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EFFECTS OF DIFFERENT STABILIZERS ON DRY DENSITY OF SOIL

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Abstract: During construction work some of the fundamental properties of soil are not at the desirable scale to be use. Replacement of such soil is not a cost effective option so it is better to stabilize to gain desirable properties for construction work. From the fundamental properties of soil one of the property named as dry density co-relates with many other properties so in this present research paper we have stabilized locally available soil with lime and cement for which we have used standard proctor test to evaluate its dry density. Stabilized soil with the combination of cement and lime gives more than 6% of improvement in dry density than actual value of soil without stabilization.

Keywords: Fundamental properties, engineering properties, dry density, standard proctor test, stabilization, stabilizers

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1. INTRODUCTION

1.1 Soil Stabilization

1.1.1 Definition: - "Soil stabilization is a technique aimed at increasing or keeping the stability of soil mass and chemical adjustment of soil to enhance their engineering properties." (Sachin N. Bhavsar et al. 2014)

1.1.2 Introduction: Stabilization allows for the founding of design criteria as well as the determination of the proper chemical additive and admixture rate to be used in order to achieve the preferred engineering properties. Benefits of the stabilization process can include higher resistance values, decrease in plasticity, lower permeability, reduction of road thickness, elimination of diggings material hauling or handling. Stabilization of expansive soils with admixtures controls the potential of soils for a change in volume, and increases the strength of soils. Soil stabilization is done by various systems by adding fly ash, rise husk ash, chemicals, fibres, adding lime, by different geo materials like geo synthetic, geo grid and geo form. Soil stabilization allows engineers to distribute a larger load with less material over a longer life cycle. **(**Sachin N. Bhavsar et al. 2014)

1.2 Dry Density

1.2.1 Definition: - Normal soil consists of solids, water (moisture) and air. Usually we calculate bulk density of soil by finding out the weight of soil per unit volume. A bulk density of over 1.6 gm/cm3 is not helpful for root growth because the soil is compacted enough. Dry density is bulk density -moisture content. (Book: Soil mechanics, R. P. Rethaliya, Atul prakashan, edition: 2015-2016)

2. LITERATURE

2.1 A.H. Alavia et al., 2009, in this paper author concluded that, Soil stabilizer mix by using radial basis function (RBF) neural network is utilized to contract comprehensive and accurate models to be able to relate the maximum dry density and optimum moisture content of stabilized soil to the properties of natural soil. By chemical stabilization, the chemical such as lime, cement and asphalt or combination of these obtain better result in dry density as 1.52 ton/m^3 to 2.2 ton/m^3.

2.2 P. Talukdar, B. Sharma, 2014, in this paper author concluded that, by static compaction method like conventional proctor test for 3 fine grained inorganic soil the maximum dry density is obtained as 14.35, 14.18 and 17.57gm/$m^{3.}$

From the study, an equipment static pressure of around 820 kN/m^2 has been obtained. This equipment static pressure can now be used in the field to obtain maximum dry density and optimum moisture content corresponding to standard proctor test.

2.3 Murad Abu – Farshkh et al., 2007, in this research paper author concluded that, Geo synthetics have increasingly been used to reinforce many earth structure and now a well-accepted means to improve engineering properties of various type of soil. By using
soil – geo-synthetic reinforcement design the reduction interface shear resistant causes by the increase in modelling moisture content suggests that interface shear parameter 95% maximum dry density and moisture content 2% above optimum value.

2.4 F.G. Bell, 1996, in this research paper author concluded that, By lime stabilization of clay minerals and soil it increase in optimum moisture content and decrease in maximum dry density by adding lime.

2.5 Sachin N. Bhavsar, 2014, in this research paper author concluded that, the maximum dry density of soil is increased by replacing some stabilizers in some proportion. By replacing the brick dust as a stabilizers, it increase the maximum dry density of soil. And by replacing 30%, 40% and 50% brick dust the maximum dry density of soil is obtained as 1.81, 1.875 and 1.937 gm/cm^3. Only black cotton soil without replacing any stabilizers it gives maximum dry density as 1.71 gm/cm^3 which is low as compare as replacement of soil by stabilizers.

