



# Using Excel for Soil Testing

An Online Continuing Education Course for Engineers

**Course Number: G-2006**

**Credit: 2 Hours / 2 PDH / 2 CPD**

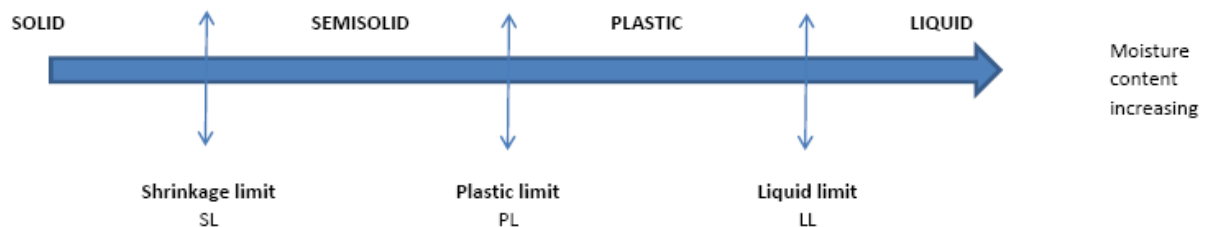
## Using Excel for Soil Testing

Excel is a spreadsheet program by Microsoft which can be used by engineers to do many design tasks and computations. We will look at using Excel to do soil testing calculations and graphs. Here are the tests covered:

- Liquid Limit
- Plastic Limit
- Sieve Analysis
- Specific Gravity
- Proctor

### Liquid Limit

The *liquid limit* is one of three tests that make up the *Atterberg limits* (ASTM D4318). The other two tests are the *plastic limit* and the *shrinkage limit*. In all three tests, you determine the moisture content at which the soil changes from one state to another.



You will need several pieces of **Equipment:**

1. Casagrande liquid limit device
2. Grooving tool
3. Moisture cans
4. Porcelain evaporating dishes
5. Spatula
6. Oven
7. Balance, sensitive to 0.01 g
8. Plastic squeeze bottle filled with water

## Procedure

1. Determine the weight of each moisture can ( $W_1$ ).
2. Put about 300-350 g of air-dry soil, passing a No. 40 sieve, into an evaporating dish. Add water and mix to form a slightly moist paste.
3. Place a portion of the paste into the brass cup of the liquid limit device. Using the spatula, smooth the surface of the paste in the cup.
4. Using the grooving tool, cut a groove down the center of the soil paste in the cup.
5. Turn the crank on the liquid limit device at a rate of about 2 revolutions per second. Start counting the number of blows. When the two sides of the groove in the bottom come together for a distance of  $\frac{1}{2}$  inch. Stop counting the number of blows ( $N$ ). Collect a sample of the soil in the moisture can determine the weight of the can and wet soil ( $W_2$ ).
6. Add more water to the soil and repeat steps 3-5 several times.
7. Place the samples in an oven to dry. After drying, determine the weight of the cans with the dry soil ( $W_3$ ).

The idea is to get some samples of soil less than 25 blows and some above 25 blows. The liquid limit is the moisture content at 25 blows.

## Calculations

### *Moisture content*

$$w(\%) = \frac{W_2 + W_3}{W_3 + W_1} (100)$$

*Flow index*,  $F_I$ , the slope of the line

$$F_I = \frac{w_1(\%) - w_2(\%)}{\log N_2 - \log N_1}$$

The *liquid limit*, (LL), by the U.S Army Waterways Experiment station approximation

$$LL = w_n(\%) \left( \frac{N}{25} \right)^{0.121}$$

We have collected the following data and entered it into Excel:

	A	B	C	D	E	F	G
1	LIQUID LIMIT						
2							
3	Description of soil						
4	Location						
5	Sample number						
6							
7	Can	Weight	Weight	Weight	Moisture	Number	
8	Number	Can	Can + wet	Can + dry	Content	blows	
9		W <sub>1</sub>	W <sub>2</sub>	W <sub>3</sub>	w	N	
10		(g)	(g)	(g)	(%)		
11							
12	3L	15.17	31.45	26.96	38.1	17	
13	2L	17.01	31.58	27.72	36.0	23	
14	1L	15.26	29.30	25.84	32.7	35	
15	4L	15.51	31.51	27.62	32.1	39	
16							
17			Flow Index F <sub>1</sub>	18.3			
18							
19			US Army approximate liquid limit		35.7		
20							

The values in column E were calculated from the moisture content equation.

$$w(\%) = \frac{W_2 + W_3}{W_3 + W_1} (100)$$

In Excel it looks something like this:

$$= (C12-D12) / (D12-B12) * 100$$

## Explain

In Excel, we have several *arithmetic operators*:

1. Parentheses, ()
2. Exponentiation, ^
3. Multiplication, \* and Division, /
4. Addition, + and Subtraction, -

They are in the order of precedence. Excel will do parentheses first and then the others next. If you have an equation that has two of the same order, then Excel does them left to right. Parentheses can be used to change the order.

