EXPERIMENT NO. 1

Calibration of speedy moisture meter / calcium carbide moisture tester

1.1 Reference

ASTM D 4944

1.2 Apparatus

- Speedy moisture meter (also called calcium carbide pressure moisture tester)
- Two 1.25 in (3.175 cm) steel balls
- Cleaning brush and cloth
- Scoop for measuring calcium carbide reagent
- Calcium carbide reagent
- Containers (Tin or Aluminum)
- Balance, sensitive to 0.01 g
- Oven with accurate temperature control at $110 \pm 5^{o}C$

1.3 Related Theory

1.3.1 Moisture Content (w)

It is defined as the ratio of the weight of water in a given volume of soil to the weight of the solid particles in that same volume.

$$w = \frac{Ww}{Ws} \times 100$$

Ww = Weight of soil water in grams

Ws = Weight of soil solids in grams (oven dried wt. of soil)

1.3.2 Calcium Carbide Gas Pressure Tester

The calcium carbide gas pressure tester (speedy moisture meter) provides a quick, simple means of determining moisture content of soil. It is particularly useful for field determination of moisture content in conjunction with field compacting testing. This method shall not be used for granular material having particles retained on the No. 4 (4.75 mm) sieve.

The basic premise of the calcium carbide gas moisture tester is that the free moisture in the soil reacts with calcium carbide reagent to form a gas called acetylene gas.

$$CaC_2 + H_2O \rightarrow CaO + C_2H_2$$
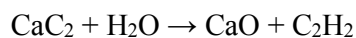
The acetylene gas is tapped within the tester and registers on the pressure dial which is calibrated to read directly in percent of moisture by wet weight of soil. Since moisture

content by definition is expressed as a %age of dry weight of soil, the readings obtained by speedy moisture meter are corrected using the following expression:

$$w = \frac{Wsp}{1 - Wsp} \times 100$$

w = moisture content in % age

Wsp = moisture content as obtained by speedy moisture meter expressed as decimal fraction

1.3.3 Calibration of Speedy Moisture Meter

Calibration is to be done annually as a minimum, and whenever damage or repair occurs. This can be accomplished by comparing the results of speedy moisture meter to the results obtained from oven drying method so that Speedy Moisture Meter Conversion Charts can be prepared.

1.4 Procedure

- Place some amount of the sample in the oven to determine the moisture content by oven drying method.
- To use speedy moisture meter, weigh 26 grams of soil and place it in the cap of the tester.
- Place three scoops (approximately 24 grams) of calcium carbide and two steel balls in the large chamber of moisture tester.
- With the pressure vessel in the horizontal position insert the cap in the pressure vessel and seal it by tightening the clamp. Take care no carbide comes in contact with soil until a complete seal is achieved.
- Raise the moisture tester in a vertical position so that the soil in the cap will fall into the pressure vessel.
- Shake the instrument vigorously so that all the lumps are broken to enable calcium carbide to react with all available free moisture. The instrument should be shaken with a rotating motion so that the steel balls will not damage the instrument or cause soil particles to become embedded in the orifice leading to pressure diaphragm.
- When the needle stop moving read the dial reading
- With the cap of the instrument pointed away from the operator, slowly release the gas pressure. Examine the material for lumps. If the sample is not completely pulverized the test should be repeated.
- Plot a graph between moisture content as obtained from oven drying method and from speedy moisture meter.

1.5 Limitation

If moisture content of the sample exceeds the limit of pressure gauge, one half weight of the sample is used and the dial reading must be doubled.

1.6 Observations & Calculations

Soil Sample = Sand

1.6.1 Moisture Content from Speedy Moisture Meter

Sr. No.	Approximate Moisture Content Added to Soil	Speedy Moisture Meter Dial Reading "R"(%)	Zero Error "Z.E" (%)	Corrected Dial Reading Wsp (%) (Wsp=R-Z.E)	Moisture Content w (%) (s.m.c) ($w = \dfrac{Wsp}{1 - Wsp} \times 100$)
1	2%	1.8	0.8	1	1.010
2	3%	3.5	0.8	2.7	2.775
3	4%	3.6	0.8	2.8	2.881
4					
5					
6					

1.6.2 Moisture Content from Oven Drying Method

Sr. No.	Approximate Moisture Content Added to Soil	Can No.	Weight of can + Wet Soil = W1 (g)	Weight of can + Dry Soil = W2 (g)	Empty Weight of Can = W3 (g)	Weight of Water Ww = W1-W2 (g)	Weight of Soil Solids Ws = W2-W3 (g)	Moisture Content w $w = \dfrac{Ww}{Ws} \times 100$ (%)
1	2%	10	31.71	31.44	14.95	0.27	16.49	1.637
2	3%	99	37.21	36.51	12.74	0.7	23.77	2.945
3	4%	76	25.72	25.33	14.03	0.39	11.3	3.451
4								
5								
6								

1.6.4 Relationship between Moisture Contents from Speedy Moisture Meter and Oven Drying Method

For finding a relationship between moisture contents obtained from speedy moisture meter (corrected moisture content on the basis of dry weight) *s.m.c* and by oven drying method *m.c*, a graph is plotted against moisture content from speedy moisture meter along X-axis and moisture content from oven drying method along Y-axis.

