Sand Equivalent Test Set with Case

Introduction

This method is intended to serve as a rapid field correlation test. The purpose of this method is to indicate, under standard conditions, the relative proportions of clay-like or plastic fines and dusts in granular soils and fine aggregates that pass the No. 4 (4.75 mm) sieve. The term "sand equivalent" expresses the concept that most granular soils and fine aggregates are mixtures of desirable coarse particles, sand, and generally undesirable clay or plastic fines and dust. This test is not intended to replace either Method D422 or Method D1140.

Applicable Documents

ASTM Standards:

D422 Particle-Size Analysis of Soils [2]

D1140 Test for Amount of Material in Soils finer than the No. 200 75 µm Sieve[2]

E11 Specification for Wire-Cloth Sieves for Testing Purposes[3]

Summary of Method

A measured volume of soil or fine aggregate and a small quantity of flocculating solution are poured into a graduated plastic cylinder and are agitated to loosen the clay-like coatings from the sand particles in the test specimen. The specimen is then "irrigated" using additional flocculating solution forcing the clay-like material into suspension above the sand. After a prescribed sedimentation period, the height of floccuiated clay is read and the height of sand in the cylinder is determined. The sand equivalent is the ratio of the height of sand to the height of clay times 100.

Significance

This test assigns an empirical value to the relative amount, fineness, and character of clay-like material present in the test specimen.

A minimum sand equivalent value may be specified to limit the permissible quantity of clay-like fines in an aggregate.

This test provides a rapid field method for determining changes in the quality of aggregates during production or placement.

Interferences

Maintain the temperature of the working solution at 72 ± 5° F (22 ± 3° C) during the performance of this test.

***Note 1**: If field conditions preclude the maintenance of the temperature range, frequent referee samples should be submitted to a laboratory where proper temperature control is possible. It is also possible to establish temperature correction curves for each material being tested where proper temperature control is not possible. However, no general correction curve should be utilized for several materials even within a narrow range of sand equivalent values. Samples that meet the minimum sand equivalent requirement at a working solution temperature below the recommended range need not be subject to referee testing.*

Perform the test at a location free from vibration. Excessive vibration may cause the suspended material to settle at a greater rate than normal.

Do not expose the plastic cylinders to direct sunlight any more than is necessary.

Occasionally it may be necessary to remove a fungus growth from the working calcium chloride solution container and from the inside of the flexible tubing and irrigator tube. This fungus can easily be seen as a slimy substance in the solution.

1. To remove this growth, prepare a cleaning solvent by diluting sodium hypochlorite solution (household chlorine beach) with an equal quantity of water.
2. Fill the solution container with the prepared cleaning solvent, allow about 1 litre of the cleaning solvent to flow through the Siphon assembly and irrigator tube, then place the pinch clamp on the end of the tubing to cut off the flow of solvent and to hold the solvent in the tube. Refill the container and allow to stand overnight.
3. After soaking, allow the cleaning solvent to flow out through the siphon assembly and irrigator tube.
4. Remove the siphon assembly from the solution container and rinse both with clear water. The irrigator tube and siphon assembly can be rinsed easily by attaching a hose between the tip of the irrigator tube and water faucet and backwashing fresh water through the tube.

Occasionally the holes in the tip of the irrigator tube may become clogged by a particle of sand. If the obstruction cannot be freed by any other method, use a pin or other sharp object to force it out using extreme care not to enlarge the size of the opening.

Apparatus

A graduated transparent acrylic plastic cylinder, rubber stopper, irrigator tube, weighted foot assembly and siphon assembly all conforming to the respective specifications.

Measuring Tin: A tinned box approximately 2¼ in. (57 mm) in diameter having a capacity of 85 ± 5 ml.

No. 4 (4.75 mm) Sieve, conforming to the requirements of Specification E 11.

Funnel, wide-mouth, for transfering test specimens into the graduated cylinder.

Bottles, two 1 gal (3.78 litres), to store stock solution and working solution.

Flat Pan for mixing.

Clock or Watch, reading in minutes and seconds.

Mechanical Sand Equivalent Shaker, having a throw of 8 ± 0.04 in. (203.2 ± 1.02 mm) and operating at 175 ± 2 cpm.

NOTE 2: *Moving parts of the mechanical shaker should be provided with a safety guard for protection of the operator.*

Manually 0perated Sand Equivalent Shaker (optional) or equivalent, capable of producing an oscillating motion at a rate of 100 complete cycles in 45 ± 5 sec, with a hand-assisted half stroke length of 5 ± 0.2 in. (127 ± 5.08 mm).

