 in.)	4000 g
25.0 mm (1 in.)	3000 g
19.0 mm (3/4 in.)	2000 g
12.5 mm (1/2 in.)	1500 g
9.5 mm (3/8 in.)	1200 g
4.75 mm (No. 4)	1200 g

If the sample size exceeds the capacity of the ignition furnace, the sample may be split into representative portions and the results combined after testing. Sample sizes shall not be more than 500 g greater than the minimum recommended sample mass.

MOISTURE CONTENT

Moisture content will be determined by AASHTO T 329 or Test Method Nev. T306 (Field Method).

CALIBRATION

1. A calibration factor is required to account for the loss of aggregate during the ignition process or for the incomplete combustion of the asphalt in a sample. The calibration factor may be affected by the type, source and gradation of aggregate used, by the type, quantity, and brand of asphalt used, and by the addition of mineral filler. Therefore, to optimize accuracy, a calibration factor shall be established for every aggregate type and source and for every type and brand of asphalt used. Any change in the aforementioned will require that a new calibration factor be established. The calibration factor shall be determined by testing samples of the asphalt mixture only.

   In addition to the reasons listed above, a new calibration factor will be required under the following conditions:

   a. Change in the recommended bitumen ratio of 0.4% or greater.

   b. Change in any of the aggregate bin percentages of 4.0% or greater.

   c. Change in the amount of mineral filler or a change in the method of adding mineral filler.

   d. If the Resident Engineer has a reason to suspect a material change that may affect the calibration factor.

      The calibration factor is also dependent upon the testing temperature. Testing will be performed at either 482°C or 538°C (900°F or 1000°F). A test temperature is selected that will provide adequate ignition of the asphalt, while minimizing aggregate loss.

      The calibration factor will be verified by testing a single sample at least once a week by the procedure outlined in this section. If the difference between the measured and actual bitumen ratio differs from the calibration factor by more than 0.20, a new calibration factor will be established as per this section.

2. The calibration factor to be used for HMA paving mixtures shall be the average difference between the measured and actual bitumen ratios of two samples tested at the same temperature to the nearest 0.01.

3. Two samples will be prepared to determine the calibration factor. Calibration samples must conform to the mass requirements of Test Method Nev. T206 (Field Method) or Table 1. For field laboratories, sample the aggregate (total blend of aggregate minus mineral filler, unless marinated, example shown below) using the automatic sampling device in accordance with Test Method Nev. T200 after the plant has been calibrated. Asphalt used for calibration purposes must be tested to ensure specification compliance. Both calibration samples shall be mixed at design bitumen ratio and at the design mineral filler content using the specified method.

   Calculate the amount of mineral filler based on actual bin percentages. Use 1% mineral filler for the coarse aggregate and 2% mineral filler for the fine aggregate.

   Example:

   7% - 1 in. aggregate (coarse)
   21% - 3/4 in. aggregate (coarse)
   25% - 1/2 in. aggregate (coarse)
   20% - crushed fines (fine)
   27% - washed sand (fine)

   53% coarse aggregate X 0.01 = 0.53% mineral filler
   47% fine aggregate X 0.02 = 0.94% mineral filler
   Total mineral filler = 1.47%

   (Example: 2500 g of blended aggregate including 1.47% mineral filler)

   Formula:

   $$\frac{\text{dry aggregate + mineral filler}}{1 + [(\%\text{ mineral filler}) \div 100]} = \text{dry aggregate without mineral filler}$$

   $$\frac{\text{2500 g of aggregate}}{\text{1.0147 mineral filler}} = \text{2463.8 g of aggregate without mineral filler}$$

4. Preheat the ignition furnace to 538°C (1000°F).

5. Dry the mixture samples in accordance with the MOISTURE CONTENT section.

6. Test samples in accordance with the PROCEDURE section, Steps 4 through 11, using a correction factor of zero.

7. If the difference between the measured bitumen ratios of the two samples is less than 0.15, these results may be used to calculate a calibration factor. If the difference between the measured bitumen ratios for the two samples exceeds 0.15, repeat the calibration procedure with two additional samples. Discard the high and the low result and determine the calibration factor from the remaining two results. The difference between these two remaining results must be within the 0.15.

