
	<p style="text-align: center;"><i>Standard Operating Procedure</i></p> 	Effective Date:	Version:
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		1 Nov 2017	
SOP_MP_05 Mechanical Properties_ Liquid Limit			Page #: <b>1 of 5</b>

## Standard Operation Procedure – Liquid Limit

### 1. Scope and Application

- The liquid limit is the moisture content at which a soil passes from the liquid phase into the plastic phase determined experimentally.
- It is used to classify a soil, particularly when the plastic limit is also known and hence the plasticity index can be established.
- This method is adapted from the British Standard BS 1377-2:1990 for use on faecal sludge.

### 2. Summary

- The cone penetrometer provides a static test depending on soil shear strength to determine its liquid limit.
- The cone is dropped from a height into the sample and the penetration is recorded and correlated to the moisture content of the sample.
- The moisture content is increased continuously and the test repeated, until an approximate linear graph can be produced.
- The water content corresponding to a penetration of 20mm is the liquid limit of the sample in question.

### 3. Interferences

- Coarse particles can affect the reproducibility of the test and should be removed from the test sample whenever possible.

### 4. Sampling

- Store samples in plastic or glass containers, taking note of the date the sample was taken.

### 5. Safety Precautions

- Always use safety glasses, gloves, closed shoes and laboratory coat when working in the laboratory.
- Dispose of sample in the sluice when test completed.
- Thoroughly clean all equipment after use.
- Any equipment that will be taken out of the laboratory should be handled with clean gloves only and disinfected with 70% ethanol after use.
- Dispose of used gloves when analysis completed.
- Wash hands with antiseptic soap and disinfect with 70% ethanol when analysis completed.
- Use metal trays to place soiled equipment when not in use.
- Avoid spillage and contact with skin. In latter case use copious washings with cold water and call for medical attention.

## 6. Apparatus

- Flat glass plate, 10mm thick and 500mm square.
- Two palette knives or spatulas.
- One or more metal cups (55 ±2mm in diameter and 40 ±2mm deep).
- Cone Penetrometer.
- Evaporating dish of approximately 150mm diameter.
- Apparatus for moisture content determination.
- A wash bottle or beaker filled with distilled water.
- A corrosion resistant airtight container.
- A metal straightedge approximately 100mm long or a straight-bladed spatula.
- A stopwatch readable to 1 second.
- A bubble level.

## 7. Sample Preparation –Faecal Sludge

- Try to select a representative sample. Use glass plate.
- Ensure the sample is well mixed.
- Do not allow sample to dry before testing.
- Sample should be of a soil in its natural state, or where the material remaining on a 425 µm test sieve has been removed from the soil.

## 8. Reagents

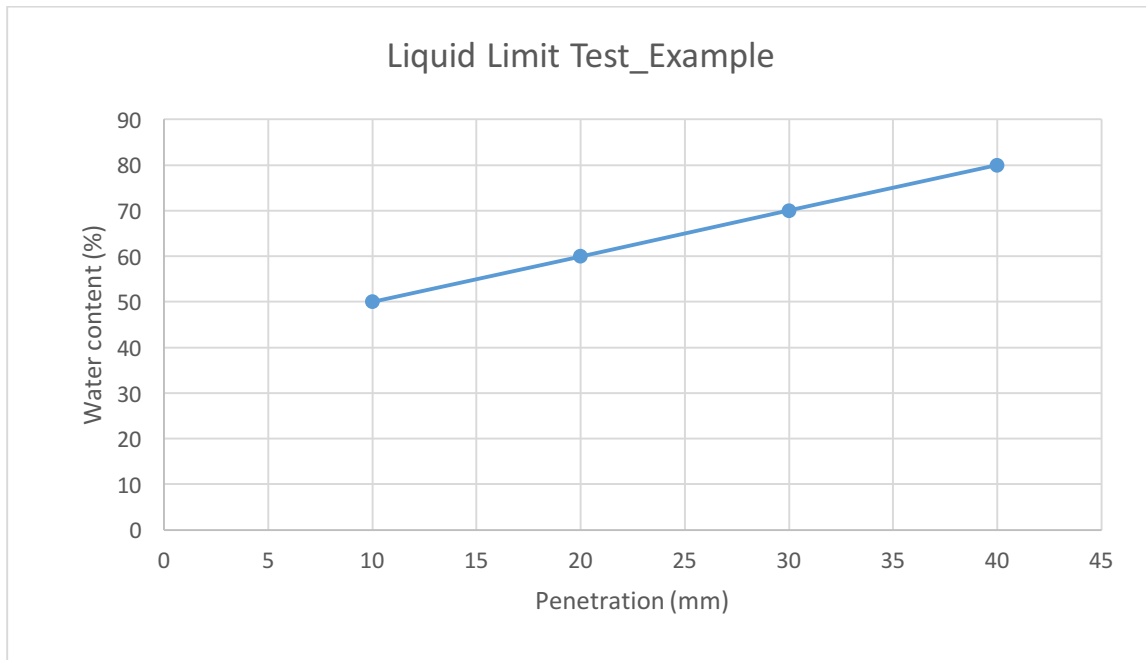
- Nil.

## 9. Calibration

- Check that the penetrometer base level is horizontal using a bubble level.

