Stabilization of Expansive Soil of Subgrade by using M- Sand

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***Abstract*: Stabilization is a technique introduced many years ago with the main purpose to render the soil capable of meeting the requirements of the specific engineering projects. Stabilized materials may be used as improved sub grades or sub-bases for road .It is the alteration of one or more soil properties, by mechanical or chemical means, to create an improved soil material possessing the desired engineering properties. In our paper we are using M-Sand as a stabilizers and PPC (Portland Pozzolona Cement). M-Sand is nothing but the Manufacturing Sand. We used these as a stabilizers because we are making use of the waste product as well as it is economical and one of the newest concept.**

***Index Terms*: Stabilization, M- sand, PPC.**

I. INTRODUCTION

Expansive soils are those clay soils which exhibited significant volume changes as a result of soil moisture variation. This type of soil, upon wetting and drying, causes severe damages to pavement constructed on such soil. Expansive soils usually have undesirable engineering properties, such as low bearing capacity, coupled with low stability and excessive swelling. The nature of this soil creating serious problems to the civil engineering structures particularly road pavements constructed on them. Among various methods for the solution to the problems posed by expansive soils, the stabilization of such soil is the best practical option. In general soil stabilization seems to be an effective alternative for improving soil properties.

Purpose of the stabilization of flexible pavement resting on weak and troublesome soil is to acquire desirable properties of sub grade which are high compressive and shear strength, permanency of strength under all weather and loading conditions, ease and permanency of compaction ,ease of, drainage and low susceptibility to volume changes and frost action.

II. EXPERIMENTATION

To find the properties of expansive soil there is need to take test on soil. Tests are taken on soil before and after adding M-Sand and results are analyzed. The soil sample that we tested in laboratory is taken from the road at the depth of 1 meter from the end of embankment of road i.e. where the slope ends, the collected sample was moist.

Test conducted on soil are as follows:

1. Water content
2. Specific gravity by using pycnometer
3. Plastic limit
4. Liquid limit
5. Standard proctor test
6. Core cutter test
7. C. B. R. Test(California Bearing Ratio)

To know the nature of soil first we conduct specific gravity test on collected 4 different soil samples.

The specific gravity of soil is determined using the relation:

$$G = \frac{M2-M1}{(M2-M1)-(M3-M4)}$$

Table 1: Specific Gravity Test

Sr No	Sample Location	Specific Gravity Results			
		1	2	3	Avg
1.	Bahirewadi Road	1.75	1.57	1.58	1.63
2.	Kodoli road soil sample	2.2	2.3	2.27	2.25
3.	Borpadle road	1.76	2.09	1.94	1.93
4.	Chikurdi road	1.81	1.57	1.7	1.69

By the following results we come to know that some of the results are below 2 and some are above 2 by the standard parameters of specific gravity the reading below 2 is loose soil and reading above to 2 is hard soil, so we come to the conclusion that soil of Bahirewadi Road. Soil sample here is loose and from that we choose the Bahirewdi road sample for next experiments.

Table 2: Soil tests results before adding M –Sand and PPC

Sr No	Soil tests	Results			
		1	2	3	Final result
1.	Water content	52.5	51.5	50.5	51.51%
2.	Specific gravity by using pycnometer	1.75	1.57	1.58	1.63
3.	Plastic limit	38%	40%	39%	39%
4.	Liquid limit	50%	77.77%	88.3%	67%(25 N blows)
5.	Standard proctor test- Dry Density	1.352	1.385	1.45	1.45gm/c(from Graph)
	OMC(%)	25.30	28.78	34.21	34.21% (from Graph)
6.	Core cutter test Dry Density	1.46(gm/cc)	1.5(gm/cc)	1.52(gm/cc)	1.5gm/cc
	Water Content	39.47%	38.66%	40.78%	39.63%
7.	C. B. R. Test CBR for 2.5mm Penetration	1.31%			1.31%
	CBR for 5mm Penetration	1.21%			1.21%

III. IDENTIFICATION OF EXPANSIVE SOIL

Table 3: Criteria for expansive soil

Sr. No.	Degree of expansion	Liquid Limit (%)	Shrinkage Limit (%)	Plasticity Index (%)
1.	Very High	60-70	>30	>35
2.	High	40-60	20-30	20-35
3.	Medium	30-40	10-20	10-20
4.	Low	20-30	<10	<10

From the obtained results we can conclude that collected soil sample is ***highly expansive soil.***

IV. RESULTS AFTER STABILIZATION OF BLACK COTTON SOIL

a) STANDARD PROCTOR COMPACTION TEST

Compaction test of soil is carried out using Proctor's test to understand compaction characteristics of different soils with change in moisture content. Compaction of soil is the optimal moisture content at which a given soil type becomes most dense and achieve its maximum dry density by removal of air voids.

Compaction is the process of densification of soil by reducing air voids. The degree of compaction of a given soil is measured in terms of its dry density. The dry density is maximum at the optimum water content. A curve is drawn between the water content and the dry density to obtain the maximum dry density and the optimum water content.

The test is carried out at different combinations of sand and PPC and the results are obtained given below.