Draw a trend line to the graph. Determine the equation of the trend line which is the relationship between speedy moisture content and actual moisture content (oven dried moisture content).
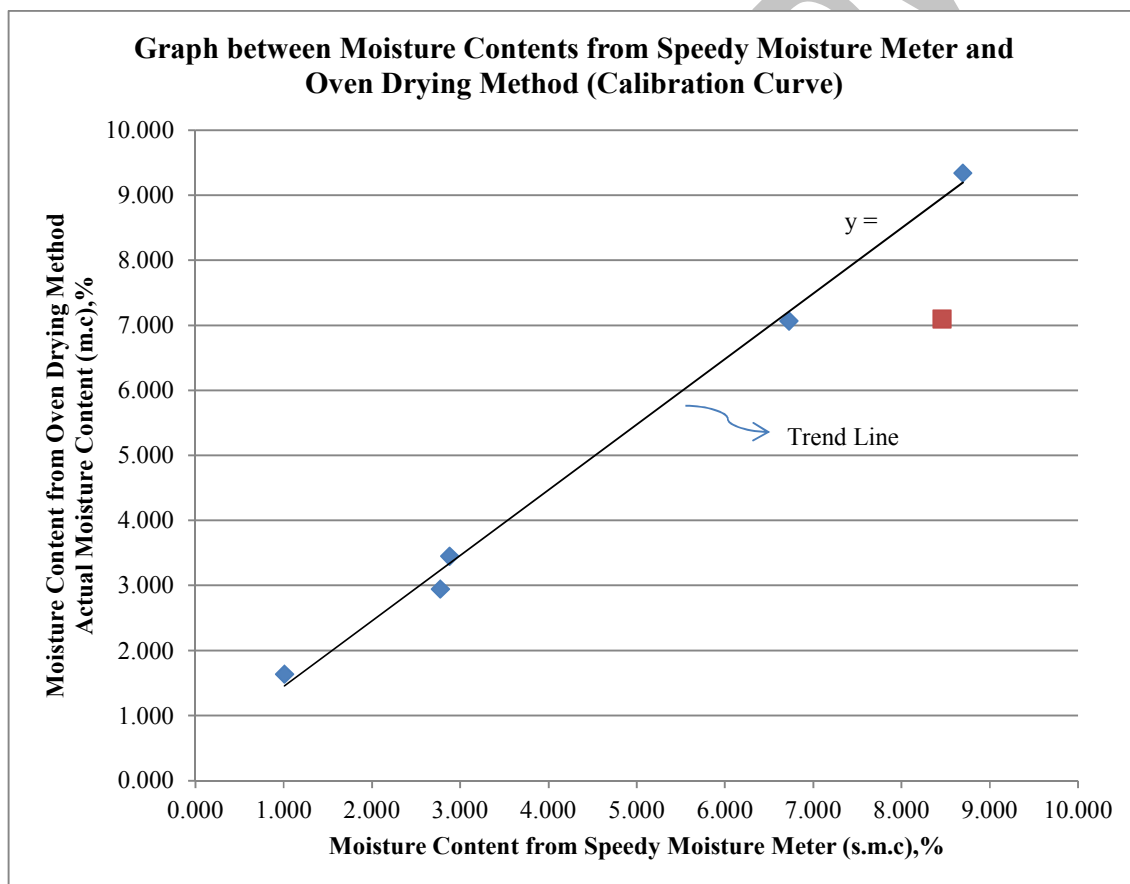

Fig 1.6.4

The red data point is not included in determination of relationship as it is off trend due to some experimental errors.