Materials

Stock Solution - The materials listed below will be required:

- 454 g (1 lb) of technical grade anhydrous calcium chloride,
- 2050 g (1640 ml) .of USP Glycerin, and
- 47 g (45 ml), cif formaldehyde (40 volume % solution).

Dissolve the 454 g of Calcium chloride in ½ gal (1.89 litres) of distilled water. Cool and filter through ready-pleated rapid filtering paper. Add the 2050 g of glycerin and· the 47 g of formaldehyde to the filtered solutlon, mix well, and dilute to 1 gal. (3.78 litres)

Working Calcium Chloride Solution - Prepare the working calcium chloride solution by diluting one measuring tin full of the stock calcium chloride solution to 1 gal. (3.8 litres) with water. Use distilled or demineralized water for the normal preparation of the working solution. However, if it is determined that the local tap water is of such purity that it does not affect the test results, it is permissible to use it, instead of distilled or demineralized water except in the event of dispute.

NOTE 3: *The effect of local tap water on sand equivalent test results may be determined by comparing the results of three sand equivalent tests using distilled water with the results of three sand equivalent tests using the local tap water. The six test specimens required for this comparison shall be prepared from the same sample of material and oven-dried as prescribed in this method.*

Sample Preparation

- Obtain at least 1500 g of material passing the No. 4 (4.75 mm) sieve in the following manner:

1. Separate the sample on the No. 4 (4.75 mm) sieve 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 sieve. Continue the sieving until not more than 1 weight % of the residue passes the sieve during 1 min. The sieving operation may be performed either by hand or by a mechanical apparatus. When thoroughness of mechanical sieving is being determined, test by the hand method described above using a single layer of material on the sieve.
2. Break down any lumps of material in the coarse fraction to pass the No. 4 (4.7 5 mm) sieve. A mortar and rubber-covered pestle or any other means that will not cause appreciable degradation of the aggregate may be used.
3. Remove any coatings of fines adhering to the coarse aggregate. These fines may be removed by surface-drying the coarse aggregate, then rubbing between the hands over a flat pan.
4. Add the material passing the sieve obtained in 1 and 3 to the separated fine portion of the sample.

- Prepare test specimens from the material the No. 4 (4.75 mm) sieve portion of the sample by the procedure described in either 1 or 2 above.

NOTE 4: *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 extreme care be exercised when preparing the test specimens.*

1. Split or quarter enough material to fill four tin measures to the brim or slightly rounded above the brim in the following manner:
   A. If it appears necessary, dampen the material to avoid segregation of loss of fines during the splitting or quartering operations. Use care in adding moisture to the sample to retain a free flowing condition of the material.
   B. Using the measuring tin, dip out four of these measures from the sample. Each time a measure full of the material is dipped from the sample, tap the bottom edge of the measure on a work table or other hard surface at least four times and jog it slightly to produce a measure of consolidated material level-full or slightly rounded above the brim.
   C. Determine and record the amount of material contained in these four measures either by weight or by volume in a dry plastic cylinder.
   D. Return this material back to the sample and proceed to split or quarter the material making the necessary adjustments to obtain this predetermined weight or volume. When this weight or volume is obtained, two successive splitting or quartering operations without adjustment should provide the proper amount of material to fill the measure.
   E. Dry each test specimen to constant weight at 230 ± 9° F (105 ± 5° C) and cool to room temperature before testing.

NOTE 5: Sand equivalent results on test specimens that have not been dried will generally be lower than the results obtained on identical test specimens that have been dried. As a time-saving expedient, it is permissible to test most materials without drying when the sand equivalent value is used to determine compliance with a specification giving a minimum acceptable test value. If the resulting test value is lower than that specified, however, it will be necessary to rerun the test on a dried test specimen. If the sand equivalent, determined from a test on one dried test specimen, is below minimum specification limit, it will be necessary to perform two additional tests on dried test specimens from the same sample. The sand equivalent for a sample shall be determined in accordance with the section on calculations.

2. Prepare the desired number of test specimens from the sample as follows:
   A. Maintaining a free-flowing condition, dampen the material sufficiently to prevent segregation or loss of fines.
   B. Split or quarter out 1000 to 1500 g of the material. Mix thoroughly with a hand trowel in a circular pan by scooping toward the middle of the pan while rotating it horizontally. Mixing or remixing should be continued for at least 1 min to achieve uniformity. Check the material for the necessary moisture condition by tightly squeezing a small portion of the thoroughly mixed sample in the palm of the hand.