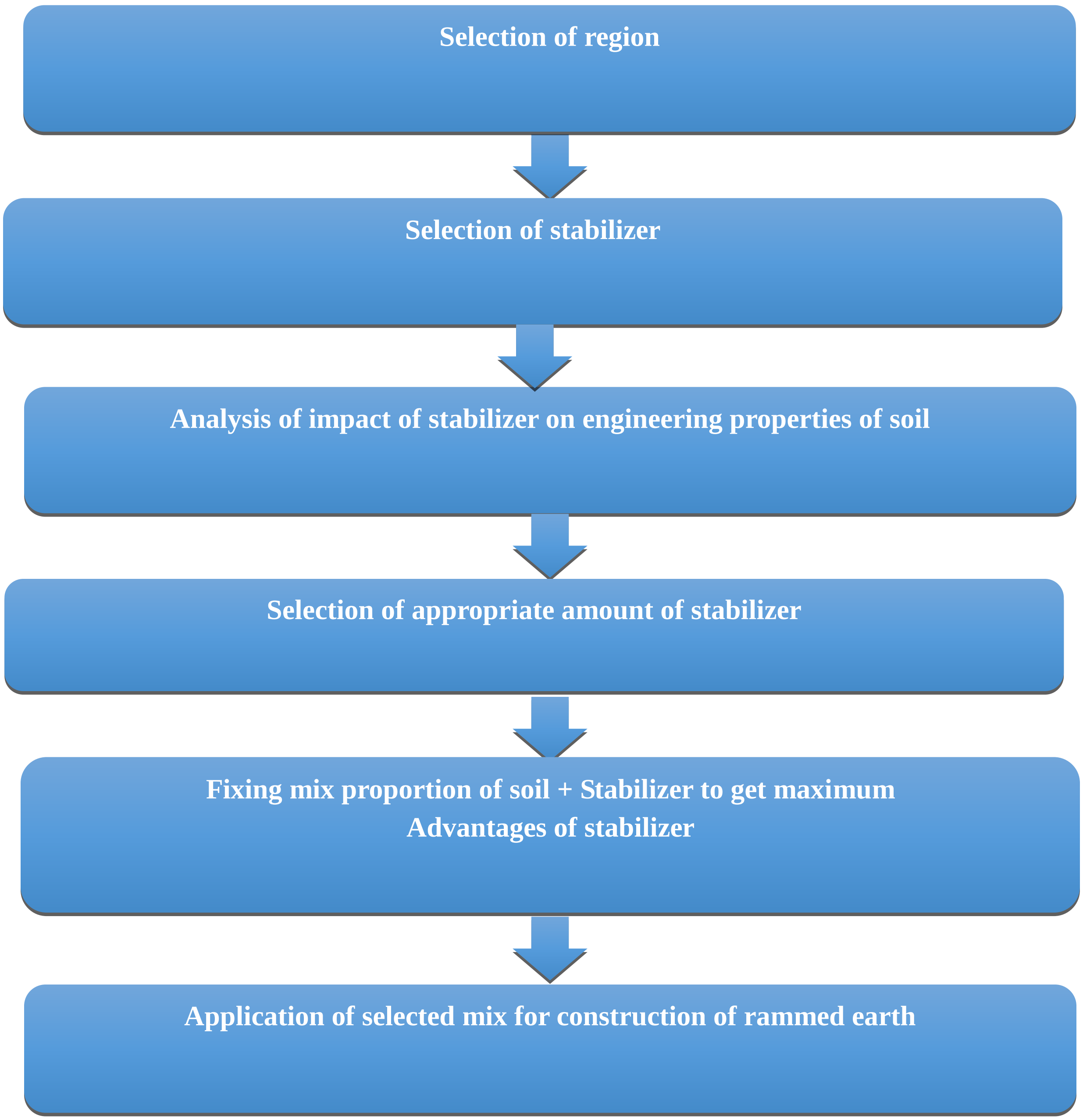
2.6 Sachin N. Bhavsar, Ankit J. Patel, 2014, in this paper author concluded that, by replacement of soil by stabilizer the value of maximum dry density is increased by 11.69%. As same after stabilization maximum dry density increased by 5.84%.

For the replacement of soil by 30% marble powder the result of maximum dry density is obtained as 1.91gm/cm^3 and by 30% brick dust the result of maximum dry density is obtained as 1.81 gm/cm^3.

2.7 Sachin N. Bhavsar, Ankit J. Patel, 2014, by replacement of soil by stabilizer the value of maximum dry density is increased by 13.45%. By replacement of soil by 40% marble powder gives the maximum dry density as 1.94gm/cm^3 and by 40% brick dust gives the maximum dry density as 1.875gm/cm^3.

3. METHODOLOGY AND MATERIALS

3.1 Methodology: -



3.2 materials: -

3.2.1 Locally available soil: - Soil is a combination of biological matter, minerals, gases, liquids, and organisms that together support life. Earth's body of soil is the pedosphere, which has four significant functions: it is an average for plant growth it is a means of water storage, supply and distillation it is a modifier of earth's atmosphere it is habitat for organisms all of which, in turn, modify soil.

