

# Australian Standard™

## Methods of testing soils for engineering purposes

### Method 3.9.2: Soil classification tests— Determination of the cone liquid limit of soil— One-point method

#### 1 SCOPE

This Standard sets out the method for determining the cone liquid limit of a soil using a cone penetrometer and only one measurement of moisture content. This method enables a result to be obtained when only a small amount of soil is available. The definition of liquid limit inherent in this method is not the same as that in the method using the Casagrande apparatus (AS 1289.3.1.1) although the values can be numerically similar (see Note 1).

##### NOTES:

- 1 Using the cone penetrometer, the one-point method is likely to give results that are less reliable than those obtained using the four-point method (see AS 1289.3.9.1) and is therefore suitable only where a less accurate result is acceptable.
- 2 If it is suspected that the liquid limit is higher than about 120%, the method specified in AS 1289.3.9.1 should be followed using the appropriate sample size.

#### 2 REFERENCED DOCUMENTS

The following documents are referred to in this Standard:

##### AS

|            |  |
|------------|--|
| 1289       | Methods of testing soils for engineering purposes  |
| 1289.1.1   | Method 1.1: Sampling and preparation of soils—Preparation of disturbed soil samples for testing                                |
| 1289.2.1.1 | Method 2.1.1: Soil moisture content tests—Determination of the moisture content of a soil—Oven drying method (standard method) |
| 1289.3.1.1 | Method 3.1.1: Soil classification tests—Determination of the liquid limit of a soil—Four-point Casagrande method               |
| 1289.3.9.1 | Method 3.9.1: Soil classification tests—Determination of the cone liquid limit of a soil                                       |

##### BS

|         |   |
|---------|---|
| 1377    | Methods of test for soils for civil engineering purposes                    |
| 2000    | Methods of test for petroleum and its products                              |
| 2000.49 | Part 49: Bitumen and bituminous binders—Determination of needle penetration |

#### 3 APPARATUS

The following apparatus is required:

- (a) Enamel, glass or plastic bowls approximately 150 mm diameter, with suitable close-fitting covers.

- (b) A flat glass plate approximately 10 mm thick and 450 mm square (optional).
- (c) Two palette knives, each with a blade approximately 200 mm long and 30 mm wide, or other convenient sizes.
- (d) A manual or automatic release penetrometer generally complying with BS 2000.49 (with the exception of the total mass of the needle and shaft) and generally as illustrated in BS 1377 and Figure 1.
- (e) A metal right cone of length not less than 32 mm and with an included angle of  $30 \pm 1^\circ$ . The cone shall have a smooth, unblemished, polished surface and shall be replaced when the point can no longer be felt when brushed lightly with a fingertip when the tip of the cone is pushed through a hole of  $1.5 \pm 0.1$  mm diameter bored through a metal plate  $1.75 \pm 0.1$  mm thick. The cone shall be fitted to the penetrometer in the manner shown in Figure 1. The combined mass of the cone and the sliding shaft shall be  $80.00 \pm 0.05$  g.
- (f) A rigid cup with a near-constant internal diameter of not less than 53 mm, an internal height of not less than 40 mm and a smooth rim parallel to a flat base.
- (g) Apparatus for moisture content determination as described in AS 1289.2.1.1.
- (h) A wash bottle and potable water.
- (i) A metal straightedge (optional).

#### 4 PROCEDURE

The procedure shall be as follows:

- (a) Obtain a sample of approximately 100 g of the material passing the 425  $\mu\text{m}$  sieve and prepared in accordance with AS 1289.1.1. Alternatively, use any soil that passes a 425  $\mu\text{m}$  sieve in its natural state, without further preparation.  
NOTE: For many soils the influence of curtailing or omitting the curing time introduces errors that are unlikely to be greater than those inherent in this rapid procedure.
- (b) Thoroughly mix the paste with distilled water using the two palette knives. Adjust the moisture content to that corresponding to a cone penetration of between 15 mm and 25 mm, and as close as possible to 20 mm. If necessary, check this with the cone penetrometer device. Mix for at least 10 min.  
NOTE: Some soils (e.g., clays of high plasticity and residual soils) may require up to 40 min of continuous mixing immediately before testing to obtain reliable results. If in doubt, carry out comparative tests.
- (c) Push a portion of the mixed soil into the cup with a palette knife, taking care not to trap air. Strike off excess soil with the straightedge to give a smooth surface.
- (d) With the cone locked in the raised position lower the supporting assembly so that the tip of the cone just touches the surface of the soil. When the cone is in the correct position a slight movement of the cup will just mark the soil surface. Record the reading of the dial gauge to the nearest 0.1 mm.
- (e) Release the cone for a period of  $5 \pm 1$  s. If the apparatus is not fitted with an automatic release and locking device take care not to jerk the apparatus during this operation. After locking the cone in position lower the dial gauge to the new position of the cone shaft and note the reading to the nearest 0.1 mm. Record the difference between the beginning and end of the drop as the cone penetration.
- (f) Lift out the cone and clean it carefully to avoid scratching.
- (g) Add a little more wet soil to the cup, taking care not to trap air. Make the surface smooth, as specified in Step (c), and repeat Steps (d) to (f).

- (h) Repeat Steps (d) to (g) until two consecutive tests within the range 15 mm to 25 mm give cone penetration readings within 0.5 mm of each other.
- (i) Remove the bulk of the soil from the cup, including the zone penetration by the cone. Place it in a suitable container and determine its moisture content as specified in AS 1289.2.1.1.

## 5 CALCULATIONS

Calculate the moisture content of the test sample as specified in AS 1289.2.1.1 and express the result to the first decimal place. Obtain the factor corresponding to the cone penetration and the moisture content range from Table 1.

Calculate the liquid limit from the equation—

$$\text{liquid limit} = \text{moisture content} \times \text{factor}$$

and express the result to the nearest whole number.

**TABLE 1**  
**FACTORS FOR ONE-POINT CONE PENETROMETER**  
**LIQUID LIMIT TEST**

| Cone penetration<br>(mm) | Factors for one-point cone penetrometer liquid limit test* |              |           |
|--------------------------|--|--------------|-----------|
|                          | Below 35%  | 35% to 50%   | Above 50% |
| 15                       | 1.057  | 1.094        | 1.098     |
| 16                       | 1.052  | 1.076        | 1.075     |
| 17                       | 1.042  | 1.058        | 1.055     |
| 18                       | 1.030  | 1.039        | 1.036     |
| 19                       | 1.015  | 1.020        | 1.018     |
| 20                       | 1.000  | 1.000        | 1.000     |
| 21                       | 0.984  | 0.984        | 0.984     |
| 22                       | 0.971  | 0.968        | 0.967     |
| 23                       | 0.961  | 0.954        | 0.949     |
| 24                       | 0.955  | 0.943        | 0.929     |
| 25                       | 0.954  | 0.934        | 0.909     |
| Plasticity               | Low  | Intermediate | High      |

\* Reference: Clayton and Jukes, 1978