Test Procedure for

SAND EQUIVALENT TEST

TxDOT Designation: Tex-203-F

Effective Date: April 2025

1. SCOPE

1.1 Use this method to determine the relative proportion of detrimental fine dust or clay-like particles in soils or fine aggregates.

1.2 The values given in parentheses (if provided) are not standard and may not be exact mathematical conversions. Use each system of units separately. Combining values from the two systems may result in nonconformance with the standard.

1.3 *This test procedure does not claim to address the safety concerns associated with its use. It is the responsibility of the user of this test procedure to establish the appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations before use.*

2. APPARATUS

2.1 *Transparent plastic graduated cylinder,* 1.25-in. inside diameter, approximate 17-in. height, graduated up to 15 in. in intervals of 0.1 in., starting at the base.

2.2 *Rubber stopper,* to fit the mouth of the graduated cylinder.

2.3 *Agitator tube,* brass, stainless steel, or copper; 0.25-in. outside diameter; approximately 20 in. long; one end closed to form a wedge-shaped tip; two holes (drill size 60) drilled laterally through the flat side of the wedge.

2.4 *Weighted foot assembly,* consisting of a metal rod connected to a foot with a flat, smooth surface at the lower end and a weight at the upper end to give the total assembly a weight of 1000 ± 5g. Use one of the assembly models described in Sections 2.4.1 and 2.4.2.

2.4.1 *Assembly with sand reading indicator*, sand reading indicator attached on the rod 10 in. above the base of the foot.

2.4.2 *Assembly with no sand reading indicator*, the foot has three small screws to center it loosely in the cylinder. A bored cap fits loosely around the rod at the top of the cylinder to center the weighted foot assembly in the cylinder. The weight of this cap is not part of the total weight of the assembly.

2.5 *Glass bottle,* 1 gal., equipped with a siphon assembly consisting of a two-hole rubber stopper and pieces of glass or copper tubing, sits 3 ft. ± 1 in. above the work surface.

2.6 *Tubing,* 4 ft. long, plastic or rubber, with pinch clamp to connect the open end of the agitator tube with the siphon assembly.

2.7 *Standard U.S. sieve*, No. 4, meeting the requirements of Tex-907-K.

2.8 *Measuring can,* 85 ± 5 mL capacity

2.9 *Wide mouth funnel.*

2.10 *Stopwatch, watch, or clock,* reading in minutes and seconds.

2.11 *Glass cylinder*, 100 mL, graduated in increments of 2 mL or less.

2.12 *Drying oven*, capable of maintaining 140 ± 5°F and 230 ± 9°F.

2.13 *Motor-driven mechanical sand equivalent shaker.*

2.14 *Straight edge or spatula.*

2.15 *Splitter or quartering device.*

3. MATERIALS

3.1 *Stock solution*, prepared either according to AASHTO T176, Section 4.8 or the method in Sections 3.1.1 – 3.1.3.

3.1.1 Dissolve 577 g of ACS grade calcium chloride dihydrate in 1.9 L of distilled or demineralized water.

3.1.2 Cool the solution.

3.1.3 Add 1,640 mL of U.S.P. glycerin and 53 mL of 50% 1,5-Pentanedial (Glutaraldehyde) in water to the solution and mix well; 1,5-Pentanedial is also known as glutaraldehyde, glutaric dialdehyde, and trade name UCARCIDE. It may also be found as "Glutaraldehyde Solution 50%."

3.2 *Working calcium chloride solution*, prepared either according to AASHTO T176, Section 4.9 or the method in Sections 3.2.1 – 3.2.2.

3.2.1 Dilute 88 mL of the stock calcium chloride solution to 3.8 L of distilled or demineralized water. After the addition of the stock solution, shake thoroughly. Use a good quality tap water if the purity does not affect the test results.

3.2.2 Maintain a working solution temperature of 72 ±5°F during the test. If this is not possible in a field laboratory, send samples to the referee laboratory for testing under proper temperature control conditions.

4. PROCEDURES

4.1 *Preparing Sample:*

4.1.1 Select a representative sample of material in accordance with the applicable specification.

4.1.2 Oven-dry the test sample to constant weight at 230 ± 9°F. Oven-dry limestone rock asphalt aggregates at 140 ± 5°F.

Note 1—Constant weight is defined as oven drying the material at the specified temperature until the material will not lose more than 0.1% moisture after 2 hr. of drying. Verify by measuring the moisture content from weighing the mass of a sample before and after consecutive 2 hr. drying periods.

Note 2—Tests on damp samples will generally give lower sand equivalent values than tests on oven-dried samples. It is permissible not to dry the sample to save time, but if the test values are near or below the specified minimum, retest the sample in the oven-dry condition.

4.1.3 Remove sample from oven and allow it to cool to room temperature.

4.1.4 Using the No. 4 sieve, separate the sample into two portions, breaking up lumps that consist of particles obviously finer that the No. 4 sieve.

4.1.5 Using the material passing the No. 4 sieve, carefully reduce the amount of material to a laboratory test size of at least 500-grams.