Fig 3.1 Soil

3.2 Cement:-
Type- Ordinary Portland cement
Grade-53grade
Chemical composition: Cao+SIO2+AL2O3
A cement is a binder, a substance used for assembly that sets, hardens, and adheres to other ingredients to bind them together. Cement is seldom used on its own, but rather to bind sand and gravel (aggregate) together. Cement mixed with fine aggregate product mortar for masonry, or with sand and gravel, produces concrete.

Fig. – 3.2 Cement

3.3 Lime:-
Type-Sprout
Chemical composition: Ca (OH) 2
Lime is a calcium-containing inorganic mineral in which oxides, and hydroxides prevail. In the strict sense of the term, lime is calcium oxide or calcium hydroxide. It is also the name of the natural mineral (native lime) CaO which occurs as a produce of coal seam fires and in changed limestone xenoliths in volcanic ejecta. The word lime creates with its earliest use as erection mortar and has the sense of sticking or following.

Fig. 3.3 Lime

4. TEST PROCEDURE

4.1 Standard Proctor Test (Indian Standard 2720 – Part-7, 1980):

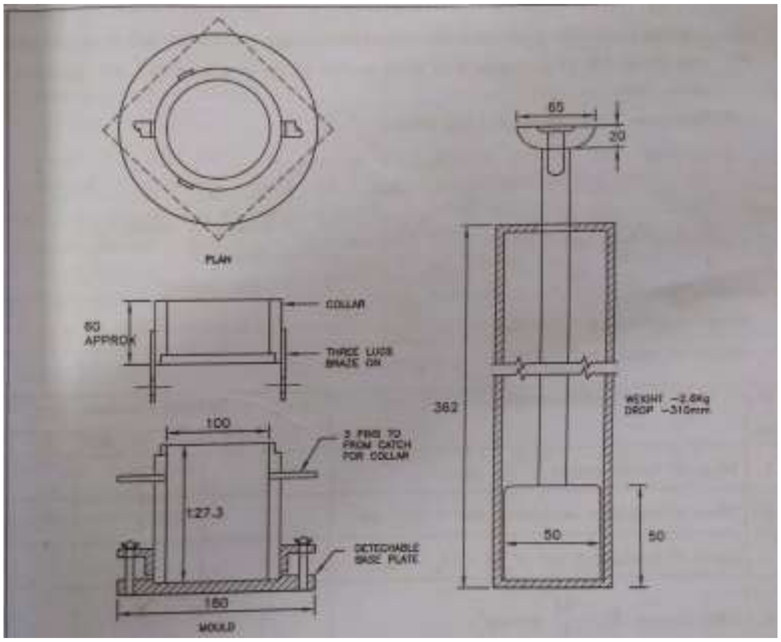
- **Equipment's for Proctor's Test**

1. Compaction mould, capacity 1000ml.
2. Rammer, mass 2.6 kg
3. Detachable base plate
4. Collar, 60mm high
5. IS sieve, 4.75 mm
6. Oven
7. Desiccator
8. Weighing balance, accuracy 1g
9. Large mixing pan

10. Straight edge
11. Spatula
12. Graduated jar
13. Mixing tools, spoons, trowels, etc.

- **Procedure**

1. Take about 20kg of air-dried soil. Sieve it through 20mm and 4.7mm sieve.
2. Calculate the percentage retained on 20mm sieve and 4.75mm sieve, and the percentage passing 4.75mm sieve.
3. If the percentage retained on 4.75mm sieve is greater than 20, use the large mould of 150mm diameter. If it is less than 20%, the standard mould of 100mm diameter can be used. The following procedure is for the standard mould.
4. Mix the soil retained on 4.75mm sieve and that passing 4.75mm sieve in proportions determined in step (2) to obtain about 16 to 18 kg of soil specimen.
5. Clean and dry the mould and the base plate. Grease them lightly.
6. Weigh the mould with the base plate to the nearest 1 gram.
7. Take about 16 – 18 kg of soil specimen. Add water to it to bring the water content to about 4% if the soil is sandy and to about 8% if the soil is clayey.
8. Keep the soil in an air-tight container for about 18 to 20 hours for maturing. Mix the soil thoroughly. Divide the processed soil into 6 to 8 parts.
9. Attach the collar to the mould. Place the mould on a solid base.
10. Take about 2.5kg of the processed soil, and hence place it in the mould in 3 equal layers. Take about one-third the quantity first, and compact it by giving 25 blows of the rammer. The blows should be uniformly distributed over the surface of each layer.
11. The top surface of the first layer be scratched with spatula before placing the second layer. The second layer should also be compacted by 25 blows of rammer. Likewise, place the third layer and compact it.
12. The amount of the soil used should be just sufficient to fill the mould ad leaving about 5 mm above the top of the mould to be struck off when the collar is removed.
13. Remove the collar and trim off the excess soil projecting above the mould using a straight edge.
14. Clean the base plate and the mould from outside. Weigh it to the nearest gram.
15. Remove the soil from the mould. The soil may also be ejected out.
16. Take the soil samples for the water content determination from the top, middle and bottom portions. Determine the water content.
17. Add about 3% of the water to a fresh portion of the processed soil, and repeat the steps 10 to 14.



