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Stabilization of Expansive Soil with Baghouse Fines

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Abstract*: Highway engineer are often faced with the problem of dealing with expansive soil for sub-grade construction. Soil stabilization provides simple and effective solution in dealing with such situation. It is expected that the stabilization agent for expansive sub-grade should be cheap and argillaceous such material should have little or no plasticity. Baghouse fines are fine grained waste material discarded from hot mix plant having no economic value and are discarded in a water body at close proximity. This material is generally non-plastic. By virtue of these favorable properties, the present dissertation was planned to admix baghouse fines as a stabilizing agent for clayey sub-grade soil and to study the geotechnical and engineering properties to determine its possible use for highway construction. In order to simulate clayey soil, bentonite was used. It is observed that plasticity index was reduced from 90.97% to 0%, after stabilization while free swelling index was reduced from 333.3% to 0%, the maximum dry density was increased from 1.25 to 1.73 g./cc, while optimum moisture content reduced from 38.91 % to 12.99 %. The soil sub-grade is layer of natural soil prepared to receive the layer of pavement materials placed over it. The load on the pavement are ultimately received by the soil sub-grade for dispersion of the earth mass. It is essential that at no time, the soil sub-grade is overstressed. It means that the pressure transmitted on the top of sub-grade is within allowable limit, not to cause excessive stress condition or to deform to same beyond elastic limit. Therefore, it is desirable that at least 50 cm layer of the sub-grade soil is well compacted under controlled condition of optimum moisture content and maximum dry density. It is necessary to evaluate strength properties of sub-grade soil.

***Keywords*: Bentonite, baghouse fines, stabilization, compaction, CBR**

1. Introduction

The expansive soil which is spread over extensive areas of Indian states, like Rajasthan, Madhya Pradesh, Gujrat, Tamil Nadu and Karnataka faces problems in construction during building & roads. In India the typical types of expansive soils are bentonite, black cotton soil. Bentonite is highly expansive soil and have a tendency of swelling when water comes in contact and shrink after removal of water. In bentonite the free swelling is upto 10 to sixteen times to its original volume. Since expansive soils have a tendency to change their volume, they cause heavy distress to construction. Some structure severely affected due to swelling pressure exerted by these soil like lightweight structures, it can be preventing by either making the structure resistant to damage from soil movement or improve the strength of soil by stabilization.

Clayey soil cannot satisfy the requirement of highway construction because of its low strength and high swelling potential. To improve the mechanical performance and applicability of clay in subgrade construction, highway engineers attempt to introduce the baghouse fines which is mixed with bentonite to reduce the plasticity index. Hot mix asphalt baghouse fines are dust particles (Hot Mix Plant, Barabanki, Lucknow) that are captured from the exhaust gases of asphalt mixing plant. Secondary collection equipment called baghouses is commonly used to capture these very fine sized materials. Soil is crucial material for the highway engineer especially in embankment and subgrade structures. Lesse the PI, better the material since it adapts to granular structure. Lower the PI, higher the California Bearing ratio (CBR).

Table 1
Properties of the bentonite soil

Property	Bentonite
Specific gravity	2.90
Liquid Limit (%)	133.23
Plastic Limit (%)	42.26
Plasticity Index (%)	90.97
Maximum dry Density (g/cc)	1.25
Optimum Moisture Content (%)	38.91

A. Soil stabilization

Stabilization of soil is the change of one or more soil properties to create an improved soil material possessing the desired engineering properties.

Advantages of Soil stabilization

- Improve soil strength
- Helps to reduce soil volume change due to moisture
- Improve soil workability

Soil stabilization can be done by either mechanical or chemical methods.

2. Literature study

Zaki A. Baghdadi: State that kiln is a waste material produce in considerable quantities during the manufacture of Portland cement. This paper presents result of testing program to explore the effect of kiln dust on plasticity, compaction and strength characteristics of clayey soil. Result indicates a considerable decrease in plasticity and marked increase in compressive strength as a result of addition of kiln dust. The first phase of the testing program deals with studying the effect of kiln dust on Atterberg's limit. Kiln dust was first added in different amounts to kaolinite to investigate changes in plasticity index. But since the plasticity of pure kaolinite was low, 9, little change in plasticity indices was recorded. These result prompted the author to use bentonite. The bentonite was chosen due to high its plastic nature so that any change due to treatment could be easily detected. For the purpose, kiln percentage of 0.5, 1.0. 4.0, and 8.0 by weight were added to bentonite.

The second phase deals with the effect of kiln dust on compaction properties. Standard Procter test (ASTM D-698) were conducted on pure kaolinite and kaolinite-kiln dust mixtures 96,12, and 30% of kiln dust by dry weight of soil. It was observed that addition of kiln dust to bentonite affects its plasticity. The liquid limit values decreased considerably with increasing amount of kiln dust, while plastic values decrease but at a slower rate.

N. K. Ameta, D.G.M. Purohit, and A.S. Wayal: Narrates the problems associated with expansive soil are related to bearing capacity and cracking, breaking up of pavements, and various other building foundation problem. Such soils are common in Australia, India and south Africa. The present paper deals wwith the properties of expansive soils of Rajasthan, India at various location. The effect of gypsum and addition of dune sand on swelling pressure was studied and it found that swelling pressure decreases with addition of dune sand and gypsum. Effect of dry density and moisture content is also presented.