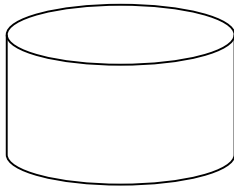
## 10. Procedure

1. Place 300g of prepared sample on the glass plate.
2. Mix sample with the two palette knives for approx. 10 minutes adding distilled water if necessary to achieve first cone penetration reading of 15mm.
3. Push the mixed sample into a metal cup with the palette knife and strike off the excess creating a smooth, level surface using the straightedge.
4. Place the metal cup on the base of the apparatus (at centre), ensuring the penetration cone is in locked a raised position.
5. Lower the penetration cone carefully until it just touches the surface of the sample; the correct position is indicated if the cone just scratches the surface when the cup is moved. (Move the clamp to lower the cone).
6. When the cup has been placed in the correct position, lower the stem of the dial gauge until it just touches the cone shaft.
7. Set the dial gauge to zero (to the nearest 0.1mm).
8. Release the cone for 5 secs  $\pm$ 1 sec. Lock the cone into position after the 5 secs have lapsed and lower the stem of the dial gauge again to touch the cone shaft. Read the dial gauge to the nearest 0.1mm, this value is recorded as the cone penetration.
9. Lift the cone from the cup and clean it carefully.
10. Place some more-wet sample into the cup, ensuring no air is trapped and repeat steps 3 through 9.
11. If the difference between the first and second penetrations is less than 0.5mm, record the average value. If the difference is greater than 0.5mm but less than 1mm, repeat the test a third time and if the overall range is no greater than 1mm record the average of the three values. If the overall range is greater than 1mm, remove the sample from the cup and repeat procedure from step 2.
12. Take the moisture content of approximately 10g of sample where the cone penetrated the cup.
13. Repeat procedure from step 2 at least 3 times using the same sample, to which increments of distilled water has been added.
14. Go from drier to wetter samples, until a cone penetration range of approximately 15mm to 25mm has been reached over the course of at least 4 test runs and values are evenly distributed.
15. Wash and dry the cup each time the sample of soil is removed to facilitate the addition of water.
16. If the soil is left in the open for extended periods of time, cover with evaporating dish or damp cloth to avoid drying.
17. Plot moisture content against cone penetration to obtain a linear graph from a straight line that best fits the plotted points.
18. The moisture content corresponding to the cone penetration of 20mm is reported as the liquid limit, to the nearest whole number.



**Figure 1:** Typical results achieved through test

Cup dimensions:



Diameter = 55 mm  $\pm$  2 mm  
Depth = 40 mm  $\pm$  2 mm

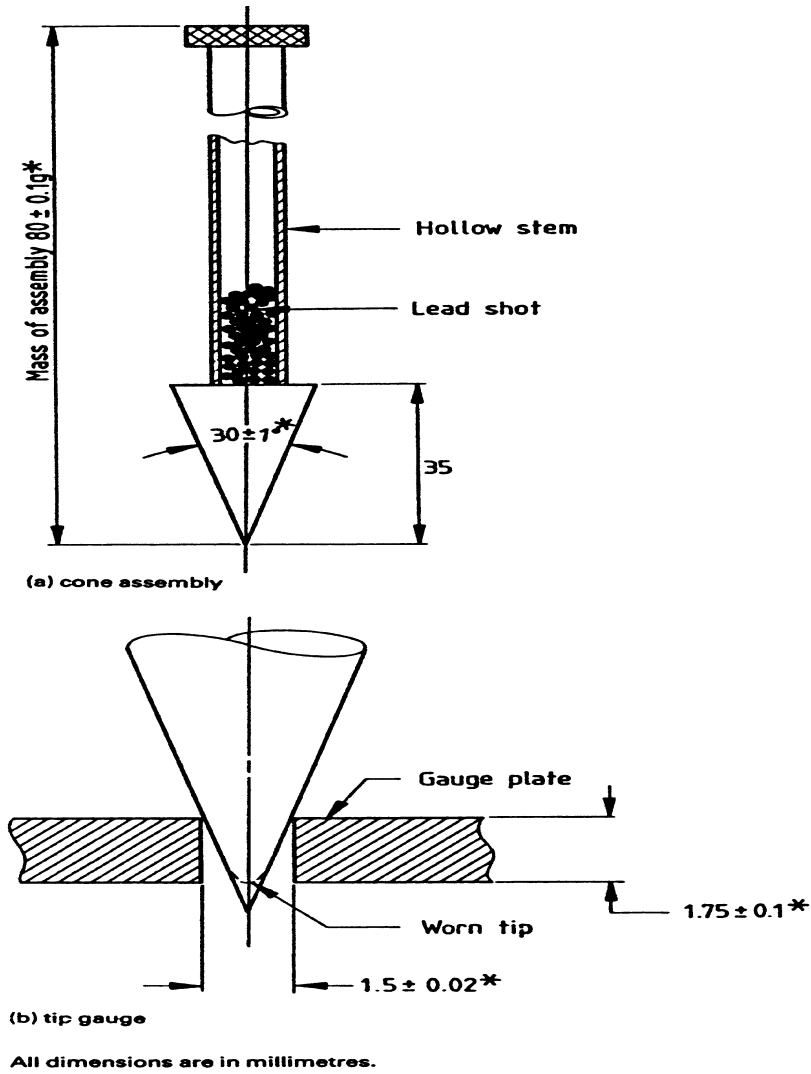


Figure 2: Details of the cone for the liquid limit test (BS 1377-2)

**APPROVAL OF STANDARD OPERATING PROCEDURE**

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Date: .....

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