If a cast is formed that permits careful handling without breaking, the correct moisture range has been obtained. If the material is too dry, the cast will crumble and it will be necessary to add water and remix retest until the material forms a cast. If the material shows any free water it is too wet to test and must be drained and air-dried, mixing if frequently to ensure uniformity. This overly wet material will form a good cast when checked initially, so the drying process should continue until a squeeze check on the drying material gives a cast which is more fragile and delicate to handle than the original. If the "as received" moisture content is within the limits described above, the same may be run immediately. If the moisture content is altered to meet these limits, the sample should be put in a pan, covered with a lid or with a damp towel that does not touch the material, and allowed to stand for a minimum of 15 minutes.

D. After the minimum curing time, remix for 1 minute without water. When thoroughly mixed, form the material into a cone with a trowel.

E. Take the tin measure in one hand and push it directly through the base of the pile while holding the free hand firmly against the pile opposite the measure.

F. As the can travels through the pile and emerges, hold enough hand pressure to cause the material to fill the can to over-flowing. Press firmly with the palm of the hand, compacting the material until it consolidates in the can. The excess material should be struck off level with the top of the can, moving the edge of the trowel in a sawing motion across the brim.

G. To obtain additional test specimens. repeat the procedures in steps D through F above.

Preparation of Apparatus

1. Fit the siphon assembly to a 1 gal (3.8 litre) bottle of working calcium chloride solution. Place the bottle on a shelf 3 ft ± 1 in. (914 ± 25 mm) above the work surface.

NOTE 6: *Instead of the 1 gal (3.8 litre) bottle, a glass or plastic vat having a larger capacity may be used provided the liquid level of the working solution is maintained between 36 and 45 in. (914 and 117 mm) above the work surface.*

2. Start the siphon by blowing into the top of the solution bottle through a short piece of tubing while the pinch clamp is open.

3. When using either the mechanical or the manually operated sand equivalent shaker, fasten the apparatus to a firm and level mount.

NOTE 7: *If only a few sand equivalent tests are to be performed at one location , it is possible to hold the manually operated shaker by hand on a firm mount.*

Procedure

1. Siphon 4 ± 0.1 in. (101.6 ± 2.54 mm) (indicated on the graduated cylinder) of working calcium chloride solution into the plastic cylinder.

2. Pour one of the test specimens into the plastic cylinder using the funnel to avoid spillage.

3. Tap the bottom of the cylinder sharply on the heel of the hand several times to release air bubbles and to promote thorough wetting of the specimen.

4. Allow the wetted specimen and cylinder to stand undisturbed for 10 ± 1 minute.
5. At the end of the 10 minute soaking period, stopper the cylinder: then loosen the material from the bottom by partially inverting the cylinder and shaking it simultaneously.
6. After loosening the material from the bottom of the cylinder, shake the cylinder and contents by any one of the following three methods:

- Mechanical Shaker Method: Place the stoppered cylinder in the mechanical sand equivalent shaker, set the time, and allow the machine to shake the cylinder and the contents for 45 ± 1 second.
- Manual Shaker Method:

A. Secure the stoppered cylinder in the three spring clamps on the carriage of the hand-operated sand equivalent shaker and reset the stroke counter to zero.

NOTE 8: *To prevent spillage, be sure the stopper is firmly seated in the cylinder before placing in the manual shaker.*

B. Stand directly in front of the shaker and force the pointer to the stroke limit marker painted on the backboard by applying an abrupt horizontal thrust to the upper portion of the right-hand spring steel strap. Then remove the hand from the strap and allow the spring action of the straps to move the carriage and cylinder in the opposite direction without assistance or hindrance.

C. Apply enough force to the right hand spring steel strap during the thrust portion of each stroke to move the pointer to the stroke limit marker by pushing against the strap with the ends of the fingers to maintain a smooth oscillating motion. The center of the stroke limit marker is positioned to provide ihe -proper stroke length and its width provides the maximum allowable limits of variation. The proper shaking action is accomplished only when the tip of the pointer reverses direction within the marker limits. Proper shaking action can best be maintained by using only the forearm and wrist action to propel the shaker.

