METHOD B15

THE DETERMINATION OF THE DRY BULK DENSITY, APPARENT RELATIVE DENSITY AND WATER ABSORPTION OF MATERIAL PASSING THE 4,75 mm SIEVE

SCOPE

The dry bulk density and apparent relative density of the --4,75 mm material, as defined below, are calculated from the loss in mass of the saturated surface-dry aggregate when it is sub-merged in water.

The water absorption is determined by calculating the percentage of water absorbed by the oven-dried material, after the 24-hour immersion in water.

Definitions

Relative density is the ratio of the mass in air of a given volume of a material at a stated temperature to the mass in air of an equal volume of distilled water at the same temperature.

Bulk relative density is the ratio of the mass in air of a given volume of material (including permeable and impermeable voids normal to the material) at a stated temperature, to the mass in air of an equal volume of distilled water, at the same temperature.

Apparent relative density is the ratio of the mass in air of a given volume of material (excluding the permeable voids but including the impermeable voids normal to the material) at a stated temperature to the mass in air of an equal volume of distilled water at the same temperature.

2 APPARATUS

2.1 A pycnometer of suitable capacity, at least two times the space required to accommodate the sample (see 5.1) .

2.2 A balance with a capacity of at least 200 gram and accurate to 0,001 gram for a 50-100 ml pycnometer, and a balance with a capacity of at least 2 000 gram, accurate to 0,01 gram, for a 500-1000 ml pycnometer.

2.3 A vacuum pump capable of maintaining a reduced pressure of 100 mm mercury.

2.4 A water bath capable of maintaining a temperature of 25 +1 EC.

2.5 A thermometer measuring 0-100°C.

2.6 A spatula or spoon.

2.7 A glass stirring rod.

2.8 A drying oven thermostatically controlled and capable of maintaining a temperature of 105 to 110EC .

2.9 A 25 ml pipette.

2.10 A metal mould in the form of a frustum of a cone with the following inner dimensions: top diameter, 37,5 1 mm; bottom diameter, 90 ± 1 mm; height, 75 ±1 mm; and a minimum metal thickness of 0,8 mm.

2.11 A metal tamping rod weighing 340 ± 15 gram and having a flat circular tamping face 25 ± 3 mm in diameter.

3 METHOD

3.1 By means of riffling obtain a sample of the material to be tested, passing the 4,75 mm sieve

The size of the test sample must be as follows:

Soil with a relatively high percentage passing the 0,075 mm sieve: approximately 25 gram

Sandy soil, sand and other fine aggregate: approximately 300 gram (see 5.2).

Cover the sample with water in a suitable container and soak for 24 + 4 hours. When the sample is in a natural soaked condition, the soaking time may be reduced (see 5.3).

3.2 Determination of the bulk relative density and apparent relative density

(It is not possible to determine the bulk relative density of cohesive soils because it is not possible to obtain the saturated surface-dry condition.)

3.2.1 After soaking the sample, drain off the free water and spread the sample on a flat surface exposed to a gently moving current of warm air. Stir the sample frequently to ensure uniform drying. Drying may be facilitated by spreading the sample on a porous surface such as heavy wrapping paper. Continue this drying operation until the material approaches a free-flowing condition.

Place the conical mould on a flat, nonabsorbent surface with the smaller opening facing upwards and fill it loosely to overflowing with the partially dried material. Tamp the surface of the material lightly 25 times with the tamping rod. Do not add additional material during or after tamping. Lift the mould vertically. If the material retains its conical shape, free water is still present.

Continue drying, with constant stirring, and test at frequent intervals until the cone of material slumps upon removal of the mould. This indicates that a saturated surface-dry condition has been reached. If the cone of material slumps upon removal

of the cone on the first trial, it may have been dried past the saturated surface-dry condition. In this case. thoroughly mix a few ml of water in the sample and permit it to stand in a covered container for 30 minutes. The process of drying and testing must then be resumed.

3.2.2 When the saturated surface-dry condition is reached, transfer the material immediately to a clean tared pycnometer and weigh, accurate to 0,001gram for a 50-100 ml pycnometer and to 0,01gram for a 500-1000 ml pycnometer. The pycnometer should have a capacity of at least twice the space required to accommodate the sample (see also 3.3).