From the trend line of the graph

$$y = \quad x + $$

Here   y = moisture content from oven drying method

y = actual moisture content

y = m.c

and   x = moisture content from speedy moisture meter

x = s.m.c

1.6.5 Another Relationship

Instead of plotting graph against the moisture content (corrected moisture content on the basis of dry weight) from speedy moisture meter and by oven drying method, the graph is plotted against moisture content *Wsp* (corrected dial reading only for zero correction) from speedy moisture meter and from oven drying method *m.c*

Graph between Moisture Contents from Speedy Moisture Meter and Oven Drying Method (Calibration Curve)

$y = \_\_x + \_\_$

Trend Line

Moisture Content from Oven Drying Method
Avtual Moisture Content (m.c),%

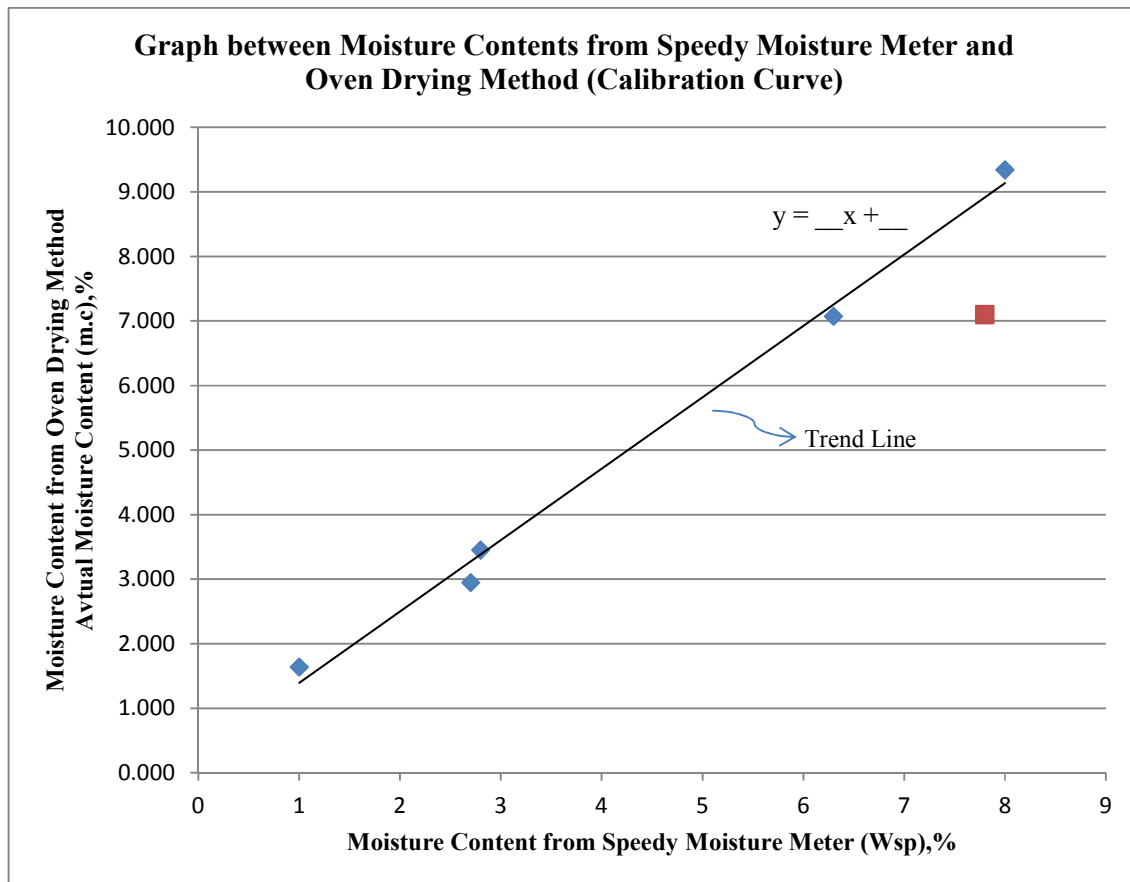Moisture Content from Speedy Moisture Meter (Wsp),%

Fig 1.6.5

The red data point is not included in determination of relationship as it is off trend due to some experimental errors.

From the trend line of the graph

$$y = \_\_x + \_\_$$

Here   y = moisture content from oven drying method

              y = actual moisture content

              y = m.c

and   x = moisture content from speedy moisture meter

x = Wsp (corrected dial reading only for zero correction)

1.7 Precautions

1.7.1 Oven Drying Method

- Since some dry materials may absorb moisture from moist specimens, the dried specimens should be removed before placing new wet samples in the oven.
- Maintain temperature at about 110±5°C for 24 hours.

1.7.2 Speedy Moisture Meter

- Note zero error before starting the experiment.
- Measure weight accurately.
- Shake instrument well so that all lumps are broken.
- Do not allow calcium carbide to mix before instrument is tightened.

1.8 Comments