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EXPERIMENTAL STUDY ON PROPERTIES OF SOIL

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Abstract - *The main aim of this work is to focus on the properties of soil available locally. Different types of soil tests are conducted on soil. The test samples were prepared for Standard Proctor Equipment to find out OMC and MDD by adding 8% and 10% water of total soil mass. Specific gravity test is conducted by using Pycnometer method and particle size distribution curve is plotted by using sieve analysis.*

Keywords: Rammed Earth, Maximum Dry Density, Optimum Moisture Content, Proctor Equipment, Pycnometer, Sieve Analysis

1. INTRODUCTION

The oldest building material known to us is soil. Earlier earth buildings were becoming unpopular due to modernization in technology, but in this age of using supplementary materials it has again gain its popularity. The problem related to using earth alone in construction is its compressive strength. Every undisturbed soil does not have same strength, durability and stability. To change its structural arrangement for desired properties of soil proper compaction is required.

Compaction is defined as the process of soil densification by reducing the voids present in it. It is the process by which particles of soil are rearranged and packed together by mechanical means. The maximum density obtained after different trails of compaction at different water content is called as Maximum dry density (MDD) .The amount of water representing the MDD in the mix is thus called as Optimum Moisture Content (OMC).To obtain right kind of OMC and MDD the amount of water added in the mix is very important.

In the soil, water mix when the water content increases, initially the dry density increases and becomes maximum. As the water content increases beyond OMC in the mix, the dry density decreases. If soil is sandy, then add 4% water initially and if soil is clayey, then add 8% of water initially.

For classification of soils, sieve analysis is used widely. The data obtained from sieve analysis distribution curves is used in design of earth dams, filters and to determine soil suitability for construction. Particle sizes greater than 0.075 mm is determined by sieving, while particles sizes smaller than 0.075 mm is determined by sedimentation process using a hydrometer.

Specific gravity is defined as the ratio of density of that substance to density of distilled water at a specified temperature. The specific gravity of soil is determined by (a) Density Bottle (b) Specific gravity flask (c) Pycnometer bottle.

2. REVIEW OF LITERATURE

Eswara Reddy Orekanti based on his research work gave following conclusion: Blocks with 5% of cement gives optimum strength result. 41% of cost was saved by stabilized soil block as compared to that of burnt bricks. For soil block with 5% cement as stabilizing material, the cost analysis can be done and compared it with ordinary soil block.

Rosenak, S (1957) from his research work gave following conclusion: For stabilization of soil with 5% cement, the soil should have liquid limit less than 25%, content of clay upto 20%, sand content upto 35% and plastic index between 8.5% to 10.5%.For clayey soil (with plasticity index >12%), the compressive strength increases with the increase in moulding moisture content.

Fetra Venny Riza based on his research gave following conclusion: Average dry compressive strength is 35% more than compressive strength. As compared to fired clay bricks, Compressed stabilized earth bricks have better conductivity value. For 10% cement stabilization soil should have plastic index less than 20% and drying shrinkage limit from 0.008% to 0.10%.

3. LABORATORY TESTING

In the experimental program, following tests were conducted on the soil samples according to standard procedures.

(a) Standard Proctor Compaction Test

(b) Specific Gravity Test (Pycnometer)

(c) Particle Size Analysis

4. TEST PROCEDURE

4.1 Standard Proctor Compaction Test Procedure (IS-2720-Part-7-1980)

Take around 10 kg of soil passing from 4.75 mm sieve. Add 8% of water to soil. Mix the soil properly by dividing it into 6 to 8 parts. Clean and dry the mould and base plate. Grease them lightly and attach the collar to mould. The mould assembly was placed on the ground and add soil in the mould. Now apply 25 number of blows on each layer having free fall of 310mm of Standard rammer (weighting 4.89 kg), so the thickness of compacted soil is nearly about one-third of height of mould. Before placing the next layer, scratch the soil of first layer. Put the next batch of soil and follow the same procedure. Compact the soil in three layer, by giving 25 number of blows on each layer. Remove the extra soil with trimming knife. Clean the mould and weight the mould with compacted soil.