8. Calculate the difference between the measured and actual bitumen ratios for each sample. The calibration factor (CF) is the average of the measured differences to the nearest 0.01.

   Note 2: It is possible that some asphalt/aggregate combinations will produce a measured bitumen ratio less than the actual ratio. This will produce a negative calibration factor. Rather than correcting for aggregate loss, a negative calibration factor corrects for the asphalt that is not completely ignited during the test procedure.

9. If the calibration factor exceeds 1.00%, lower the test temperature to 482°C (900°F) and repeat the calibration procedure. Use the calibration factor obtained at 482°C (900°F) even if it exceeds 1.00%.

   Note 3: If excessive aggregate breakage occurs at 538°C (1000°F), the test temperature may be lowered to 482°C (900°F) and the calibration procedure repeated even if the calibration factor does not exceed 1.00%.

10. The calibration factor is to be recorded and used to determine the corrected bitumen ratio of HMA paving mixtures as per the PROCEDURE section. The temperature for testing HMA samples in the PROCEDURE section, shall be the same temperature selected for testing calibration samples.

11. A database can be kept to record the required testing temperatures for various asphalt/aggregate combinations. This database can be used to predetermine the correct testing temperature of a specific asphalt/aggregate combination for calibration purposes.

PROCEDURE

1. Preheat the ignition furnace to the proper temperature for the sample to be tested as determined in the CALIBRATION section.

2. Obtain a sample of hot mix asphalt paving mixture in accordance with the SAMPLE PREPARATION section.

3. Oven dry the sample or determine the moisture content in accordance with the MOISTURE CONTENT section. If the mixture is not sufficiently soft to separate with a spatula or trowel, place it in an oven at 135°C (275°F) until it can be handled.

4. Weigh and record the mass of the sample basket assembly - sample baskets, catch pan and guards.

5. Evenly distribute the sample into the baskets and spread into thin layers. If basket size allows, keep the mix approximately 25 mm (1 in.) away from the sides of the baskets to reduce aggregate loss. Determine the total mass of the sample, baskets, catch pan, and guards. Calculate and record the initial mass (MI) of the sample (total mass - mass of the sample basket assembly) to the nearest 0.1 g.

6. Program the initial mass (MI) of the sample and the calibration factor, obtained in the CALIBRATION section, into the ignition furnace controller.

Note 4: Take care to input the correct sign (positive or negative) when entering the correction factor.

7. Open the furnace door and place the sample baskets inside. Care must be taken to ensure that the samples baskets do not contact the furnace wall. Verify that the sample mass (including the basket(s)) displayed on the furnace scale equals the total mass recorded within ± 5 g. Differences greater than 5 g or failure of the furnace scale to stabilize may indicate that the sample basket(s) are contacting the furnace wall. Initiate the test by starting the ignition furnace. This will lock the furnace door and start the combustion blower.

Note 5: The furnace temperature will drop below the setpoint when the door is opened, but will recover with the door closed and when ignition occurs. Sample ignition typically increases the temperature well above the setpoint, depending on sample size and bitumen ratio.

8. Heat the sample in the furnace at the specified temperature until the mass loss does not exceed 0.01 percent of the sample mass for three consecutive one minute intervals. The visible indicator and audible stable alarm will indicate that the test is complete. At this point, stop the test and print out the results. (This may be an automatic function of the furnace).

Note 6: Mass loss may occasionally level out for a few minutes during the test causing the furnace to signal premature completion. Care must be taken to ensure that complete ignition has been obtained.

9. Remove the sample from the furnace and allow it to cool to room temperature. This will take approximately 30 minutes. The sample should be placed on a heat resistant surface and covered with the protective cage during cooling.

10. Corrected bitumen ratio will be automatically computed by the ignition furnace and reported on a printed tape. If a moisture content has been determined, subtract the moisture content from the bitumen ratio on the printed tape and report the difference as the corrected bitumen ratio.

    The furnace shall calculate the corrected bitumen ratio or asphalt content by the following formulas (excluding temperature compensation):

$$\text{Corrected Bitumen Ratio} = \left(\left(\frac{MI - MF}{MF}\right) \times 100\right) - CF$$

where:

MI = Total mass of HMA sample prior to ignition.

