Study of strength of clayey soil of Baliapur, Dhanbad, by different parameters.

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ABSTRACT

The main focus of this research was to improve the strength of clayey soil & to obtain an optimum amount of soil-gypsum-cacl$_2$mix. The objective of study was to increase the strength of clayey soil using Gypsum and Calcium Chloride. As clay shows high shrinkage, swell characteristics & low bearing capacity especially under sub-grade, Therefore, there is a need to improve the strength characteristics of soil. The tests performed in laboratory on clayey soil was Pycnometer test for specific gravity, Casagrande's test for liquid limit, plastic limit test, Standard proctor test for determination of optimum moisture content (OMC) & maximum dry density (MDD) and California bearing ratio (CBR) tests.

Keywords- Gypsum,Cacl$_2$,Specific gravity,OMC,MDD,CBR.

INTRODUCTION

Soil stabilization is the term in which engineering properties of soil are changed with the help of another material and improve properties of soil. Soil for testing purpose is collected from Baliapur (sindri) , Jharkhand. Approximately 20 to 25 kg of soil sample is collected. Further the sample was kept for drying.

Stabilization of soil is the process of varying the properties of soil to improve its engineering properties, so that it can be used in various works of civil engineering. The soil over which the construction is to be carried out should have enough strength to carry the design load, neither should failure occur. This problem mainly occurs when construction is to be done on clayey soil. This soil is considered poorest material from civil engineering point of view. Various techniques are used for improving the engineered properties of clayey soil, known as soil stabilization.

LITERATURE REVIEW

Usama H.Issa (2014) has studied the stability of soft clay soil stabilized with recycled gypsum in a wet environment. The recycled gypsum was mixed with cement and lime in different ratio in dry state. The results show that increasing the content of both types of admixtures had a positive effect on the improvement of stability and durability for the tested soil in a wet environment.

Kenichi Sato (2015) reviewed on the effect of gypsum content on soil behavior. They added the varying percentages of gypsum to the soil. Form the results, it is reviewed that addition of gypsum content to the soil, the properties of soil are also increased significantly.

Tamadher et.al (2007) investigated the stabilization of soft soils like silty clay using salts of chloride like NaCl, $MgCl_2$ and $CaCl_2$.The results showed that the increase in the percentage of each of the chloride salts increased the maximum dry density and decreased the optimum water content. The liquid limit, plastic limit, and plasticity index decreased with increasing salt content. Also the results showed that the unconfined compressive strength increased when the salt content increased too.

Işık Yilmaz, , Berrin Civelekoglu (2009) studied the effect of the gypsum as an stabilizer for treatment of the expansive clay soils by means of swell potential and strength. Maximum dry density and optimum moisture content for bentonite soils was determined by standard compaction test. Different quantities of gypsum such as 2.5%, 5%, 7.5%, and 10% by mass are added to bentonite. A series of compaction tests, Atterberg limit tests are performed to see the changes in the plasticity, swell percent and strength parameters of treated and untreated samples. Results indicated that gypsum can be used as a stabilizing agent for expansive clay soils effectively.

Swarna Kolaventi et.al (2016) studied the stabilization of black cotton soil using salts and their comparative analysis. To investigate the effect of adding different chloride compounds including (NaCl, CaCl2) on the engineering properties of black cotton soil. Various amount of salt (2%, 4%, 6%and 8%) were added to the soil to study the effect of salts on the compaction characteristics, consistency limits and compressive. The main findings of this study were that the increase in the percentage of each of the chloride compounds increase the maximum dry density and decrease the optimum moisture content. The liquid limit, plastic limit and plasticity index decreased with the increase in salt content. The strength increases as the salt content increases.

MATERIAL USED

CLAY- In general, the term "clay" implies a natural, earthy, fine-grained material which when mixed with a limited amount of water develops plastic properties. Plasticity, as related to Soil Mechanics, is that property which allows a material to undergo rapid deformation without rupture, volume change, or elastic rebound. Chemical analyses of clays show them to have essentially silica, alumina, iron, alkalies, and alkaline earths. The term "clay" is sometimes used to signify a material that is the product of weathering, that formed by

hydrothermal action, or that deposited as a sediment. As a particle-size term, soil investigators tend to consider two microns as the upper limit of the clay particle size.