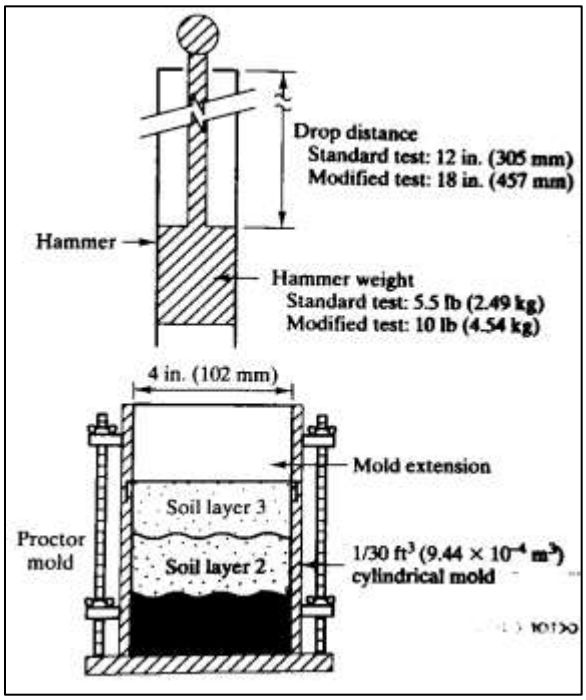

Fig -1: Standard Proctor Equipment

4.2 Specific Gravity Test Procedure (IS-2720-Part-3-1980)

The specific gravity of the soil can be evaluated by using Pycnometer.

For the Pycnometer test take 200 grams of soil passing from 4.75 mm IS sieve and retained on 2.36 mm IS sieve. Clean and dry the Pycnometer bottle. Weight the empty bottle with the stopper. Take 200 grams of oven dry soil sample and determine the weight of bottle and soil. Now fill the bottle with distilled water, put the stopper and keep the bottle under constant temperature water baths. Determine the weight of bottle and wet soil. Now empty the bottle and clean it thoroughly. Fill the bottle again with only distilled water and weigh it. Repeat the process for 2 to 3 times, to take the average reading of it.

The Pycnometer method is used to determine the specific gravity of coarse grain soil.

The Hydrometer method is used to determine the specific gravity of fine grain soil.

Fig -2: Pycnometer Bottle

4.3 Grain Size Analysis Procedure (IS-2720-Part-4-1985)

A sieve analysis can be done on any type of material such as coal, feldspar, soil, granite, sand, etc.

Take the set of IS sieve and arrange it in descending order from top to bottom. (i.e. from 4.75 mm to 0.075 mm). Take required quantity of soil sample and shake them thoroughly for 15 minutes. Now record the weight of soil retained on each sieve. Determine percentage retained and percentage finer. Plot the graph for percentage finer vs. sieve size. Now determine the uniformity coefficient (C_u) and coefficient of curvature (C_c).

5. RESULTS

5.1 Result of Proctor Test:

From the above test the results obtained are:

Mould diameter = 100 mm

Mould height = 127.3 mm

Volume of mould = 1000 cc

Table -1: Proctor Test Results

Description	Sample 1 (8%)	Sample 2 (10%)
Weight of empty mould with base plate (gm)	7100	7100
Weight of compacted soil + weight of mould (gm)	9835	9881
Weight of compacted soil (gm)	2735	2781
Bulk Density of soil (gm/cc)	2.735	2.781
Water content (%)	8	10
Dry Density (gm/cc)	2.532	2.528

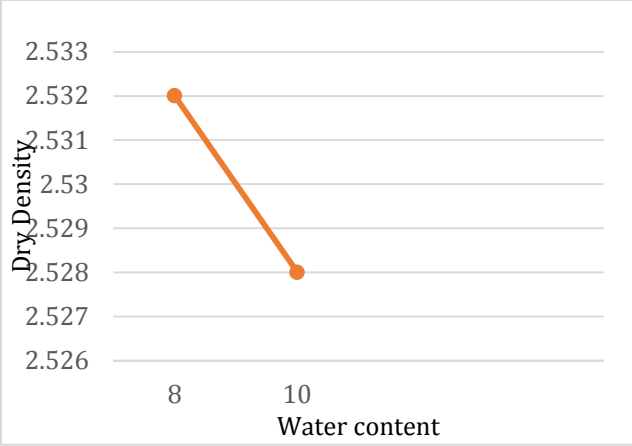

Chart -1: Compaction Curve (Water content vs. Dry Density)