MF = Total mass of aggregate and mineral filler (if applicable) remaining after ignition.

CF = Calibration factor obtained in accordance with the CALIBRATION section.

$$\text{Corrected Asphalt Content} = \left(\left(\frac{MI - MF}{MI}\right) \times 100 - CF\right)$$

where:

MI = Total mass of HMA sample prior to ignition.

MF = Total mass of aggregate and mineral filler (if applicable) remaining after ignition.

CF = Calibration factor obtained in accordance with the CALIBRATION section.

11. If for any reason the furnace cannot be used to automatically calculate a corrected bitumen ratio or asphalt content, calculations can be performed manually. Determine the total mass of the sample after ignition, baskets, catch pan, and guards. Calculate and record the final mass (MF) of the sample (total mass - mass of the sample basket assembly) to the nearest 0.1 g. Using the initial mass (MI) and final mass (MF), manually calculate a corrected bitumen ratio or asphalt content with the formulas in Step 10 of the PROCEDURE section. Apply a moisture correction if necessary.

    Note 7: Since dry aggregate absorbs moisture when exposed to air containing moisture, determine the mass of the aggregate remaining after ignition immediately after cooling to a suitable temperature.

12. The aggregate remaining after ignition may be used for gradation analysis if desired. The gradation will be performed using AASHTO T 30 or Test Method Nev. T206 (Field Method), in accordance with the SCOPE section.

REPORT

1. Bitumen ratio shall be reported to the nearest 0.1%. Gradation will be reported as per AASHTO T 30 or Test Method Nev. T206 (Field Method).

Designation: D 4263 – 83 (Reapproved 1993)$^{\epsilon 1}$

Standard Test Method for
Indicating Moisture in Concrete by the Plastic Sheet Method[1]

This standard is issued under the fixed designation D 4263; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

$^{\epsilon 1}$ Note—Keywords were added editorially in January 1993.

1. Scope

1.1 This test method is used to indicate the presence of capillary moisture in concrete.

1.2 The values stated in inch-pound units are to be regarded as the standard. The values given in parentheses are for information only.

1.3 *This standard does not purport to address all of the safety problems, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.* For specific caution statements, see Section 4.

2. Significance and Use

2.1 Capillary moisture in the concrete may be detrimental to the performance of certain coating systems that cannot tolerate moisture on or within the surface boundary.

2.2 This test method is used prior to the application of coatings on concrete.

3. Materials

3.1 *Transparent Polyethylene Sheet*, commercially available, approximately 4 mils (0.1 mm) thick.

3.2 *Adhesive Tape* that will adhere to the substrate. (Duct tape 2 in. (50 mm) wide is suggested.)

4. Cautions

4.1 This test method shall be conducted when the surface temperature and ambient conditions are within the established parameters for application of the coating system.

4.2 Avoid direct sunlight, direct heat, or damage to the plastic sheet, as such treatment affects the reliability of the results.

5. Procedure

5.1 Tape a segment of plastic sheet, approximately 18 by 18 in. (457 by 457 mm), tightly to the concrete surface making sure that all edges are sealed.

5.2 Allow the plastic sheet to remain in place a minimum of 16 h.

5.3 After the allowed time has elapsed, remove the plastic sheet and visually inspect the underside of the sheet and the concrete surface of the patch for the presence of moisture.

5.4 *Sampling:*

5.4.1 *Floors*—One test area per 500 ft^2 (46 m^2) or portion thereof, of surface areas unless otherwise specified.

5.4.2 *Walls and Ceilings*—One test area per 500 ft^2 (46 m^2) or portion thereof, of surface area unless otherwise specified.

5.4.3 The recommended practice is a minimum of one test for each 10 ft (3 m) of vertical rise in all elevation starting within 12 in. (300 mm) of the floor.

6. Report

6.1 Report the presence or absence of moisture.

7. Precision and Bias

7.1 This test method indicates the presence of capillary moisture. No precision or bias has been established for this test method.

8. Keywords

8.1 concrete; moisture

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of hazardous substances including epoxy compounds.

ANSI standards: ANSI Z 129.1 and ANSI K 68.1 provide further guidance regarding classification and precautions.

