METHOD A4

THE DETERMINATION OF THE LINEAR SHRINKAGE OF SOILS

SCOPE

This method covers the determination of the linear shrinkage of soil when it is dried from a moisture content equivalent to the liquid limit to the oven-dry state.

Definition

The linear shrinkage of a soil for the moisture content equivalent to the liquid limit, is the decrease in one dimension, expressed as a percentage of the original dimension of the soil mass, when the moisture content is reduced from the liquid limit to an oven-dry state.

2 APPARATUS

2.1 A shrinkage trough with inside dimensions of 150 ± 0,25mm long x 10 ± 0,25 x 10 ± 0,25mm and made of 1,6 mm thick tinned copper or stainless steel.

2.2 A small thick-bristle paint brush, about 5 mm wide.

2.3 Paraffin wax.

2.4 A small enamel dish or other suitable container in which to melt the wax.

2.5 A spatula with a slightly flexible blade about 100 mm long and 20 mm wide.

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

2..7 A pair of dividers and a millimetre scale.

3 METHOD

3.1 Waxing the trough

A clean, dry shrinkage trough is first warmed to prevent premature setting of the wax. The inside ot the trough is then covered completely with a thin layer ot molten wax applied by means of a small paint brush. Any excess or molten wax is shaken out by tapping the trough lightly in an inverted position. The layer ot wax is now chilled by rubbing the outside ot the trough with a damp cloth. This prevents the tendency to crack on cooling, leaving the surface of the trough partly exposed. The tilm of wax in the trough should weigh from 0,1 to 0,2 9 to obtain satisfactory results. Before using, the trough should be inspected carefully, so as to ensure that there are no patches without any wax.

3.2 Filling the trough

The test should be run immediately after the flow curve or one-point liquid limit test (see Method A2) has been completed so that the moist material left over can be used for filling the trough without further mixing. The number of taps required for groove closure for the final determination in the liquid limit test should be recorded, since this value is required in the calculation of the linear shrinkage.
Fill one half of the waxed trough with the moist soil by taking small pieces of soil on the spatula and pressing the soil down against the one end of the trough and working along the trough until the whole side is filled and the soil forms a diagonal surface from the top of one side to the bottom of the opposite side (see Fig. (a)).
The trough is now turned round and the other portion is filled in the same manner (see Fig. (b)). The hollow along the top of the soil in the trough is now filled so that the soil is raised slightly above the sides of the trough (see Fig. (c)). The excess material is removed by drawing the blade of the spatula once only from the one end of the trough to the other. The index finger is pressed down on the blade so that the blade moves along the sides of the trough (see Fig. (d)). During this process the wet soil may pull away from the end of the trough, in which case it should be pushed back gently with the spatula.

N.B. The soil surface should on no account be smoothed or finished off with a wet spatula.

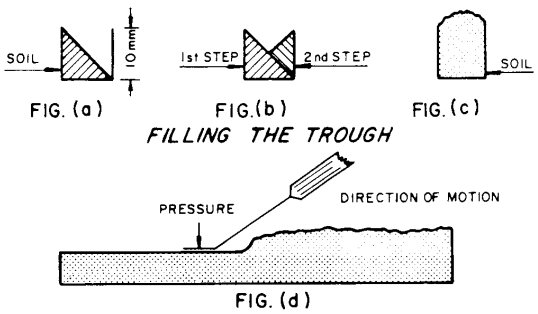

FIG. (a) FIG.(b) FIG.(c)
FILLING THE TROUGH

FIG. (d)
SCRAPING OFF THE EXCESS MATERIAL

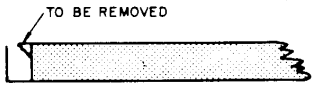

FIG. (e)
REMOVING THE LIP

3.3 Drying the wet material

The trough with wet material is now placed in a drying oven and dried at a temperature of between 105 and 110 EC until all shrinkage has stopped. As a rule the material is dried out overnight--though three hours should be sufficient time in the oven. The trough with material is taken out and allowed to cool in the air.

3.4 Measuring the shrinkage

It will be found that the ends of the dry soil bar have a slight lip or projecting piece at

the top. These lips must be removed by abrading with a sharp, narrow spatula, so that the end of the soil bar is parallel to the end of the trough (see Fig. (e)) . If the soil bar is curved, it should be pressed back into the trough with the finger-tips so as to make the top surface as level as possible.
The loose dust and sand, removed from the ends, as well as loose material between cracks should be emptied out of the trough by carefully inverting the trough whilst the material is being held in position with the fingers. The soil bar is then pressed tightly against the end of the trough. It will be noticed that the soil bar fits better at the one end than at the other end. The bar should be pressed tightly against the end at which there is a better fit. The distance between the other end of the soil bar and the respective end of the trough, is measured by means of a good pair of dividers, measuring on a millimetre scale, to the nearest 0,5 mm and recorded on Form A2/1, or similar, appended to Method A2.

4 CALCULATIONS

4.1 The linear shrinkage is calculated from the following formula (see 5.1):

$$LS = LS_N x \frac{0.8}{1 - 0.008N}$$

where

LS = linear shrinkage, expressed as a percentage of the original wet length of 150 mm, when the moisture content is reduced from the liquid limit to an oven-dry state.

LS_N = linear shrinkage, expressed as a percentage of the original wet length of 150 mm, when the moisture content corresponding to N taps in the liquid limit test is reduced to an oven-dry state.

The linear shrinkage is reported to the nearest 0.5 % on Form A1/2, or a similar form.

The formula may also be written as follows:

LS = shrinkage in mm as measured x f where :

$$f = \frac{100}{150} \times \frac{0.8}{1 - 0.008N}$$

To simplify the calculation, values of f are given in the table below for various values of N:

N	f	N	f	N	f
15	0,61	22	0,65	29	0,70
16	0,61	23	0,65	30	0,70
17	0,62	24	0,66	31	0,71

18	0,62.	25	0,67	32	0,72
19	0,63	26	0,67	33	0,73
20	0,64	27	0,68	34	0,73
21	0,64	28	0,69	35	0,74

5 NOTES

5.1 For a soil paste with a moisture content requiring between 15 and 35 taps for groove closure in the liquid limit test, a linear relationship has been found to exist between the number of taps (N) and the shrinkage of the soil paste when dried. Different soil types give different straight line curves and there is a tendency for these lines to converge at about N = 125 when the shrinkage = 0. For this family of straight lines, the relationship between the linear shrinkage from a moisture content equivalent to the liquid limit and the linear shrinkage from a moisture content corresponding to N taps in the liquid limit test, is as given by the formula.

5.2 The troughs should be examined for dents and distorted sides, and any faults corrected before use.

5.3 After testing, the soil bar should be examined to ensure that the corners of the trough were filled properly and that no air pockets were contained in the soil bar.

REFERENCE

California Test Method 228 - A