Compaction Effort (E)

$$= \frac{(\text{No. of layer}) \times (\text{No. of blow per layer}) \times (\text{Hammer weight}) \times (\text{Drop height})}{\text{Volume of mould}}$$

E = 1.79 kg/cm²

5.2 Result of Specific gravity Test:

Total weight of soil = 200 grams

Table -2: Specific Gravity Test Results

Description	Weight (grams)
Weight of empty bottle (W_1)	580
Weight of bottle + weight of dry soil (W_2)	820
Weight of bottle + weight of dry soil + weight of water (W_3)	1490
Weight of bottle + weight of water (W_4)	1344

$$\text{Specific Gravity} = \frac{W_2 - W_1}{(W_2 - W_1) - (W_3 - W_4)}$$

Specific Gravity of soil = 2.55

Void Ratio: $e = \left[\frac{\gamma_w G}{\gamma_d} - 1\right]$ = 4.16 %

Porosity: $n = \frac{e}{1+e}$ = 3.99 %

5.3 Result of Grain Size Analysis:

Table -3: Grain Size Analysis Test Results

Sieve Size (mm)	Retained weight (gm)	% retained weight	Cumulative weight (gm)	% finer
4.75	300	8.34	8.34	91.66
2.36	704	19.57	27.91	72.09
1.18	1129	31.39	59.3	40.7
0.600	608	16.74	76.04	23.96
0.425	682	18.96	95	5
0.300	14	0.389	95.34	4.66
0.150	90	2.502	97.90	2.1
0.090	65	1.807	99.71	0.29
0.075	10	0.278	99.98	0.02
Pan	0.8	0.024	100	0

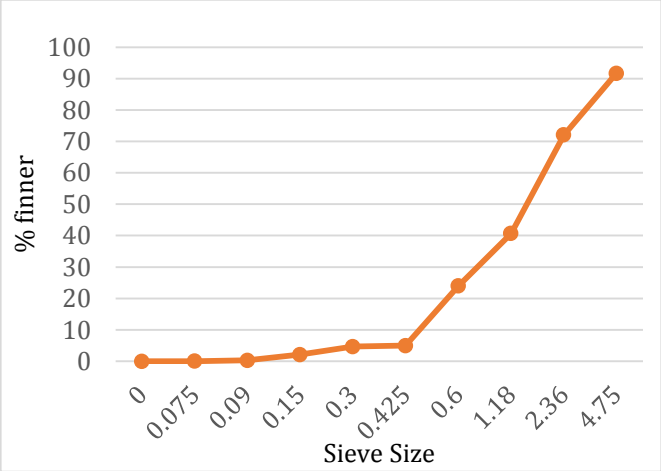

Chart -2: Particle Distribution Curve

D_{10} is called as effective particle size. This means that 10% percent of the particles are finer and 90% of the particles are coarser than D_{10}. This is the size at 10% finer by weight.

Similarly, D_{60} is the particle size at which 60% of the particles are finer and 40% of the particles are coarser than D_{60} size.

D_{30} is the size at which 30% is finer by weight and remaining 70% particles are coarser than D_{30} size. Hence, D_{10}, D_{30} and D_{60} are used to determine the measures of gradation.

D_{10} = 0.425 (Effective Diameter, where 10 represent)

D_{60} = 1.77, D_{30} = 0.85

$$\text{Uniformity Coefficient } (C_U) = \frac{D60}{D10} = 4.16$$

$$\text{CoefficinentofCurvature}(C_C) = \frac{D30^2}{D60 \times D10} = 1.2$$

6. CONCLUSION

1. The Maximum Dry Density obtained from Standard Proctor Test is 2.46 gm/cc.
2. Optimum Moisture Content obtained from standard Proctor Test is 10%.
3. Uniformity Coefficient (C_U) is 4.16, so the soil is well graded.
4. Coefficient of curvature is (C_c) is 1.2 so that the soil is well graded.
5. Specific Gravity of the soil is 2.55.
6. The void ratio (e) of locally available soil is 4.16%.
7. The porosity (n) of locally available soil is 3.99%.
8. Compaction Energy required is 1.79 kg/cm^2.

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BIOGRAPHIES

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