TESTS CONDUCTED

1) **Atterberg Limit**
   a) Liquid Limit
   b) Plastic Limit

2) **Standard Proctor Test**
   a) Optimum Moisture Content(OMC)
   b) Maximum Dry Density(MDD)

3) **California Bearing Ratio Test.**

4) **Unconfined Compressive Strength Test**

5) **Specific Gravity Test**

METHODS

1) ATTERBERG LIMITTEST

a) Liquid Limit

It is defined as the water content at which a soil is practically in a liquid state, but has infinitesimal resistance against flow which can be measured by any standard liquid limit device .The liquid limit test was carried out on clayey soil as per the procedure given in IS:2720 Part 5-1985. Liquid limit test was done by usingCasagrande's apparatus.

b) Plastic Limit

It is defined as the minimum water content at which a soil is just begins to crumble when rolled into the thread of approximately 3mm diameter. This test was carried out in clayey soil as per the procedure given in IS: 2720 Part 5-1985.

2) STANDARD PROCTOR TEST

The water content corresponding to the maximum dry unit weight is known as the optimum moisture content (OMC).OMC&MDD test was carried out on the clayey soil as per procedure given in IS: 2720 Part7-1974. This test is also called as the standard proctor test or light compaction test.

3) CALIFORNIA BEARING RATIO TEST

CBR is a penetration test for evaluation of the mechanical strength of natural ground, sub-grades and base courses beneath new carriage way. CBR values are usually calculated for penetration of 2.5 and 5.0 mm. Corresponding to the penetration value at which the CBR values is desired, corrected load value shall be taken from the load penetration curve and the CBR value is calculated. CBR test was carried out as per procedure given in IS: 2720 Part 16-1987.

4) UNCONFINED COMPRESSIVE STRENGTH TEST

This is a special case of the tri-axial test in which confining or cell pressure is zero. This test is an undrained test or quick test and is often used to determine the in situ strength of soft, saturated fine grained soil deposits. The test was carried out on clayey soil as per procedure given in IS: 2720 Part 10-1991.

5) SPECIFIC GRAVITY TEST

Specific gravity of soil is defined as the ratio of mass of sample of given volume to the mass of standard fluid (water) of equal volume at the same temperature. The specific gravity test was carried out on clayey soil as per procedure given in IS: 2720 Part 3 -section 1- 1980.

RESULTS

1) ATTERBERG LIMIT

a) Liquid Limit

Weight of container (g)	Weight of container + soil (g)	Weight of container + dry soil (g)	Weight of dry soil (g)	Weight of moisture (g)	Moisture content (%)	No. of blows
8.83	11.40	10.62	1.79	0.78	43.57	12
9.26	13.57	12.40	3.14	1.17	37.20	20
9.31	13.64	12.54	3.23	1.10	34	29
9.81	15.90	14.45	4.64	1.45	31.2	34