9.1.6—Many epoxy resin formulations are classified as "corrosive" or "flammable" in 49 CFR Transportation Subchapter C "Hazardous Materials Regulations." Packaging, labeling, and shipping for such materials is controlled by 49 CFR Transportation.

9.2—Safe handling

Safe handling of epoxy materials can be accomplished by:

9.2.1—Working in a well-ventilated area. As with most chemicals, materials should be stored below eye level.

9.2.2—Disposable suits and gloves, available from many suppliers of work garments, are suitable for this use. Gloves should be tested for resistance to resins and solvents. Disposable rubber or plastic gloves are recommended and should be discarded after each use. Gloves should be tested for resistance to resins and solvents. Cotton gloves, if used, should never be reused if they have become soiled with epoxy compounds.

9.2.3—Careful attention to personal cleanliness and protection. Safety eye-glasses or goggles are strongly recommended both when handling epoxy compounds and acids. Involuntary habits such as face scratching or eyeglass adjustment should be avoided. For similar reasons, handling important tools, eating or smoking should not be done until the individual has washed up. When wearing soiled gloves, the workers should avoid touching door handles and other equipment which may subsequently be touched by a person not wearing gloves.

9.2.4 *Federal regulations* — CFR 29, Part 1910 (OSHA Standards) regulate handling of hazardous substances including epoxy compounds.

9.3—What to do in case of direct contact

9.3.1 *To the clothing* — Remove soiled clothing at once and change to clean garments. If the soiled garment cannot be thoroughly cleaned, it should be destroyed.

9.3.2 *To the body* — Shower immediately with soap and water to remove spilled epoxy compounds from the body. Avoid contact with the genital areas until after the hands are carefully cleaned of all epoxy.

9.3.3 *To the eyes* — Flush out with large amounts of water for at least 15 min, followed by immediate medical attention. (Safety goggles will usually prevent getting chemicals into eyes.)

9.3.4 *Other places* — Do not use solvents other than soap and water or water soluble proprietary cleaners. Most solvents merely dilute the epoxy compounds, aiding them in penetrating the skin. At the same time, solvents tend to dry out the skin and any subsequent exposure is more likely to cause problems.

9.4—Use of solvents

9.4.1 *General* — The epoxy compounds considered for concrete applications are usually solvent free. However, solvents may be used as a convenience for cleanup of equipment and areas on which epoxies might be spilled. The solvents used will require additional precautions depending on the characteristics of the type used. It is generally true that solvents should not be used to remove epoxy products from the skin. They tend to dry the skin and may themselves cause dermatitis. Additionally, they dissolve the epoxy compound and carry it into more intimate contact with the skin, thus aggravating the dermatitic problems which already exist due to skin contact with the epoxy compound. The following hazards might be encountered in the use of solvents and should be taken into consideration. It may be emphasized that when using a solvent, the combined hazards of both the solvent and the epoxy compound are encountered.

9.4.1.1 *Flammability and explosion hazard* — Many solvents having low flash points are not recommended and should be avoided. Cleaning solvents such as ketones are red label materials and present a fire hazard. If used, adequate ventilation should be provided, equipment should be grounded and smoking or other fire initiating devices should be barred from the area of use. The chlorinated solvents, while not representing a fire hazard, will present a toxicological problem if a person smokes in their presence or if a fire occurs in the immediate area.

9.4.1.2 *Vapor hazard* — Most solvents have some degree of volatility and the vapors can be toxic when inhaled. Avoid using solvents which may be harmful.

9.4.1.3 *Contact hazard* — Some cleanup solutions contain phenols or other very aggressive chemicals which can cause burns or other serious effects when contacting any part of the body directly or indirectly. Use such materials with great care following the recommendations of the supplier.

9.4.1.4 Dispose of spent solvents in accordance with local and federal regulations.

9.5—Education of personnel

No amount of equipment will substitute for worker education. Those involved in using epoxy materials should be thoroughly informed of the characteristics and hazards of the particular materials they must handle. Not only label instructions but also the manufacturer's literature and MSDS sheets should be reviewed and pertinent information passed on to each worker. The handling of epoxy materials is not a dangerous occupation as long as reasonable care is taken and personnel and equipment are kept clean. Instances of sensitization are rare but the possibility of a burn, a damaged eye, or other loss-of-time accidents makes knowledge and observance of safe handling practices absolutely essential. A sensitized person must not be allowed to continue working with epoxy materials.

