c) SHRINKAGE LIMIT TEST

(IS-2720-PART-6-1972) (Reaffirmed-2001)

THEORY:

The water content at which a reduction in water content will not cause a decrease in volume of the soil mass but an increase in water will increase the volume. It is the minimum water content at which soil is still in a saturated condition. It is the state which acts as boundary between solid and semi-solid states.

NEED AND SCOPE:

A shrinkage limit test gives an indication of how much moisture content can change before any significant volume change. The shrinkage limit is useful in areas where soils undergo large volume changes when going through wet and dry cycles (e.g., Black cotton soil) due to seasonal variation.

APPARATUS REQUIRED:

1.) Evaporating Dish of Porcelain
2.) Spatula and Straight Edge
3.) Balance-Sensitive to 0.01 g minimum
4.) Shrinkage Dish - Circular, porcelain or non-corroding metal dish
5.) Glass cup. 50-55 mm in diameter and 25 mm in height
6.) Glass plates - Two, 75×75 mm one plate of plain glass and the other prongs
7.) Thermostatically controlled Oven
8.) Wash bottle containing distilled water
9.) Graduate-Glass, with capacity of 25 ml
10.) Mercury
11.) Grease

PROCEDURE:

Preparation of soil paste

1. Take about 100 gm of a soil sample from a thoroughly mixed portion of the material passing through a **425 µm Sieve**. Place about 30 gm of the above soil sample in the evaporating dish and thoroughly mixed with distilled water and make a creamy paste. (Use water content slightly higher than the liquid limit)

Filling the shrinkage dish

2. Coat the inside of the shrinkage dish with a thin layer of grease to prevent the soil from sticking to the dish.
3. Fill the dish in three layers by placing approximately 1/3 rd of the amount of wet soil with the help of the spatula. Tap the dish gently on a firm base until the soil flows over the edges and no apparent air bubbles exist. Repeat this process for the 2nd and 3rd layers also till the dish is completely filled with the wet soil. Strike off the excess soil and make the top of the dish smooth. Wipe off all the soil adhering to the outside of the dish.
4. Weigh immediately the dish with wet soil and record the weight.
5. Air- dry the wet soil cake for 24 hrs, until the color of the pat turns from dark to light. Then oven-dry the cake at 105^0C to 110^0C say about 24 hours.

6. Remove the dried disk of the soil from the oven. Cool it in a desiccator. Then obtain the weight of the dish with a dry sample.
7. Determine the weight of the empty dish and record.
8. Determine the volume of the shrinkage dish which is evidently equal to the volume of the wet soil as follows:

   Place the shrinkage dish in an evaporating dish and fill the dish with mercury till it overflows slightly. Press it with a plain glass plate firmly on its top to remove excess mercury. Pour the mercury from the shrinkage dish into a measuring jar and find the shrinkage dish volume directly. Record this volume as the volume of wet soil pat.

Volume of the dry soil pat

9. Determine the volume of dry soil pat by removing the pat from the shrinkage dish and immersing it in the glass cup full of mercury in the following manner.

- Place the glass cup in a larger one and fill the glass cup to overflow with mercury. Remove the excess mercury by covering the cup with a glass plate with prongs and pressing it. See that no air bubbles are entrapped. Wipe out the outside of the glass cup to remove the adhering mercury. Then, place it in another larger dish, which is, clean and empty carefully.
- Place the dry soil pat on the mercury. Submerge the pat which is floating with the pronged glass plate which is again made flush with the top of the cup. The mercury spills over into the larger plate. Pour the mercury that is displaced by the soil pat into the measuring jar and find the volume of the soil pat directly.

TABULATION AND RESULTS:

Sr.No	Determination No.	1	2	3
1	Wt. of container in gm, W_1			
2	Wt. of container + wet soil pat in gm, W_2			
3	Wt. of container + dry soil pat in gm, W_3			
4	Wt. of oven-dry soil pat, W_0 in gm = (W_3-W_1)			
5	Wt. of water in gm = (W_2-W_3)			
6	Moisture content (%), $W = (W_2-W_3)/ (W_3-W_1)*100$			
7	Volume of wet soil pat (V), in cm			
8	Volume of dry soil pat (V_d) in cm^3 = $(W_m)/ (G_m)$ By mercury displacement method a. Weight of displaced mercury in gm (W_m) b. Specific gravity of the mercury (G_m)			
9	Shrinkage limit (W_S) = $[W – \{(V-V_d)*(\gamma_w /W_o)\}] \times 100$			
10	Shrinkage ratio (R) = $\{(V-V_d)/V_d\}*100/(W-W_s)$			

INTERPRETATION:

Correlation between shrinkage limit with degree of expansion is given in the table below:

Shrinkage limit (%)	Degree of expansion
>15	Low
10-16	Medium
7-12	High
<11	Very high

CAUTION: DO NOT TOUCH THE MERCURY WITH GOLD RINGS.