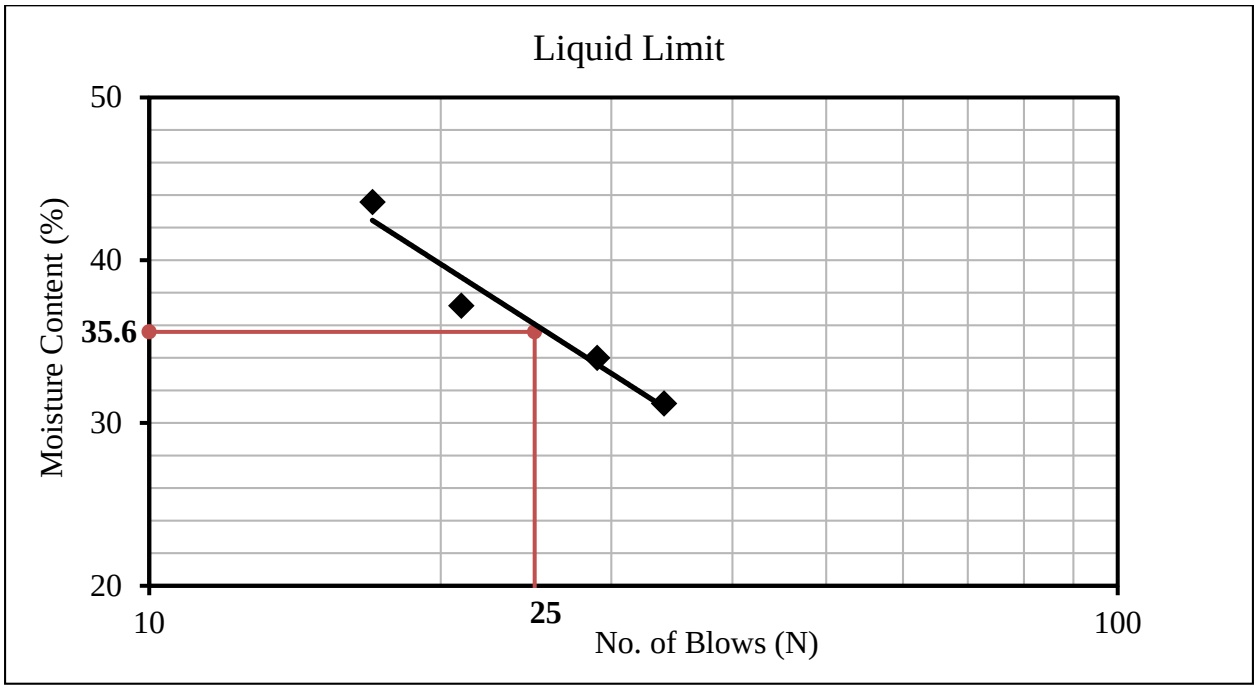

Fig-1: Liquid limit graph

From the graph, it is found that water content corresponding to 25 blows is 35.60%.
Hence,**Liquid limit = 35.60%**

b) Plastic Limit

Weight of container (g)	Weight of container + soil (g)	Weight of container + dry soil (g)	Weight of dry soil (g)	Weight of moisture (g)	Moisture content (%)
15.33	15.86	15.76	0.43	0.1	23.25
14.84	15.25	15.19	0.35	0.06	17.14

Plastic limit=20.20%
Plasticity Index (I_p) =Liquid limit-Plastic limit =35.60-20.20
I_p=15.40% (Medium plastic soil)

2) STANDARD PROCTOR TEST

a) Moisture content determination:

Weight of container (g)	Weight of container + soil (g)	Weight of container + dry soil (g)	Weight of dry soil (g)	Weight of moisture (g)	Moisture content (%)
13.83	32.29	31.21	17.38	1.08	6.21
13.38	33.19	31.54	18.16	1.65	9.10
14.82	34.98	32.81	17.99	2.17	12.10
13.04	28.82	26.83	13.79	1.99	14.43
14.44	34.09	31.36	16.92	2.73	16.13
14.87	30.42	28.07	13.2	2.35	17.80

b) Dry density determination:

Weight of mould (g)	Weight of mould + compacted soil (g)	Weight of soil (g)	Bulk density (g/cc)	Dry density (g/cc)
4468	6081	1613	1.62	1.52
4468	6202	1734	1.74	1.59
4468	6332	1804	1.87	1.67
4468	6443	1975	1.98	1.73
4468	6493	2025	2.03	1.75
4468	6470	2002	2.01	1.71