APPENDIX A—TEST METHODS

A.1—Field test for surface soundness and adhesion

A.1.1—Clean a portion of the area to which the epoxy compound is to be applied according to prescribed cleaning methods. The area selected for testing should represent the worst of surface conditions within the area to be repaired. The test area should be large enough so that the cleaning equipment and methods of cleaning to be employed in full scale operation may be used. This avoids the possibility of attaining a degree of cleanliness in a small test area which could not be matched later with the equipment to be used on a continuing basis. The surface must be thoroughly dry before undertaking Step A.1.2.

A.1.2—Mix materials and apply a test patch according to applicable procedures of Chapters 6 and 7 using the epoxy compound to be used in the work. The test patch should cover enough of the surface to include all the typical surface conditions found in the larger areas to be covered. For example, in a warehouse subjected to considerable forklift truck traffic, the test patch should span a line to include the wheel tracks where applied load and wear are most severe, and the center areas where deposition of oil and traffic soil is heaviest.

A.1.3—After the test patch has hardened, core drill through the coating and down barely into the subsurface by means of an electric drill fitted with a carbide-tipped or diamond core bit (Fig. A.1). The core bit should be of such size as to produce a cored disc 2 in. (5 cm) in diameter which will have the appearance of a small island of coated material (Fig. A.2).

A.1.4—Bond a standard 1½ in. (3.7 cm) diameter pipe cap, the bottom surface of which has been machined smooth and shoulder-cut to provide a 2 in. (5 cm) diameter surface (Fig. A.3), to the cored disc using nearly any commercially available room temperature rapid curing epoxy compound adhesive. Mix the epoxy components according to the supplier's recommendations just prior to use. A 2 oz (50 gm) portion of this material should have a working life of 20-25 min at 70-90 F (20-32 C). Apply a small amount of the mixed adhesive to the cored disc and to the bonding face of the pipe cap by spatula. Where desired, the bonding face may be heated to facilitate spreading of the adhesive. However, the cored disc should never be heated directly. Place the pipe cap on the cored disc. Direct a flame from a small gasoline blow-torch (an electric heat lamp or a portable gas radiant heater may be used as alternatives) into the interior of the pipe cap in such a way that no direct heat reaches the cored disc or the pavement bond line, and heat the pipe cap to about 160 F (70 C). (This temperature can readily be checked with a surface pyrometer.) Under these conditions the adhesive should harden in less than 1 minute. The bonded cap will be ready for testing as soon as it has cooled to air temperature.

A.1.5—After cooling the pipe cap and core, test the core by applying tension to it using a testing device similar to the one shown in Fig. A.4 and A.5. To prepare the testing device, screw the lower hook into the threaded pipe cap and attach to the loop on the lower portion of a Dillon dynamometer. Screw the upper hook, which has a threaded shaft, into the loading arm at the top of the rig, and attach to the loop on the upper portion of the dynamometer. When force is applied, the axis of the dynamometer must coincide with the axis of the pipe cap extended. Rotate the loading arm so that the threaded shaft and its connections are lifted, placing the pipe cap (and core) in tension. Tensile load should be applied at the approximate rate of 100 lb (45 kg) every 5 sec. The tensile load is indicated on the dynamometer gage. Record the load at which the pipe cap and connected core is separated from the concrete surface and convert to unit stress. Note the type of failure of which there are three possibilities or combinations thereof:

