Australian Standard®

Methods of testing soils for engineering purposes

Method 3.8.1: Soil classification tests—Dispersion—Determination of Emerson class number of a soil

1 SCOPE

This Standard sets out the method for determining the Emerson class number* of a soil. Soils are divided into seven classes on the basis of their coherence in water, with one further class being distinguished by the presence of calcium-rich minerals.

2 REFERENCED DOCUMENT

The following document is referred to in this Standard:

ISO
3310 Test sieves—Technical requirements and testing (series)

3 PRINCIPLE

The test primarily provides a visual assessment of the behaviour of soil particles to deflocculation in water. The particle is immersed in water and the soil crumb is observed after 10 minutes and classified as to colloids in suspension. However, if the soil is dispersive, the colloid suspension will not settle after a few hours.

The test may be performed using varying water types and on oven dried or in situ samples. In adopting varying preparation methods, the test results will vary to the standard method adopted.

4 APPARATUS

The following apparatus shall be used:

(a) 250 mL beakers (squat pattern).

(b) Sieves, 4.75 mm, 2.36 mm and 0.425 mm aperture, as designated in the ISO 3310 series.

(c) Spatula.

(d) Test tubes and stand.

(e) Thermometer readable to 1°C.

(f) A black background using heavy parchment or other suitable material.

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* For further information refer to Emerson, WW. 'A Classification of Soil Aggregates Based on their Coherence in Water'. *Australian Journal of Soil Research* 5(1) pp 47–57. 1967. Available on the CSIRO Publishing website.

(g) Balance with a limit of performance not exceeding 0.5 g.

(h) Timer.

(i) Funnel.

(j) Filter paper.

5 REAGENT

Distilled water.

NOTE: The test may be performed using other water sources if required by the specifier.

6 PROCEDURE

Figure 1 provides a flow chart of the method of determination of the Emerson class number.

The procedure shall be as follows:

(a) Obtain about 5 g of air-dried soil and screen through 4.75 mm and 2.36 mm sieves. Select three soil crumbs that are not individual particles retained on the 2.36 mm sieve.

(b) Put about 200 mL of water in a beaker. Carefully place three air-dried crumbs into the beaker of water, spaced around the base. Do not stir or otherwise disturb.

(c) Record the time of placing the crumbs in the water and allow a time period of ten minutes to elapse.

NOTE: Most dry soil crumbs slake (break up and run out along the bottom of the beaker in a flat pile) when immersed in water, owing to the stresses induced both by the compression of air as the negative pore water pressure attracts water into the soil, and by swelling. Release of compressed air may cause particles to fly off the crumb.

(d) Observe whether slaking occurs. If after two hours slaking does not occur, observe the crumbs to determine if swelling occurs. At the determination of a class number, measure and record the water temperature to the nearest 1°C.

(i) If the crumb does not slake and swelling does not occur classify the soil as Class 8.

(ii) If the crumb does not slake and swelling does occur, classify the soil as Class 7.

(iii) If a colloidal cloud covers the bottom of the beaker within 10 minutes (strong dispersion) or all the water in the beaker becomes cloudy leaving only a coarse residue in a cloud of clay (extreme dispersion), classify the soil as Class 1.

(iv) If a recognizable cloud of colloids in solution spreads as a thin streak on the bottom of the beaker (moderate dispersion) or there is a bare hint of a cloud in the water on the surface of the crumb (slight dispersion), classify the soil as Class 2.

(e) If the soil does not disperse after two hours, obtain a few grams of air-dried soil passing the 0.425 mm sieve and add distilled water to bring the soil to approximately the plastic limit. Use the spatula to remould at this moisture content for 2 min. Do not mould the soil to the plastic limit by hand as this will influence the test result. Mould three balls of this soil approximately 3 mm in diameter.

NOTE: For some soils there is a minimum initial moisture content at which they just start to show dispersion when immersed in water. This moisture content is intermediate between the maximum water uptake of an initially dry soil and that corresponding to a suspension. In engineering laboratories, it is convenient to wet to the plastic limit or up to 2% wet of the plastic limit. At this moisture content, the bonds between the clay particles are loosened by the water layers and dispersion is easier. The action of remoulding or shearing the soil tends to further break up the clay domains and establish a more random orientation with a

predominance of edge-to-face contacts. Dispersion is easier from this condition than from the oriented face-to-face condition. Thus, the 2 min of mechanical work with the spatula to bring the soil to the required moisture range is an important part of the operation. After the balls have been rolled, immerse them in the water immediately to avoid thixotropic regain of strength.

Carefully place remoulded balls into the beaker of water. Observe whether dispersion occurs.

If dispersion (extreme, strong, moderate or slight) occurs, classify the soil as Class 3.

(f) If the soil still does not disperse, check chemically for presence of calcium carbonate (calcite) or calcium sulfate (gypsum) using the applicable procedure in Appendix A. If the calcium carbonate or calcium sulphate is present, classify the soil as Class 4.

NOTE: The clay present in the soil may still not be dispersive if there are minerals in the crumbs or balls that dissolve rapidly enough to maintain the ionic concentration above the flocculating concentration. As the soluble salts diffuse out of soils containing calcium, the percentage of exchangeable sodium on the as yet undispersed clay is gradually reduced by exchange of sodium ions for calcium ions derived from the calcium-bearing minerals [usually calcium carbonate (calcite) or calcium sulfate (gypsum)] present, and the soil becomes less and less dispersive. Thus, it is necessary to determine whether calcium-rich minerals are present in soils that do not disperse from the moist state.

(g) If calcium carbonate (calcite) or calcium sulfate (gypsum) is not present, prepare a 1:5 soil/water suspension by placing 2 g of original air-dried soil in the bottom of a test tube and adding 10 mL of water. Shake vigorously for 10 min. Place test tube in a stand and allow to rest for 10 min.

(i) If the suspension remains dispersed, classify as Class 5.

(ii) If the suspension begins to flocculate within 10 min, i.e. the soil has settled and the water is becoming clear or almost clear at the surface of the water, classify as Class 6.

7 TEST REPORT

The following results shall be reported:

(a) Emerson class number.

(b) Sample identification.

(c) Source of material.

(d) Date of sampling.

(e) Soil description.

(f) Water used if not distilled.

(g) Reference to this Standard, i.e. AS 1289.3.8.1.