1. **SCOPE**

   1.1. **Description of Test**

       This method describes the procedure for determining the plasticity index of fine-grained soils. This includes all soils having more than 50% of its particles passing a No. 400 mm Canadian Metric sieve.

   1.2. **Units of Measure**

       The plasticity index of a soil is the numerical difference between its liquid and plastic limits.

       The lowest water content determined by the following procedure at which the soil remains plastic is the plastic limit.

       The water content determined by the following procedure at which the soil passes from a plastic state to a liquid state is the liquid limit.

2. **APPARATUS AND MATERIALS**

   2.1. **Equipment Required**

       Pulverizing apparatus - a mortar and rubber covered pestle.

       Drying apparatus - oven or stove suitable for drying samples.

       Sieve - a 400 mm sieve with pan.

       Evaporating dish - a porcelain dish about 100 mm in diameter.

       Spatula - a spatula having a blade approximately 75 mm in length and 19 mm in width.

       Liquid limit device - a mechanical device consisting of a brass cup and carriage, constructed as shown in Figure 205-1.

       Grooving tool - a combination grooving tool and gauge as shown in Figure 205-1.
Surface for Rolling - a ground glass plate or piece of smooth unglazed paper used for rolling plastic limit determinations.

Containers - suitable containers such as aluminum tares with covers to prevent the loss of moisture during the weighing of the sample.

Balance - a balance sensitive to 0.02 g.

3. **PROCEDURE**

3.1. **Sample Preparation**

Select a representative air dried soil sample to yield approximately 115 grams of material passing the No. 400 mm sieve.

Separate the soil into two parts using a No. 400 mm sieve.

Grind the retained fraction using the mortar and pestle to break up soil aggregations without fracturing the individual grains and re-sieve. Regrind the material retained until the grindings produce only a small quantity of material passing the sieve.

Discard the material retained on the sieve.

Recombine the portions passing the No. 400 mm sieve and mix thoroughly before determination of the liquid limit and plastic limit.

3.2. **Test Procedure**

3.2.1. **Liquid Limit Determination**

Adjust the liquid limit device by means of the adjustment plate on the device and the gauge on the handle of the grooving tool. Adjust so the centre of the wear point on bottom of cup is lifted exactly 1 cm above the base. Secure adjustment plate by tightening screws.

Place approximately 100 grams of prepared soil in the evaporating dish and add 15 to 20 ml of water and mix water thoroughly with the soil. Then add sufficient water and thoroughly mix to form a uniform mass of stiff consistency.

Place mixture in the cup over the spot where the cup rests on the base and spread into place with as few strokes as possible to a depth of 10 mm.
Take care to prevent the entrapment of air bubbles within the mass.

Divide the soil in the cup with a firm stroke of the grooving tool along the diameter through the centreline of the cam follower.

Sand soils may require several strokes of the grooving tool to make a satisfactory groove without tearing the soil. For these soils, increase the depth of the groove gradually with each stroke and only the last stroke should scrape the bottom of the cup.

Turn the crank to raise and drop the cup twice per second until the two sides of the grooved sample come in contact at the bottom of the groove for a distance of 12.5 mm.

Record the number of blows.

If the number of blows is between 15 and 40, take a representative sample of the soil in the cup for moisture content.

If the number of blows is outside the range of 15 to 40, transfer the soil from the cup to the evaporating dish. Adjust the moisture content by mixing, with or without the addition of water and repeat the test until the blows fall within the range of 15-40 blows.

Clean the cup of the liquid limit device after each trial test.

Determine the moisture content by placing the sample in a tared aluminum can and weighing.

Repeat the test and obtain a second moisture sample.

Oven dry the samples at 110°C to a constant weight and weigh after cooling.

### 3.2.2. Plastic Limit Determination

Place approximately 20 grams of the prepared soil in evaporating dish and thoroughly mix with water until the mass becomes plastic enough to be shaped into a ball.

Take approximately 8 to 12 grams of the moistened soil and form into a uniform mass roughly elliptical in shape.
Roll the ball of soil by hand on the rolling surface with just enough pressure to form an elongated thread as rolling proceeds.

If the soil can be rolled to a thread 3 mm thick without crumbling, amass it and re-roll it.