4.2 *Performing the Sand Equivalent Test:*

4.2.1 Set up the workstation so that the glass bottle containing the working calcium chloride solution sits 3 ft. ± 1 in. above the work surface.

4.2.2 Siphon 4 ± 0.1 in. of the working calcium chloride solution into the plastic cylinder. Check the agitator tube to be certain that the solution flows freely.

4.2.3 Secure the test sample by passing the measuring can through the thoroughly mixed sample of the prepared material in a pan.

4.2.4 Strike off the excess material using a straight edge or spatula.

Note 3—Do not compact the sample before striking it off.

4.2.5 Transfer the sample from the measuring can into the plastic cylinder using the small funnel.

4.2.6 Stopper the cylinder.

4.2.7 Tap the bottom of the cylinder on the heel of the hand several times to remove air bubbles and promote thorough wetting of the sample.

4.2.8 Remove stopper.

4.2.9 Wash particles clinging to wall of cylinder into the mixture, using a minimum amount of solution.

4.2.10 Allow the cylinder with contents to stand undisturbed, free of any vibration, for 10 ± 1 min.

4.2.11 Replace stopper in the end of cylinder.

4.2.12 Partially invert cylinder and shake to dislodge material from the bottom.

4.2.13 Place stoppered cylinder in the mechanical sand equivalent shaker and set the timer.

4.2.14 Allow machine to shake the cylinder and contents for 45 ± 1 sec.

4.2.15 Following the mixing operation, place the cylinder on the worktable.

4.2.16 Remove stopper.

4.2.17 Wash down the cylinder wall with the agitator tube.

4.2.18 Force the agitator through the material to the bottom of the cylinder by gently twisting and shoving while the solution flows from the tip of the tube.

4.2.19 Continue smoothly jabbing the agitator tube up and down with a gentle twisting motion while slowly rotating the cylinder in a vertical position to flush the fine clay-like material into suspension above the coarse sand particles. Continue the operation until the cylinder is filled to the 15 in. mark.

4.2.20 Slowly remove the agitator tube without shutting off the flow, so the level of the liquid is maintained at 15 in.

4.2.21 Regulate the flow of the solution and adjust the level of solution to 15 in. when the agitator tube is entirely withdrawn.

4.2.22 Allow the cylinder and contents to stand undisturbed for 20 min. ± 15 sec. Start the timing immediately after the removal of the agitator tube.

4.2.23 After the 20-min. sedimentation period, read the level of the top of the clay suspension and record as the clay reading.

4.2.24 If there is no clear line of demarcation or clay meniscus at the end of the 20-min. sedimentation period, allow the material to stand undisturbed until the division is clear.

4.2.25 Read and record the level of the clay meniscus and the total sedimentation time.

Note 4—If the total sedimentation time exceeds 30 min., rerun the test using three more samples of the same material. Use the clay reading obtained from sample with the shortest sedimentation time.

4.2.26 Determine the sand reading by following the instructions in Sections 4.2.25 or 4.2.26.

4.2.27 When using the weighted foot assembly with sand reading indicator, gently lower the foot assembly into the cylinder until it comes to rest on the sand. Very gently tilt the assembly until the indicator touches the graduation marks on the cylinder. Tilt assembly back to vertical before taking reading. Read the level indicated by the top edge of the indicator and subtract 10 in. Record this reading as the sand reading.

4.2.28 When using the weighted foot assembly with no sand reading indicator, gently lower the weighted foot assembly in the cylinder until it comes to rest on top of the sand. Keep one of the centering screws in contact with the cylinder wall near the graduation marks while lowering the foot assembly so that the centering screw remains visible. Read the middle of the centering screw and record this reading as the sand reading.

4.3 If the clay or sand readings fall between two divisions on the graduated cylinder, round up to the nearest marked interval (e.g., 8.68 = 8.7 in., 6.21 = 6.3 in.)

4.4 Calculate the sand equivalent in accordance with Section 5.1.

Note 5—If running the test in pairs, the two values should not differ by more than four points. If the two values are different by more than four points repeat the test until two results are within four points of each other.

5. CALCULATIONS

5.1 Calculate the sand equivalent value to the nearest 0.1 in.:

$$\text{Sand Equivalent Value (SE)} = 100 * (\text{Sand Reading} / \text{Clay Reading})$$

6. REPORTING TEST RESULTS

6.1 Report sand equivalent test result rounded up to the next highest whole number.

EXAMPLE:

$$SE = 100 * (3.2/6.9) = 46.4$$

Report the value as 47.

6.2 If it is desired to average a series of sand equivalent values (such as for pairs), average the whole number values determined as described above. If the average of these values is not a whole number, raise it to the next higher whole number. Examples of this calculation can be found below.

EXAMPLE for two SE results: 45, 44

$$\text{Average SE Value} = (45+44)/2 = 44.5$$

This is then raised and reported as 45.

EXAMPLE for three SE results: 62, 63, 65

$$\text{Average SE Value} = (62+63+65)/3 = 63.3$$

This is then raised and reported as 64.

6.3 If the calculated SE value exceeds 100, report the value as 100.

7. ARCHIVED VERSIONS

7.1 Archived versions are available.