Table No 4: Standard proctor compaction test

Sr. No	Soil and M Sand combination	MDD (gm/cc)	OMC (%)
1.	Natural soil	1.45	34.21
2.	Soil + 10% sand + 2% cement	1.5	31.32
3.	Soil + 15% sand + 2% cement	1.58	27.27
4.	Soil + 20% sand + 2% cement	1.6	26

The above table shows the values obtained from compaction, for varying percentages of cement, & M-sand. We can see that the stability of the subgrade black cotton soil can be increased by using stabilizers like cement, m-sand, as there is OMC decreases and dry density increases when stabilizers are used.

b) CALIFORNIA BEARING RATIO TEST

The california bearing ratio test is penetration test meant for the evaluation of subgrade strength of roads and pavements. The results obtained by these tests are used with the empirical curves to determine the thickness of pavement and its component layers. This is the most widely used method for the design of flexible pavement.

DEFINITION OF C.B.R.

It is the ratio of force per unit area required to penetrate a soil mass with standard circular piston at the rate of 1.25 mm/min. to that required for the corresponding penetration of a standard material.

C.B.R. = Test load/Standard load 100

The following table gives the standard loads adopted for different penetrations for the standard material with a C.B.R. value of 100%

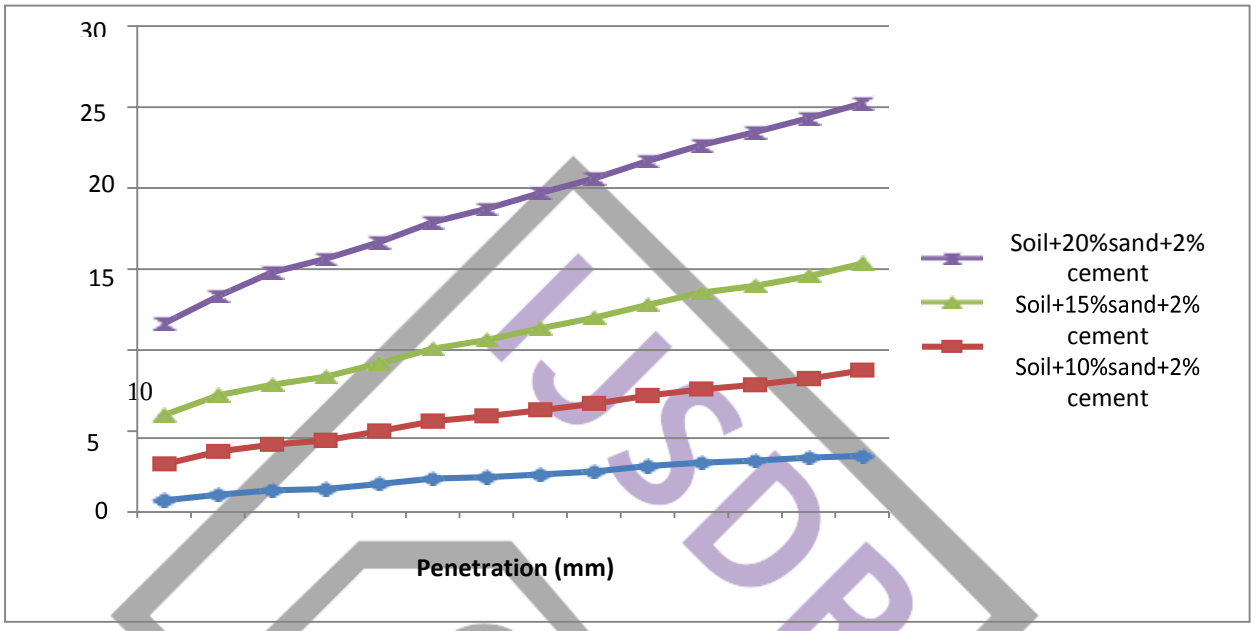
Table 5: Standard load for different penetraation

Penetration of plunger (mm)	Standard load (kg)
2.5	1370
5.0	2055
7.5	2630
10.0	3180
12.5	3600

Table No 6: California Bearing Ratio Test

Type	2.5mm penetration	5mm Penetration
Natural BC Soil	1.31	1.21
Soil +10%sand + 2% cement	1.98	1.66
Soil +15%sand + 2% cement	2.59	2.10
Soil +20%sand + 2% cement	4.88	3.66

Graph 1: Comparison of CBR test results



From CBR tests of black cotton soil with varying percentage of stabilizers like cement, M – sand. It can seen that from the graph the CBR values increases when stabilizers were used. Hence can conclude that the stability of the Black cotton soil can be increased by making use of the stabilizers such as cement, M - sand.

CBR value of the natural soil is 1.31% and after the stabilization the CBR value is 4.88%. The CBR value increased by the 3.57% therefore the dry density of soil is increases.

V. CONCLUSION

By these all the results, we can conclude that the stabilizers which we have been used is economical and increased good strength after the addition of the M-Sand & PPC. In our country expansive soil has liquid limit ranging from 45-100%, plasticity index from 20-65%and shrinkage limit 9-14%.The result of experimental work proves swell increases along plasticity index, swelling potential rely on the clay minerals, cation exchange capacity, degree of saturation densities and water content.

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