D. Continue the shaking action for 100 strokes.

- Hand Method:

A. Hold the cylinder in a horizontal position and shake it vigorously in a horizontal linear motion from end to end.

B. Shake the cylinder 90 cycles in approximately 30 seconds using a throw of 9 ± 1 in. (229 ± 25 mm). A cycle is defined as a complete back and forth motion. To shake the cylinder at this speed properly, it will be necessary for the operator to shake with the forearms only, relaxing the body and shoulders.

7. Following the shaking operation, set the cylinder upright on the work table and remove the stopper.
8. Irrigation Procedure:

- During the irrigation procedure, keep the cylinder vertical and the base in contact with the work surface, Insert the irrigator tube in the top of the cylinder, remove the spring clamp from the hose, and rinse the material from the cylinder walls as the irrigator is lowered. Force the irrigator through the material to the bottom of the cylinder by applying a gentle stabbing and twisting action while the working solution flows from the irrigator tip. This flushes the fine material into suspension above the coarser sand particles.

- Continue to apply a stabbing and twisting action while flushing the fines upward until the cylinder is filled to the 15 in. (381 mm) graduation. Then raise the irrigator tube slowly without shutting off the flow so that the liquid level is maintained at about the 15 in. graduation while the irrigator tube is being withdrawn. Regulate the flow just before the irrigator tube is entirely withdrawn and adjust the final level to the 15 in. graduation.

9. Allow the cylinder and contents to stand undisturbed for 20 min ± 15 seconds. Start the timing immediately after withdrawing the irrigator tube.

10. At the end of the 20 min sedimentation period, read and record the level of the top of the clay suspension as prescribed in 12 below. This is referred to as the "clay reading".

    If no clear line of demarcation has formed at the end of the specified 20 minute sedimentation period, allow the sample to stand undisturbed until a clay reading can be obtained; then immediately read and record the level of the top of the clay suspension and the total sedimentation time. If the total sedimentation time exceeds 30 minute rerun the test using three individual specimens of the same material. Record the clay column height for the sample requiring the shortest sedimentation period as the clay reading.

11. Sand Reading Determination:

- After the clay reading has been taken, place the weighted foot assembly over the cylinder and gently lower the assembly until it comes to rest on the sand. Do not allow the indicator to hit the mouth of the cylinder as the assembly is being lowered.
- As the weighted foot comes to rest on the sand, tip the assembly toward the graduations on the cylinder until the indicator touches the inside of the cylinder. Subtract 10 in. (254 mm) from the level indicated by the extreme top edge of the indicator and record this value as the "sand reading".

NOTE 9: *If the sand reading indicator and foot is used, modify the sand reading determination procedure given above as follows: While the weighted foot is being lowered, keep one of the centering screws in contact with the cylinder wall near the gradua tions so that it can be seen at all times. When the weighted foot has come to rest on the sand, read and record the level of the slot of the centering screw as the value for the "sand reading".*

- When taking the sand reading, use care not to press down on the weighted foot assembly since this could give an erroneous reading.

12. If clay or sand readings fall between 0.l in. (2.5 mm) graduations, record the level of the higher graduation as the reading. For example, a clay level at 7.95 would be recorded as 8.0. A sand level at 3.22 would be recorded as 3.3.

Calculation and Report

1. Calculate the sand equivalent to the nearest 0.1 % as follows:
   SE=(sand reading/clay reading) X 100
   where:
   SE = sand equivalent.

2. If the calculated sand equivalent is not a whole number, report it as the next higher whole number. For example, if the sand equivalent were calculated from the example in 12 above, the calculated sand equivalent would be:

(3.3/8.0) X 100 = 41.2

Since this calculated sand equivalent is not a whole number it would be reported as the next higher whole number which is 42.

3. If it is desired to average a series of sand equivalent values, average the whole number value determined as described above. If the average of these values is not a whole number, raise it to the next higher whole number as shown in the following example :

- Calculate SE values: 41.2, 43.8, 40.9.
- After raising each to the next higher whole number they become 42, 44, 41.
- Determine the average of these values as follows: (42 + 44 + 41)/3 = 42.3
- Since the average value is not a whole number, it is raised to the next higher whole number, and the sand equivalent value is reported as 43.