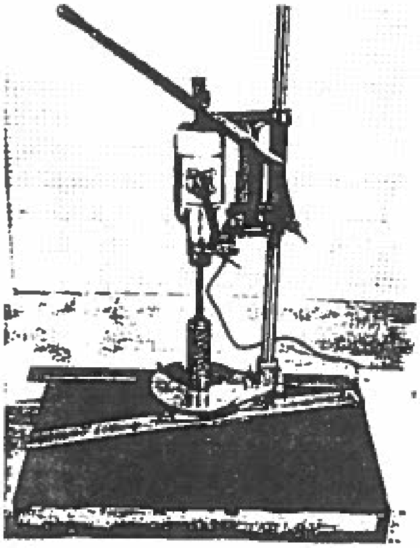

Fig. A.1—Portable carbide-tipped core drill in position for drilling

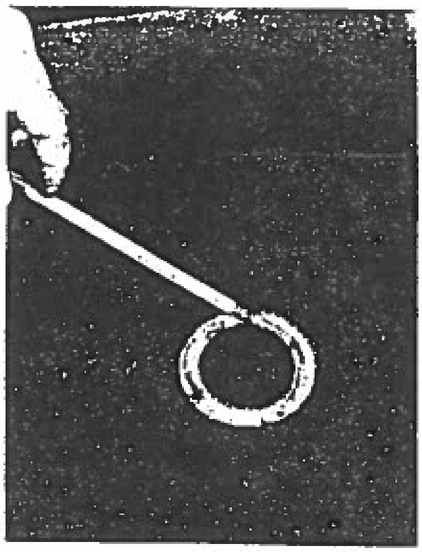

Fig. A.2—Cored disc after drilling and ready for the attachment of the pipe cap

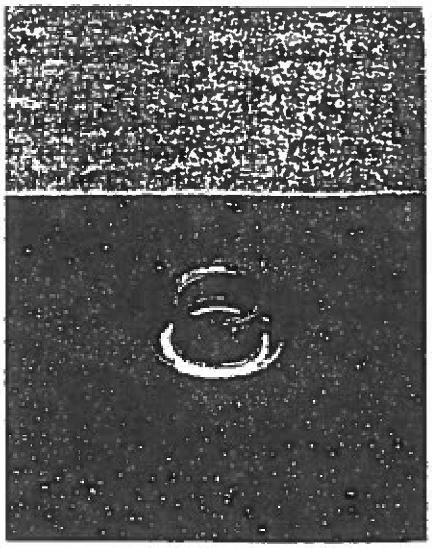

Fig. A.3—Machine faced pipe cap bonded to cored disc with epoxy compound

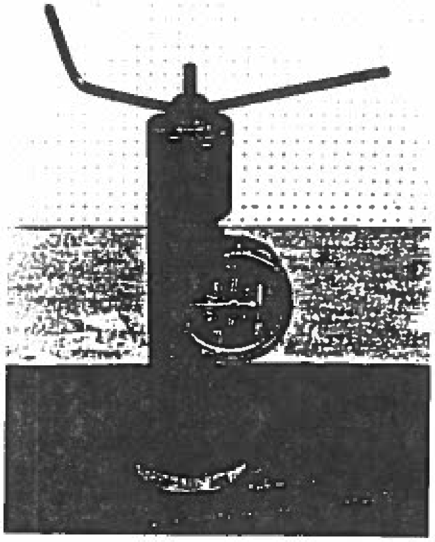

Fig. A.4—Mechanical testing device for pulling bonded pipe cap in tension

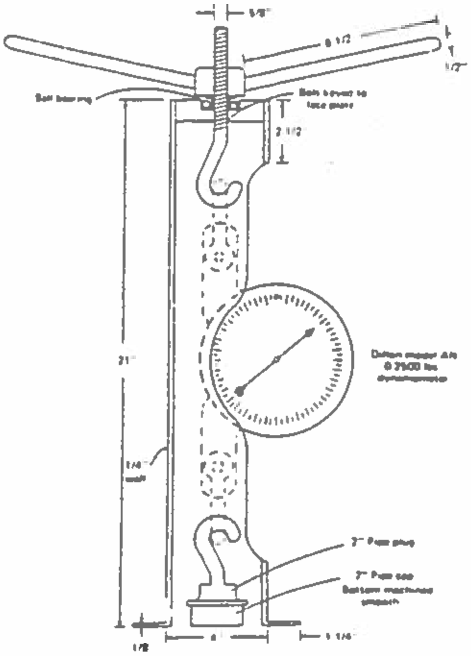

Fig. A.5—Functional sketch of mechanical testing device

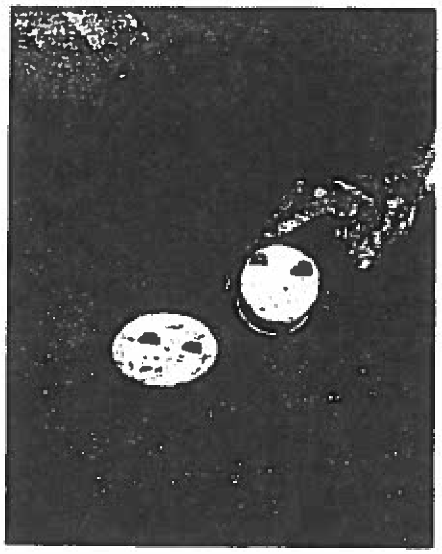

Fig. A.6—Typical failure in concrete; dark spots on cap and in aggregate indicate split aggregate

a) Failure in the concrete (cohesive concrete failure)

b) Separation of the epoxy compound from the concrete surface (adhesive failure)

c) Failure in the epoxy compound (cohesive resin failure)

Record the percent of each type of failure along with the load required to bring about the failure. A properly formulated epoxy compound applied to a properly prepared surface should result in a concrete failure as shown in Fig. A.6. When the pipe cap and core have been separated from the surface, the hole created by the test can easily be repaired using either an epoxy resin compound or the remaining epoxy adhesive if there is a surplus. When the strength of a concrete surface is to be tested alone, Steps A.1.1 through A.1.3 may be eliminated, except that a small area must be cleaned for bonding the pipe cap directly to the concrete surface. Tests should be performed in several areas which represent the worst conditions, and which give a statistical estimate of results to be expected.

A.2—Simplified field test for surface soundness

