

84-033 SHRINKAGE OF NATURAL CLOD SAMPLES (COLE clod)**1. Application**

- 1.1 The coefficient of linear extensibility for clod samples is determined using the dry and moist bulk densities. Bulk densities are obtained using natural clods, 5 to 8 cm. in diameter that have been coated with Saran resin. Volume is measured at 1/3 bar (33 kPa) retention and at oven dryness. The weight and volume of the coarse fragments (>2 mm) are subtracted from the weight and volume of the clod. Bulk density is reported only for the <2 mm material.

For undisturbed samples or clods, volume measurements are used rather than length measurements. It is assumed that dimensional changes per unit length along the three axes are equal. Then

$$\text{COLE} = \left[\left(\frac{V_m}{V_d} \right)^{1/3} \right] - 1$$

where V_m = volume of moist soil and V_d = volume of dry soil. If the reciprocals of the dry and moist bulk densities are substituted for the respective volumes then

$$\text{COLE} = \left(\left(\frac{D_{bd}}{D_{bm}} \right)^{1/3} \right) - 1$$

2. Apparatus and Materials

- 2.1 Identification tags
- 2.2 Nylon strings (fishing line)
- 2.3 Balance capable of weighing suspended samples
- 2.4 Diamond saw
- 2.5 Tension table
- 2.6 Pressure pot (optional)
- 2.7 Oven
- 2.8 2 mm sieve

3. Reagents

- 3.1 Methyl ethyl ketone
- 3.2 Saran resin F-310
- 3.3 Saran - methyl ethyl ketone solutions of ratios 1:4 and 1:8.
Dissolve the resin by shaking on a paint shaker or by stirring with an electric stirrer in a fume hood. Keep containers tightly closed to avoid evaporation and breathing of fumes.

4. Procedures

- 4.1 Select clods of about 50 to 200 cm³, trim off loose material and tie a tagged string around the clod. Determine the average weight of the string and tag (W_1).

- 4.2 Dip the clod in saran solution and let dry for 30 minutes. Any loose material is usually removed by the first dipping and weighing after one coating compensates for any loss of material. Previous experiments have shown that the first coating can be two to three times heavier than the average of many coatings. Therefore, the first coating must be accomplished by a rapid immersion in the saran solution.
- 4.3 Weigh the clod (W2) and then apply additional coatings at 15 minute intervals until the sample is waterproofed and bubbles are no longer released during dippings. Record the total number of coatings (N) and allow 30 minutes before weighing in air (W3).
- 4.4 Using a diamond saw cut off some of the clod and coating and create a flat surface. Determine the weight of the plastic remaining on the clod (Pr). Previous experiments have shown that Pr will be 0.8 times the weight of coating for most samples.
- 4.5 The flat surface of the clod is seated on a tension table at 5-10 cm tension until the entire coating has turned white. Poking a few holes in the coating on top of the clod allows any air present in the sample to escape. Then apply 1/3 bar tension (33 kPa) for 5-6 days on the tension table or pressure pot.
- 4.6 The clod is carefully removed from the table or pot, weighed in air (W4) and waterproofed by applying about 5 coats of saran.
- 4.7 After the final coating has dried for at least 30 minutes, the clod is weighed in air (W5) and in water (W6).
- 4.8 The clod is oven dried by gradually raising the temperature from 50°C to 105°C over a period of 3 days. After cooling in a desiccator, the clod is weighed in air (W7).
- 4.9 Apply as many coats as necessary to waterproof the clod and then weigh in air (W8) and in water (W9). Oven drying commonly cracks the coating and the clod takes up water as indicated by air bubbles. Coating the clod removes this possibility.
- 4.10 If the clod is suspected to contain more than about 5% gravel, break the clod apart and separate the >2 mm material by sieving. The coarse material is washed with water, dried and weighed (W10). The volume (Vg) is determined by measuring the displacement of water in a graduated cylinder when the material is added.

5. Calculations

5.1 Weight and volume of saran coatings

- a) weight of air dry plastic after 4.6 is A1

$$A1 = \frac{W3-W2}{N-1} + W3-W2) Pr + (W5-W4)$$
- b) weight of oven dry plastic after 4.6 is A2 = 0.9A1
 (on drying saran loses about 10% of the weight).
- c) weight of plastic after 4.8 is A3 = A2 + (W8-W7).

d) volume of coatings after 4.6 is $V1 = \frac{A1}{1.3}$

The density of saran is 1.3 g/cm^3 .

e) volume of coatings after 4.8 is $V2 = \frac{A3}{1.3}$

5.2 Corrected weight of clods

a) at 1/3 bar = $A4 = W5 - A1 - W1 - W10$

b) oven-dry = $A5 = W7 - A2 - W1 - W10$

5.3 Corrected volume of clods

a) at 1/3 bar = $V3 = (W5-W6) - V1 - Vg$

b) oven-dry = $V4 = (W8-W9) - V2 - Vg$

5.4 Corrected bulk density

a) at 1/3 bar = $Db \text{ 1/3 bar} = \frac{A5}{V3}$

b) oven-dry = $Dbod = \frac{A5}{V4}$

5.5 Water content at 1/3 bar

a) percent by weight = $\frac{A4-A5}{A5} \times 100$

b) percent by volume = percent by weight X $Db \text{ 1/3 bar}$

5.6 Coefficient of linear extensibility = COLE =

$$\left(\frac{Dbod}{Db \text{ 1/3 bar}} \right)^{1/3} - 1$$

6. Interpretation of Results

6.1 Since COLE clod values are usually less than 0.1 and provide an estimate of shrinkage, the validity of results depends on the number of replicate clods per horizon.

7. References

7.1 Brasher, B.B., Franzmeier, D.P., Valassis, V.T. and Davidson, S.E. 1966. Use of saran resin to coat natural clods for bulk density and water retention measurements. Soil Sci. 101:108.

- 7.2 Grossman, R.B., Brasher, B.R., Fransmeier, D.P. and Walker, J.L. 1968. Linear extensibility as calculated from natural clod bulk density measurements. Soil Sci. Soc. Am. Proc. 32:570-573.
- 7.3 Franzmeier, D.P. and Ross, S.J., Jr. 1968. Soil swelling: Laboratory measurements and relation to other soil properties. Soil Sci. Soc. Am. Proc. 32: 573-577.