3.2.3 Add distilled water to the sample in the pycnometer until it is about three-quarters full. Remove entrapped air by subjecting the sample to a partial vacuum (air pressure approximately 100 mm mercury) for a few minutes. This can be done by connecting the pycnometer directly to an aspirator or vacuum pump, or by using a bell jar. Some soils boil violently when subjected to reduced air pressure and in such cases the pressure should be increased. Place the pycnometer and contents in a constant temperature bath at 25 + 1 EC and leave until the contents of the pycnometer are at this temperature (approximately 20 minutes)(see 5.4). Fill the pycnometer with distilled water at 25 EC with a pipette up to.the mark (see 5.5 and 5.6). Dry the pycnometer quickly and thoroughly, and weigh it

3.2.4 Gently pour off the water without spil ling any of the sample. Dry the pycnometer with its contents to a constant mass in an oven at 105 to 110EC and weigh it. If the water in the pycnometer contains suspended material the water should not be poured off but the total quantity dried (see 5.7). Clean the pycnometer, fill with distilled water at 25EC, dry the outside and weigh it. Record the mass determinations on a suitable data sheet.

3.3 **Determination of the apparent relative density only**

After soaking the sample, as described in paragraph 3.1, transfer it to a clean, tared pycnometer. The capacity of the pycnometer must be at least twice the space required to accommodate the sample. Normally this will be:

for a sample of approximately 25 gram, a50- 100 ml pycnometer;

for a sample of approximately 300gram. a 500 - 1000 ml pycnometer.

Proceed as described in paragraphs 3 2.3 and 3.2.4. Record the determinations of mass on a suitable data sheet.

4 CALCULATIONS

4.1 Calculate the bulk relative density and apparent relative density to the nearest 0.001 from the following formulae:

$$\text{Dry bulk relative density } (25/25\,^{\circ}\text{C}) = \frac{A-E}{(D-E)-(C-B)}$$

$$\text{Apparent relative density } (25/25\,^{\circ}\text{C}) = \frac{A-E}{(D-E)-(C-A)}$$

where :

A = mass of oven-dry sample and pycnometer
B = mass of saturated surface-dry sample plus pycnometer
C = mass of saturated sample and pycnometer filled with water
D = mass of pycnometer filled with water only
E = mass of clean, dry pycnometer.

4.2 Calculate the percentage of water absorption to the nearest 0,1 from the following formula:

$$\textit{Percentage of water absorption } (m/m) = \frac{B-A}{A-E} \times 100$$

4.3 Report the bulk relative density and apparent relative density to the nearest 0,001 and water absorption to the nearest 0,1 per cent.

5 **NOTES**

5.1 The pycnometer may be a relative density flask with a perforated glass stopper or a volumetric flask or any other glass container equipped with a suitable means of ensuring that it can be filled to constant volume.

5.2 When the particle size of the grains is widely distributed, the test will not be wholly repeatable and more or larger samples should be tested .

5.3 Clayey materials should be mechanically dispersed to facilitate testing.

5.4 The standard temperature is taken as 25EC. The test may, however, be done at any

temperature in which case the relative density may be corrected to the relative density at 25EC, or the temperature at which the test was done must be stated, i.e. relative density at Tx/Tx EC.

5 5 Some materials tend to foam, thus interfering with the filling of the pycnometer. A drop or two of amyl alcohol will disperse the foam without affecting the test.

5.6 Organic material included in the weighed sample should not be removed. If it interferes with the test it may be removed, dried and weighed. This mass should then be deducted from the dry mass of the sample

5.7 When a soil sample is oven-dried there is a possibility of driving off chemically-held water. Samples with water in the chemical composition should be dried at a lower temperature at reduced air pressure.

5.8 Paraffin is a better wetting agent than water. Finer-grained samples may therefore be tested with paraffin and the relative density corrected accordingly. When paraffin is used the sample must be oven-dried before testing and the paraffin should be free of any water.

5 9 When the sample contains material both passing and retained on the 4,75 mm sieve. the relative density of the total sample is calculated as in Method B14, Section 5.4.

REFERENCES

AASHTO Designation T84~0 and T100-60
ASTM Designation D854-58 and C128
SABS Methods 843 and 844