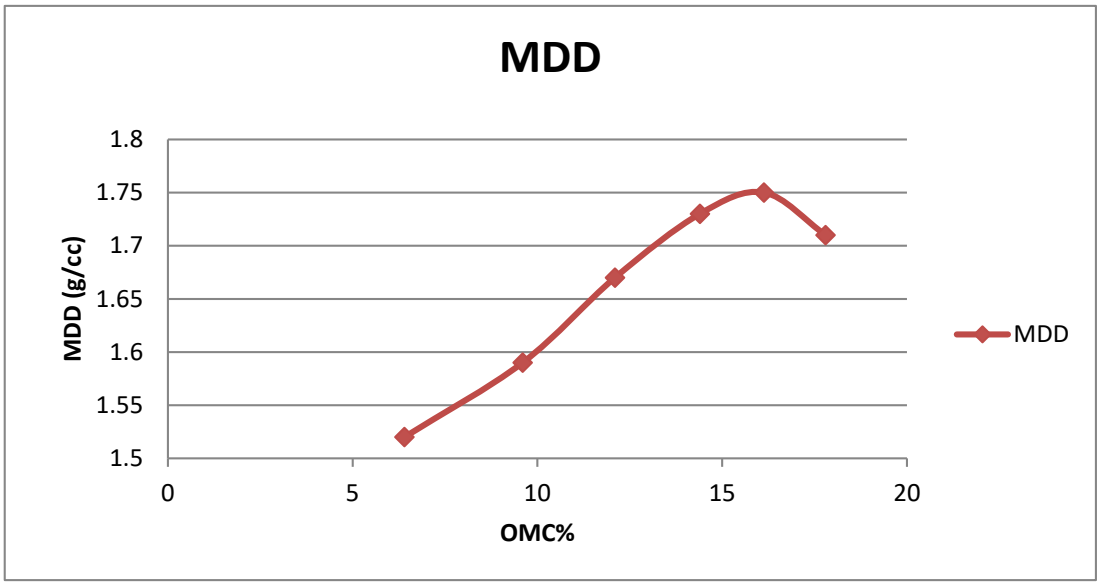

Fig-2: OMC& MDD graph

From above graph,
OMC = 16.13%,MDD = 1.750 g/cc

3) CALIFORNIA BEARING RATIO TEST

a) Soaked CBR

S.N	Penetration Value		Load		CBR Value (%)
	DGR	Penetration mm	PRR	Load Kg	
1.	0	0	0	0	
2.	50	0.50	0.7	3.85	
3.	100	1.00	1.4	7.70	
4.	150	1.50	2.6	14.30	
5.	200	2.00	3.8	20.90	
6.	**250**	**2.50**	**5.1**	**28.05**	$\frac{28.05}{1370} \times 100 = 2.04\%$
7.	300	3.00	5.4	29.7	
8.	400	4.00	5.8	31.9	
9.	**500**	**5.00**	**6.8**	**37.40**	$\frac{37.40}{2055} \times 100 = 1.82\%$

10.	750	7.50	8.9	48.95	
11.	1000	10.00	9.6	52.80	
12.	1250	12.50	10.0	55.0	

CBR = 2.04% (soaked)

b) Un-soaked CBR

S.N	Penetration Value		Load		CBR Value (%)
	DGR	Penetration mm	PRR	Load Kg	
1.	0	0	0	0	
2.	50	0.50	5.7	31.35	
3.	100	1.00	6.5	35.75	
4.	150	1.50	7.6	41.80	
5.	200	2.00	8.4	46.20	
6.	**250**	**2.50**	**10.4**	**57.20**	$\frac{57.20}{1370} \times 100 = 4.17\%$
7.	300	3.00	11.5	63.25	
8.	400	4.00	12.4	68.20	
9.	**500**	**5.00**	**13.6**	**74.8**	$\frac{74.8}{2055} \times 100 = 3.64\%$
10.	750	7.50	15.7	86.35	
11.	1000	10.00	16.8	92.40	
12.	1250	12.50	18.4	101.20	

CBR Value= 4.17% (Un-soaked)

4) UNCONFINED COMPRESSIVE STRENGTH TEST

Observations & Calculations for UCS Test of Natural Soil

SL. No.	PARAMETERS	SAMPLE 1	SAMPLE 2	SAMPLE 3
1.	Initial length (L)	76mm	76mm	76mm
2.	Final length (L)	69mm	67mm	67.5mm
3.	Average diameter (D)	38mm	38mm	38mm
4.	Strain (e = dL/L)	0.092	0.118	0.111
5.	Area (Ao = π X D X D/4)	11.34cm^2	11.34cm^2	11.34cm^2
6.	Corrected area (A = Ao/1-e)	12.48cm^2	12.85cm^2	12.75cm^2

7.	Maximum proving ring reading	2.8	3.0	3.2
8.	Load (P)	$5 \times 2.8 \times 2.82366 = 39.53\ kg$	$5 \times 3.0 \times 2.82366 = 42.35\ kg$	$5 \times 3.2 \times 2.82366 = 45.17\ kg$
9.	UCS (P/A)	3.16 kg/cm^2	3.29 kg/cm^2	3.54 kg/cm^2

Hence the unconfined compressive strength (UCS) = 3.54 kg/cm^2.

5) SPECIFIC GRAVITY TEST

Determination	Sample-1	Sample-2	Sample-3	Average Specific Gravity
Empty weight of pycnometer(W_1)	594 g	594 g	594 g	2.475
Weight of pycnometer + oven dried soil (W_2)	765 g	821 g	872.5 g	
Weight of pycnometer + soil + water(W_3)	1624.5 g	1659.2 g	1684.5 g	
Weight of pycnometer + water(W_4)	1522.5 g	1518.5 g	1525.8 g	
Specific Gravity (G)	2.470	2.636	2.320	

Specific Gravity of soil = 2.475

CONCLUSIONS

1) Atterberg limit test a) Liquid Limit(L.L) b) Plastic Limit(P.L) c) Plasticity index(L.L – P.L)	 35.60% 20.20% 15.40%(Medium Plastic)

2) Standard Proctor Test	
a) OMC	16.13%
b) MDD	1.750gm/cc
3) California Bearing Ratio Test	
a) Soaked	2.04%
b) Un-soaked	4.17%
4) Unconfined Compressive Strength	3.54kg/cm^2
5) Specific gravity	2.475

DISCUSSION

After completion of basic tests we will add $cacl_2$ and gypsum in different percentage and then the result is compared with basic test result. Evaluation of strength characteristics of virgin as well as blended soil with different percentage of gypsum and calcium chloride will be tested in laboratory.

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