(Fig 4.1 Standard Proctor test Equipment's)

5. RESULTS AND DISCUSSION

5.1 100% SOIL

TABLE 5.1 MDD & OMC RESULTS FOR 100% SOIL

100% SOIL					
Water Content	10%	12%	13%	14%	16%
W1(gm)	3603	3603	3603	3603	3603
W2(gm)	5458	5567	5514	5664	5539
W(gm)	1855	1964	1911	2061	1936
γb = W/V(gm/cm3)	84.35	89.31	86.9	93.72	8804
Container No.	3	5	10	30	5
M1(gm)	9	20	37	13	20
M2(gm)	27	42	62	52	37
M3(gm)	26	38	61	47	35
W=(M2-M3/M3-M1)	0.058	0.11	0.125	0.14	0.13
γd = γb/1+W	79.72	80.12	83.55	82.21	77.91

As per above results it is observed that maximum dry density for 100% soil achieved is of 83.55 gm/cm^3 for optimum moisture content of 12.5 %.

5.2 95% Soil & 5% Cement

Table 5.2 MDD & OMC For 95% Soil And 5% Cement

95% Soil + 5% Cement						
Water Content	10%	12%	14%	15%	16%	17%
W1(gm)	3603	3603	3603	3603	3603	3603
W2(gm)	5528	5445	5636	5663	5650	5499
W(gm)	1925	1842	2033	2006	2047	1896
γb = W/V(gm/cm^3)	87.53	83.76	92.45	93.67	93.08	86.22
Container No.	6	5	10	30	8	44
M1(gm)	26	20	37	13	31	10
M2(gm)	40	49	54	36	55	45
M3(gm)	39	38	52	34	53	41
W=(M2-M3/M3-M1)	0.076	0.026	0.13	0.095	0.09	0.129
γd = γb/1+W	81.34	81.63	81.81	85.54	85.39	76.36

As per above results it is observed that maximum dry density for a mixture of 95% Soil and 5% cement, is of 85.54 gm/cm^3 for optimum moisture content of 10 %.

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5.3 90% Soil + 5% Cement + 5% Lime

Table 5.3 MDD & OMC For 90% + 5% Cement + 5% lime

90% Soil + 5% Cement + 5% Lime							
Water Content	8%	10%	12%	13%	14%	15%	16%
W1(gm)	3603	3603	3603	3603	3603	3603	3603
W2(gm)	5550	5600	5690	5694	5787	5725	5713
W(gm)	1948	1997	2087	2091	2184	2122	2113
γb = W/V(gm/cm^3)	88.54	90.81	94.90	95.08	99.31	96.49	95.95
Container No.	10	8	6	9	24	3	5
M1(gm)	37	34	26	13	72	9	20
M2(gm)	115	73	50	31	101	39	48
M3(gm)	110	69	47	29	98	36	44
W=(M2-M3/M3-M1)	0.068	0.093	0.14	0.13	0.11	0.11	0.16
γd = γb/1+W	82.90	83.08	83.25	84.14	89.46	86.93	82.71

As per above results it is observed that maximum dry density for the mixture of 90% Soil, 5% cement and 5% Lime, is of 89.46 gm/cm^3 for optimum moisture content of 11%.

6. CONCLUSION

By observations of above results it is clearly identified that for 100% soil MDD is 83.55 gm/cm^3, for replacement of soil by 5% of cement to its dry weight MDD is 85.54 gm/cm^3, and for replacement of soil by 5% cement and 5% lime MDD is 89.46 gm/cm^3. Which shows continuous improvement in the dry density of soil after stabilizing it with cement and lime. It is also observed that the combination of cement and lime gives higher value of dry density than cement stabilized soil. By above results it is conclude that for further improvement of soil in fundamental as well as in engineering properties we can apply stabilization to the soil with combination of cement and lime.

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