Flow Index  $F_I$  18.3

$$F_I = \frac{w_1(\%) - w_2(\%)}{\log N_2 - \log N_1}$$

In Excel it is calculated like this:

$$= (E13-E14) / (\text{LOG10}(F14) - \text{LOG10}(F13))$$

## Explain

Excel has about 341 built-in worksheet functions. LOG(number), returns the base-10 logarithm of a number. The number needs to be a positive real number.

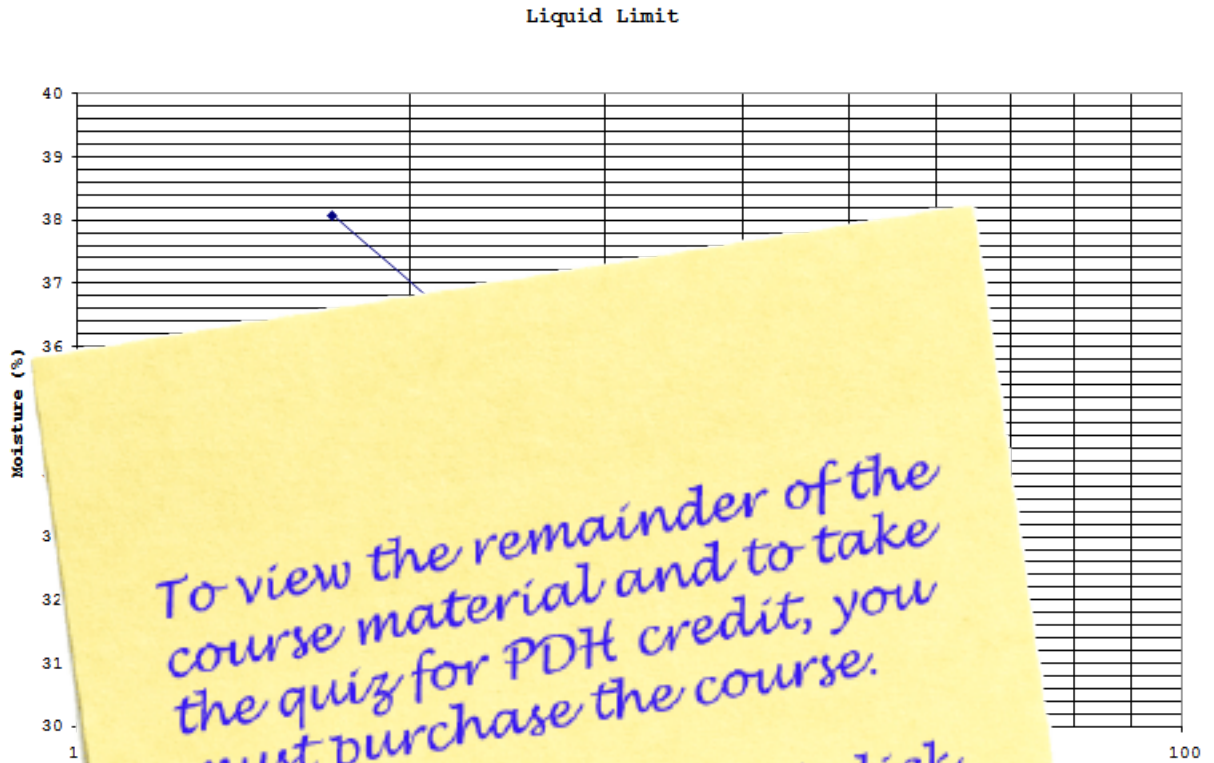
US Army approximate liquid limit 35.7

$$LL = w_n(\%) \left( \frac{N}{25} \right)^{0.121}$$

In Excel it is calculated like this:

$$= E13 * (F13/25)^{0.121}$$

You also make an X-Y- scatter graph with a logarithmic X-axis.



To view the remainder of the course material and to take the quiz for PDH credit, you must purchase the course.

Close this window and click "Add to cart" on the product page.

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limit of 3

**Plastic L**

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4. Mois
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