A.2.1—If this test is being employed to ascertain the need for surface preparation and detecting relative differences in potential surface strength over an area to be repaired, skip to Steps, A.2.2 and A.2.3. If the test is employed to ascertain adequacy of surface preparation, clean the area, or portions thereof if a large area, according to the prescribed cleaning methods. Portions of large areas to be test cleaned should be sufficient in number to be representative of the total area and each portion should be large enough so that the cleaning equipment intended for the full scale application can be used in a standard cleaning operation. Provision should be made for conducting the test at the rate of at least one test per 100 ft^2 (9.3 m^2) of area to be repaired. The surface to be tested must be dry before proceeding with Step A.2.2.

A.2.2—Cut 1 in. lengths of 1 in. aluminum T-section to provide a one in^2. bonding surface at the bottom of the flange. Drill a hole in the stem of each T-section for subsequent attachment of the testing device. Thoroughly clean the aluminum surface by abrading with crocus or emery cloth being careful to water wash and dry before using. Bond the aluminum T-section to the concrete surface using a fast setting epoxy compound mixed just prior to its use in accordance with the supplier's recommendations. This is accomplished by applying a small quantity of the epoxy compound to the concrete surface followed immediately by working the T-section into the epoxy in a manner to establish thorough contact between the epoxy, the concrete and the aluminum T-section. Upon completion of this operation, score around the perimeter of the T-section to remove excess epoxy which has squeezed out so that the bonded area will be the desired one square inch.

A.2.3—The following day, or as soon as the epoxy has set, attach a testing device similar to the one shown in Fig. A.7 to the aluminum T-section or the mechanical device described in Step A.1.5. Apply tension at an uninterrupted, uniform rate. The tensile load is indicated on the dynamometer gage. Record the load at which each T-section is separated from the concrete surface and express it as unit stress. Note the type of failure, as in Step A.1.5.