Joel H. Beeghly: Found that fine grained soil with high clay (<0.005 mm) and silt (<0.074 mm) content are generally less desirable as pavement subgrade than natural soil containing higher amounts of granular material such as gravel and sand. Soil with more than 25% passing the 75-micron sieve and a plasticity Index of at least 10 are amenable to lime stabilization.

Erdal Cokca (2001): Effect of flyash on expansive soil was studied by Erdal Cokca, Flyash consists of often hollow spheres of silicon, alluminium and iron oxides and unoxidized caebon. There are two major classes of flyash, class C and class F. the former is produced from burning anthracite or bituminous coal and the latter is produced from burning lignite and sun=b bituminous coal. Both the classes of flyash are puzzolans, which are defined as siliceous and aliminous materials. Thus flyash can provide an array of divalent and trivalent cations. Thus expansive soil can be potentially stabilized effectively by cation exchange using flyash. He carried out investigations using soma flyash and tuncbilek flyash and added it to expansive soil at 0 to 25 %. Specimen with flyash were cured for 7 days and 28 days after which they were subjected to Oedometer free swell test and his experimental findings confirmed that the plasticity index, activity, swelling potential of the samples decreased with increasing percentage of stabilizer.

3. Laboratory investigation

Following laboratory tests have been carried out as per IS: 2720.

1. Atterberg limit
2. Procter Compaction Test

Experimental result of Atterberg's Limit with varying proportion of Baghouse fines:

Table 2
Experimental result

Mixer Proportion		Atterberg Limit		
Bentonite (% by weight)	Fines (% by weight)	LL (%)	PL (%)	PI (%)
100	0	133.23	42.26	90.97
90	10	98.30	38.96	59.34
80	20	81.50	29.65	51.85
70	30	70.35	28.90	41.45
60	40	62.50	27.85	34.65
50	50	55.60	26.35	29.25
40	60	41.80	23.98	17.52
30	70	38.26	24.16	14.10
20	80	0	0	0
10	90	0	0	0
0	100	0	0	0

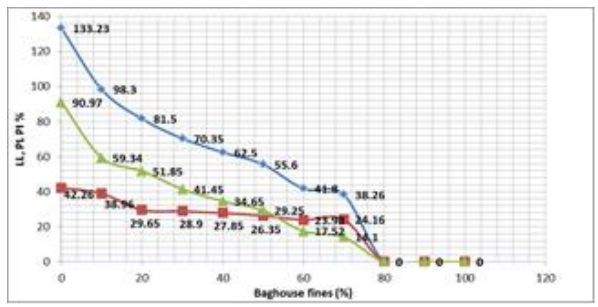

Fig. 1. Variation of LL, PL, PI with baghouse content

Table 3
Mixer proportion and Standard Procter test

Mixer Proportion		Standard Procter Test	
Bentonite (% by weight)	Fines (% by weight)	OMC (%)	MDD (g/cc)
100	0	38.91	1.25
90	10	32.20	1.29
80	20	32.00	1.37
70	30	28.56	1.42
60	40	25.50	1.49
50	50	25.00	1.51
40	60	22.07	1.58
30	70	20.00	1.61
20	80	18.85	1.67
10	90	18.01	1.69
0	100	12.99	1.73

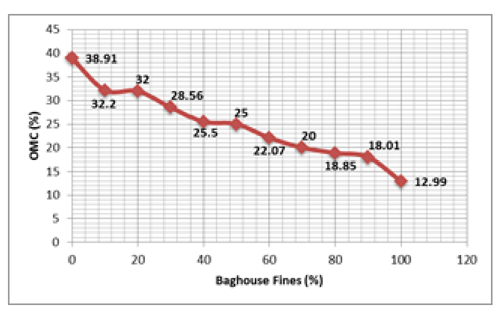

Fig. 2. Variation of OMC with Baghouse content

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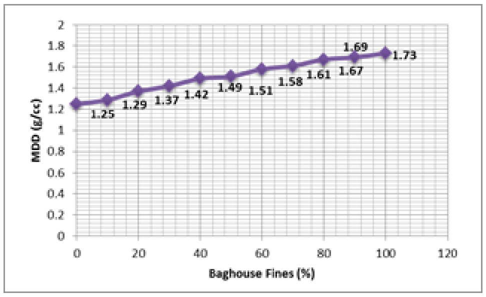

Fig. 3. Variation of MDD with baghouse fines

4. Conclusion

- As the bentonite soil has generally high plasticity so it was difficult to construction on it.
- Liquid Limit for baghouse fines was 0%, while that of bentonite clay was 133.23%, with increase in baghouse fines proportion in the admixed soil the liquid limit decreases.
- Plastic limit for baghouse fines was 0%, while that of bentonite clay was 42.26%, with increase in baghouse fines proportion in the admixed soil the plastic limit decreases.
- The baghouse fines were non-plastic, while the plasticity of bentonite clay was 90.97 %, with the increase in baghouse fines content in the admixed soil the plasticity index decreases.
- OMC for baghouse fines was 12.99%, while that of bentonite clay was 38.91%, with increase in baghouse fines proportion in the admixed soil the OMC decreases.
- MDD for baghouse fines was 1.73 g/cc%, while that of bentonite clay was 1.25%, with increase in baghouse fines proportion in the admixed soil the MDD increases.

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