State of Nevada
Department of Transportation
Materials Division

METHOD OF TEST FOR DETERMINING THE PLASTIC LIMIT AND PLASTICITY INDEX OF SOILS

SCOPE

The plastic limit of a soil is the lowest water content determined in accordance with the following procedure at which the soil remains plastic. The plasticity index of a soil is the range in water content, expressed as a percentage of the mass of the oven dried soil, within which the material is in a plastic state. It is the numerical difference between the liquid limit and the plastic limit of the soil.

APPARATUS

1. Porcelain dish or similar mixing dish, approximately 115 to 150 mm (4.5 to 6 in.) in diameter.

2. Spatula or pill knife having a blade approximately 75 to 100 mm (3 to 4 in.) in length and 13 to 20 mm (1/2 to 3/4 in.) in width.

3. Ground glass plate, on which to roll the sample.

4. Containers, made of materials resistant to corrosion and not subject to change in mass or disintegration on repeated heating and cooling. Containers shall have tight fitting lids to prevent loss of moisture from samples before initial mass determination and to prevent absorption of moisture from the atmosphere following drying and before final mass determination. One container is needed for each moisture content determination.

5. Glass beaker, 600 mL or other suitable microwave safe container.

6. Watch glass, approximately 75 mm (3.0 in.) in diameter.

7. Balance, 500 g minimum capacity, accurate to ± .01 g.

8. Oven, thermostatically controlled, capable of maintaining temperatures of 110 ± 5ºC (230 ± 9ºF).

9. Microwave oven, preferably with vented chamber and variable power control to prevent overheating of soil.

SAMPLE

After hydration, take a sample with a mass of about 8 g from the thoroughly wet and mixed portion of the soil prepared in accordance with Test Method Nev. T203 and Test Method Nev. T210. Take the sample during the mixing process when the mass becomes plastic enough to be easily shaped into a ball without sticking to the fingers excessively when squeezed. If the sample is taken before completion of the liquid limit test, set it aside until the liquid limit test has been completed. If the sample taken during the liquid limit test is too dry to permit rolling to a 3 mm (1/8 in.) thread, add more water and remix.

PROCEDURE

1. Squeeze and form the 8 g test sample into an ellipsoidal shaped mass. Divide the sample into 1.5 to 2.0 g portions. Cover the remainder of the 8 g sample to prevent moisture loss.

2. Roll each portion into a 3 mm (1/8 in.) thread at a rate of 80 to 90 strokes per minute, counting a stroke as one complete motion of the hand forward and back to the starting position again. Roll the mass between the palm or fingers and the ground glass plate on a smooth horizontal surface with just sufficient pressure to roll the mass into a thread of uniform diameter throughout its length. The thread shall be further deformed on each stroke so that its diameter reaches 3 mm (1/8 in.), taking no more than two minutes. The amount of hand or finger pressure required will vary greatly, according to the soil. Fragile soils of low plasticity are best rolled under the outer edge of the palm or at the base of the thumb.

3. When the diameter of the thread becomes 3 mm (1/8 in.), break the thread into six or eight pieces. Squeeze the pieces together between the thumb and fingers of both hands into a uniform mass roughly ellipsoidal in shape and reroll. Continue this alternate rolling into a thread 3 mm (1/8 in.) in diameter, gathering together, kneading and rerolling, until the thread crumbles under the pressure required for rolling and the soil can no longer be rolled into a thread. The crumbling may occur when the thread has a diameter greater than 3 mm (1/8 in.). This shall be considered a satisfactory end point, provided the solid has been previously rolled into a thread 3 mm (1/8 in.) in diameter. The crumbling will manifest itself differently with the various types of soils. Some soils fall apart in numerous small aggregations of particles; others may form an outside tubular layer that starts splitting at both ends. The splitting progresses toward the middle, and finally, the thread falls apart in many small platy particles. Heavy clay soils require much pressure to deform the thread, particularly as they approach the plastic limit, and finally, the thread breaks into a series of barrel shaped segments each about 6 to 9 mm (1/4 to 3/8 in.) in length. At no time shall the operator attempt to produce failure at exactly 3 mm (1/8 in.) diameter by allowing the thread to reach 3 mm (1/8 in.), then reducing the rate of rolling or the hand pressure, or both, and continuing the rolling without further deformation until the thread falls apart. It is permissible, however, to reduce the total amount of deformation for feebly plastic soils by making the initial diameter of the ellipsoidal shaped mass nearer to the required 3 mm (1/8 in.) final diameter. Note: If the soil will not roll out to the required 3 mm (1/8 in.) diameter and sufficient moisture has been added, the plastic limit will be reported as NA and the plasticity index will be reported as NP.

4. Repeat the procedure described above until the 8 g sample is completely tested.

5. Gather the portions of the crumbled soil together and place in a suitable tared container. Weigh the container and soil and record the weight.

6. Oven dry the soil in the container to a constant weight at 110°C (230°F) or by the following microwave oven procedure: Place a 600 mL glass beaker or other suitable container filled with approximately 300 mL of water (maintain water level during drying) into the microwave oven to prevent overheating during the drying process. Place the sample on a watch glass, then place into microwave oven. Dry the sample for 5 minutes, then at 2 minute intervals until a constant weight is achieved. Drying times may be adjusted based on type and size of microwave oven. Weigh and record the loss in weight as the weight of water.

CALCULATIONS

1. Calculate the plastic limit, expressed as the water content in percentage of the mass of the oven dry soil, as follows:

$$\text{Plastic Limit} = \frac{\text{mass of water}}{\text{mass of oven dry soil}} \text{ X } 100$$

   Calculate the plastic limit to the nearest 0.1.

2. Calculate the plasticity index of a soil as the difference between its liquid limit and its plastic limit, as follows:

   Plasticity Index = Liquid Limit – Plastic Limit

   The plasticity index is the difference calculated above, except under the following conditions:

   a. When the liquid limit or plastic limit cannot be determined, report the plasticity index as NP (non-plastic).

   b. When the plastic limit is equal to, or greater than, the liquid limit, report the plasticity index as NP (non-plastic).

   Calculate the plasticity index to the nearest 0.1.

REPORT

Report the plasticity index to the nearest whole number.

PRECISION STATEMENT

This precision statement applies to soils with a plastic limit range between 15 and 36.

Repeatability (Single Operator): Two results obtained by the same operator on the same sample in the same laboratory using the same apparatus should be considered suspect if they differ by more than 10 percent of their mean.

Reproducibility (Multilaboratory): Two results obtained by different operators in different laboratories should be considered suspect if they differ from each other by more than 18 percent of their mean.