Repeat rolling and amassing until the soil crumbles under slight pressure required for rolling. Crumbling may occur when the soil has a diameter greater than 3 mm, however, this is considered a satisfactory end point, provided the soil has been previously rolled into a 3 mm thread.

Gather portions of the crumbled soil and place in a tared aluminum can and weigh, then oven dry at 110°C to a constant weight and weigh again after cooling.

4. RESULTS AND CALCULATIONS

4.1. Calculations

4.1.1. Calculations for Liquid Limit

Record the numerical difference between the wet and dry weight as weight of moisture.

The "weight of moisture" divided by the "dry weight of sample" and multiplied by one hundred is the percent moisture.

The moisture content and corresponding number of blows for the two liquid limit determinations is used to calculate the liquid limit ($w_L$) at 25 blows. Adjust the moisture content of the sample by dividing by a denominator selected from the following chart:
Calculate the liquid limit for each test and average the results as shown in the following example.

\[
\begin{array}{c|c|c|c|}
\text{Test} & 1 & 2 \\
\text{Blows} & 19 & 31 \\
\text{Moisture} & 33.79 & 31.50 \\
\end{array}
\]

\[
w_L(25 \text{ blows}) = \frac{33.79}{1.037} = 32.6 \quad \frac{31.50}{.972} = 32.4
\]

The duplicate liquid limit results should be repeated if they do not fall within the limits shown below.

- \(w_L\) 30 - repeatability within 1.0%
- \(w_L\) 30-60 - repeatability within 2.0%
- \(w_L\) 60 - repeatability within 3.0%

### 4.1.2. Calculations for Plastic Limit

Record the difference between the wet and dry weights as the weight of moisture.

Calculate the plastic limit \(w_p\) by dividing the "weight of moisture" by the "dry weight of sample" and multiply by 100.

\[
\text{Plastic Limit (} w_p \text{) } = \frac{\text{wt. of moist.}}{\text{wt. of oven dry soil}} \times 100
\]
4.1.3. **Calculations for Plasticity Index**

Plasticity Index ($I_p$) of a soil is the numerical difference between its Liquid Limit and its Plastic Limit.

$$I_p = w_L - w_p$$

4.2. **Reporting Results**

Report the liquid limit and plasticity index on Form MR-20 and MR-85.

Report as non-plastic if the liquid limit or plastic limit cannot be determined.

Report as non-plastic if the plastic limit is equal to or greater than the liquid limit.

5. **ADDED INFORMATION**

5.1. **References**

ASTM D423 and D424.

5.2. **General**

It is important to take the correct amount of soil for the plastic limit test. The usual error is to take too large a sample which may give an incorrect answer.

For the liquid limit test, it is important to thoroughly mix soil and water. Avoid adding dry soil to a mixture which is too wet; dry it by stirring instead.

When making liquid limit tests for reference purposes, the following will apply:

Mixing of soil with water: 5 to 20 minutes, the longer period used for the more plastic soils.

Seasoning in the humidifier for 25 hours.

Add 1 ml of water and mix for 1 minute and remix until the soil appears to have such a consistency that the groove will close in 25 to 35 blows.

Place in the brass cup, testing and weighing within 3 minutes.

Washing cup and grooving tool, adding water and remixing within 3 minutes.
<table>
<thead>
<tr>
<th>Section</th>
<th>Subject</th>
</tr>
</thead>
<tbody>
<tr>
<td>SOILS</td>
<td>ATTERBERG PLASTICITY INDEX</td>
</tr>
</tbody>
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Repeat in triplicate and in no case shall dried soil be added to the seasonal soil being tested.

Do not record any trials requiring less than 15 drops or more than 35 drops of the cup.

For important research projects, the soil used for liquid and plastic limits should not be dried prior to preparation for testing; drying may alter soil by causing the particles to subdivide or agglomerate by driving off absorbed water which is not completely regained on rewetting. Also oven drying of organic soils may cause chemical changes which significantly lower the liquid limit values.
FIGURE 205–1

SQUARE END

10mm

2.2mm

73mm

10mm

2mm

13.5mm

60°

54mm

2mm

21mm

12.7mm

59.5mm

50mm

HARD RUBBER