Precision

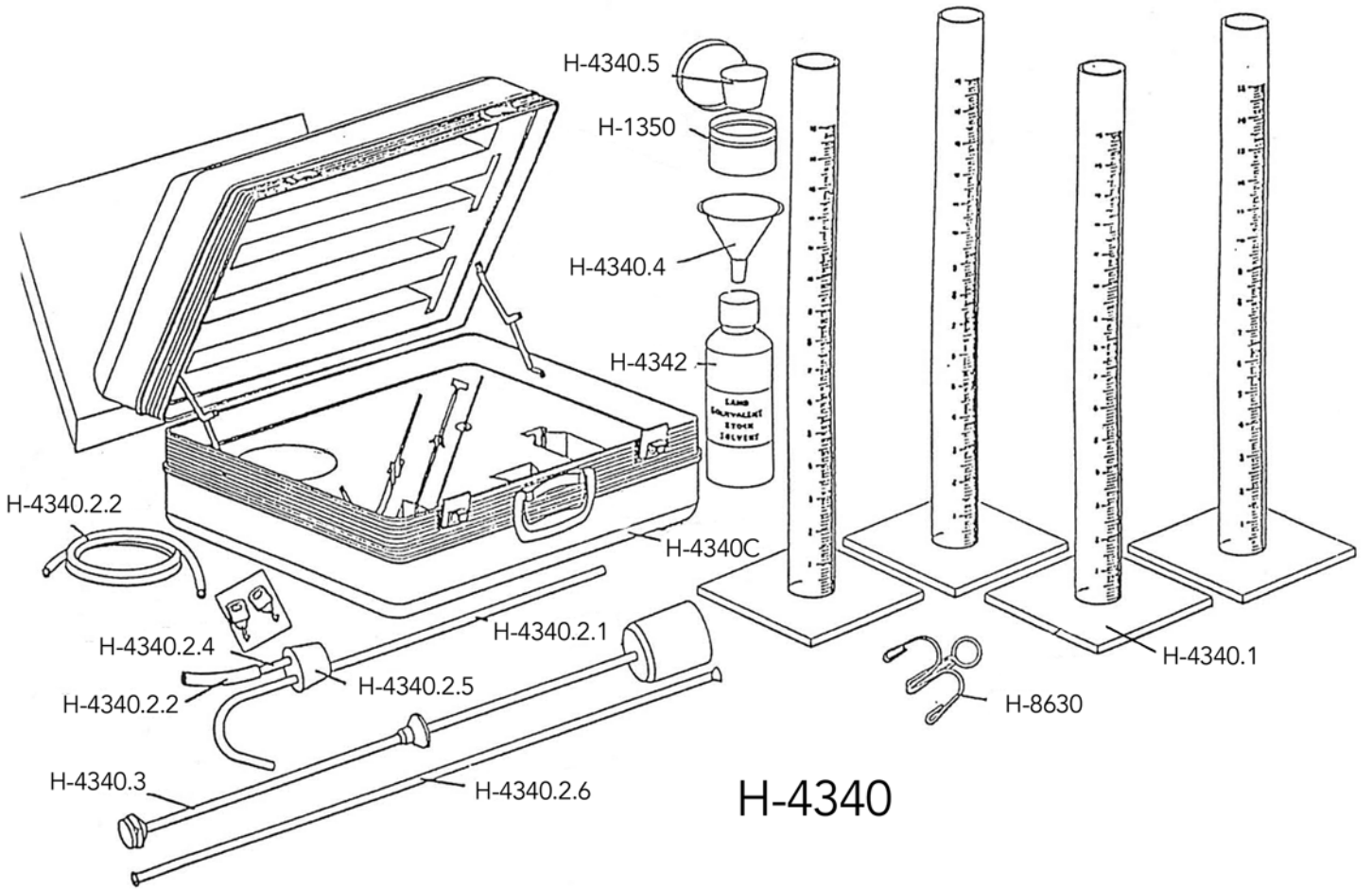
Before an operator is allowed to perform the sand equivalent test they must be capable of obtaining consistent test results on representative samples of any given material when the test is performed in accordance with the prescribed procedure for the particular method used. An operator's test results are considred to be consistent if the individual results of three tests performed by them on representative samples of the same material do not vary by more than ± 4 points from the average of these tests.

If an operator is not capable of obtaining consistent results, they are not to perform the sand equivalent test until they have perfected their technique sufficiently to bring their test results into the specified limits.

[1] This method is under the jurisdiction of ASTM committee D-18 on Soil and Rock and is the direct responsibility of Subcommittee D 18.08 on Special and Construction Control Tests. Current edition approved June 27, 1974. Published September 1974. Originally published as D 2419-65T. Last previous edition D 2419-69.

[2] Annual Book of ASTM Standards, Part 19

[3] Annual Book of ASTM Standards, Part 41.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