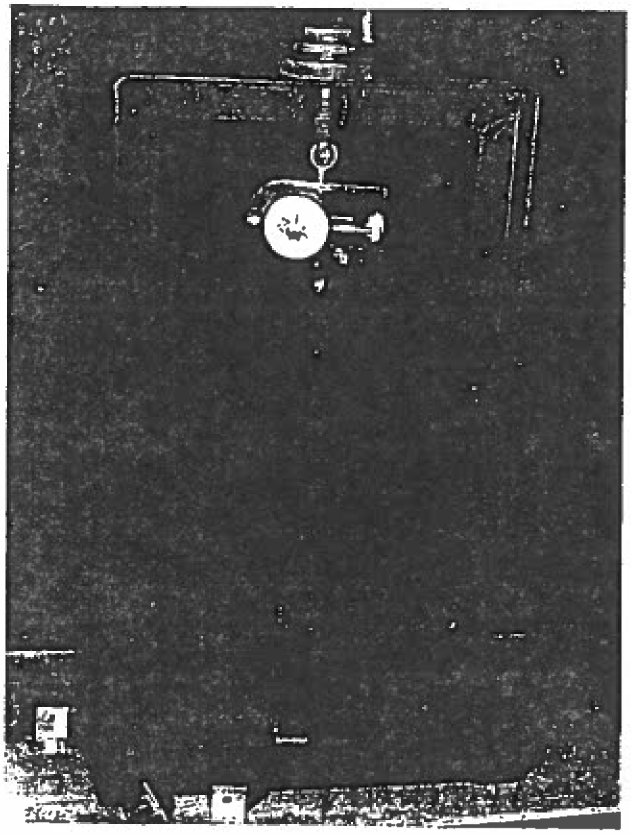

Fig. A.7—Tension frame for pulling T-sections bonded to a surface (courtesy George W. Whitesides Co., Inc.)

APPENDIX B TERMINOLOGY

Ambient: Usually used to describe temperature; meaning the same as the surroundings. Ambient usually, but not always, implies a temperature that is in the range of 60 to 90 F (15 to 32 C).

Broadcast: To toss granular material, such as sand over a horizontal surface so that a thin, uniform layer is obtained.

Delamination: Loss of adhesion and separation between coatings or between a coating and its substrate.

Diluent: A liquid ether which lowers the viscosity of epoxy formulations and which reacts chemically with them.

Epoxy concrete: A combination of epoxy resin and fine and coarse aggregate in a consistency similar to portland cement concrete.

Epoxy grout: A fluid epoxy compound used to fill cracks, set dowels, etc., in a manner similar to conventional grout.

Epoxy mortar: See resin mortar.

Extender: A nonreacting liquid substance added to epoxy compounds to extend pot life, increase flexibility, and lower the cost.

Flexibilizer: A substance which will react with epoxy compounds to impart flexibility.

Filler: A finely divided material, such as mica or talc, incorporated in an epoxy formulation to increase the hardness and lower the cost.

Hardener: A substance formulated so that when mixed with an epoxy resin it will cause the epoxy to solidify and harden.

Ionic: An adjective used to describe substances that dissolve to form ions. Upon dissolving, each molecule of the ionic substance splits into two or more ions. The ions always carry an electrical charge, either positive or negative. The positive and negative charges are always equal, so that the overall electrical charge is neutral.

Mil: One-thousandth of an inch.

Non-ionic: An adjective used to describe substances that dissolve without formation of ions. (See ionic)

Non-polar: Used to describe molecules characterized by a uniform distribution of electrons so that there is essentially no electrical charge, separation in the molecule. (see semi-polar)

Overlay: To apply a mortar to sufficient thickness, usually ¼ in. (6 mm) or more, to form a new surface. (see semi-polar)

Pot life: The period of time during which the epoxy compound is in a suitable condition for use.

Resin mortar: A combination of epoxy resin and fine aggregate in a consistency suitable for troweling.

Rout: To deepen and widen a crack to prepare it for patching or sealing.

Semi-polar: An adjective used to describe molecules that are intermediate between non-polar and polar types. Non-polar molecules are characterized by a uniform distribution of electrons such that there is essentially no electrical charge separation in the molecule. Polar molecules are characterized by a nonuniform distribution of electrons such that there is a difference in electrical potential from one end of the molecule to the other. Polar molecules tend to have higher solvent strength than non-polar molecules.

Stripper: A liquid compound formulated to remove coatings by chemical and/or solvent action.

Substrate: The uncoated surface upon which a coating is applied.

Thermoplastic plastic: A plastic that generally does not require curing agents and can be dissolved in a solvent or melted without permanent chemical change.

Thermosetting plastic: A plastic that, once cured, cannot be melted or dissolved in a solvent without undergoing drastic chemical change.

ACI 503R-93 was submitted to letter ballot of the committee and was approved according to Institute balloting procedures.