Analysis Of Effect Of Saturation On Subgrade Strength By Lime & Rice Husk Ash

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Abstract -The design of the pavement layers to be laid over sub grade soil starts off with the estimation of sub grade strength and the volume of traffic to be carried. Design of the various pavement layers are very much dependent on the strength of the sub grade soil over which they are going to be laid. Sub grade strength is mostly expressed in terms of CBR (California Bearing Ratio). Weaker sub grade essentially requires thicker layers whereas stronger sub grade goes well with thinner pavement layers. The sub grade is always subjected to change in saturation level due to precipitation, capillary action, flood or abrupt rise or subside of water table. Change in moisture level in sub grade causes change in the sub grade strength. And it becomes quite essential for an engineer to understand the exact nature of dependence of sub grade strength on moisture variation. An understanding of the dependence of the CBR strength of local soils on water content will contribute towards better design and maintenance practices. Normally CBR test is an easy and well adopted method conducted on soil samples to measure the strength of sub grade. However, many other tests are also considered for assessing the sub grade strength.The strength of soil, used for sub grade may vary largely on the amount of saturation in it, i.e. amount of water exposed to the soil. To overcome this problem the pavement industry looks for ways of improving lower quality materials through stabilization process that are readily available for use in roadway construction. Cement/ lime treatment has become an accepted method for increasing the strength and durability of soils and marginal aggregates, reducing quantity of aggregates. Indian Roads Congress (IRC) developed a Special Publication (SP) for mix design of lime/cement treated base/subgrade.In this experiment Rice husk ash (RHA) is also used as a stabilizer for soil sample. . In the present investigation, an attempt has been made to evaluate the changes in the compaction and strength characteristics of black cotton soils such as optimum moisture content, maximum dry density and CBR in addition of lime and rice husk ash in different proportions.It is observed that 3% lime addition to the sub-grade soil is giving relatively maximum strength.

I.INTRODUCTION

Effective pavement design is one of the most important aspects of project design. The pavement is the portion of the highway which is most obvious to the motorist. The condition and adequacy of the highway is often judged by the smoothness or roughness of the pavement. Deficient pavement conditions can result in increased user costs and travel delays, braking and fuel consumption, vehicle maintenance repairs and probability of increased crashes.The pavement life is substantially affected by the number of heavy load repetitions applied, such as single, tandem, tridem and quad axle trucks, buses, tractor trailers and equipment. A properly designed pavement structure will take into account the applied loading.Subgrade layer is the lowest layer in the pavement structure underlying the base course or surface course, depending upon the type of pavement. Generally, subgrade consists of various locally available soil materials that sometimes might be soft and/or wet that cannot have enough strength/stiffness to support pavement loading. A sound knowledge of performance of the subgrade soil under prevailing in-situ condition is necessary prior to the construction of the pavement. The better the strength/stiffness quality of the materials the better would be the long-term performance of the pavement. Hence, the design of pavement should be focused on the efficient, most economical and effective use of existing subgrade materials to optimize their performance. In case of soft and wet subgrades, proper treatment might be needed in order to make the subgrade stiff/hard for cost-effective pavement design.

II.SOIL STABILIZATION

For this research study we collected the enough quantity of best representative sample of black-cotton soil from Nadargul village in Saroornagar mandal of Rangareddy District for laboratory investigation. At this site flexible pavement is going to construct by govt authority in future. The proposed tests on subgrade soils have been shown in Table

The tests on collected subgrade soils have been shown in Table Tests on Existing Subgrade

Testing Criteria	
Description of Test	Standard Code Applicable
Soil Classification	IS 1498
Sieve Analysis	IS 2720 (Pat – 4)
Atterberg Limits	IS 2720 (Pat – 5)
Laboratory Compaction Test (Modified Proctor Test)	IS 2720 (Pat – 8)
Triaxial test	IS 2720 (Pat – 11)
4-day soaked CBR at 3 energy levels	IS 2720 (Pat – 16)
Free swell Index	IS : 2720 (Pat-40)

Soil stabilization can be explained as the alteration of the soil properties by chemical or physical means in order to enhance the engineering quality of the soil. The main objective of the soil stabilization is to increase the bearing capacity of the soil, its resistance to weathering process and soil permeability.

The long-term performance of any construction project depends on the soundness of the underlying soils. Unstable soils can create significant problems for pavements or structures, Therefore soil stabilization techniques are necessary to ensure the good stability of soil so that it can successfully sustain the load of the superstructure especially in case of soil which are highly active, also it saves a lot of time and millions of money when compared to the method of cutting out and replacing the unstable soil.

Fig: Black cotton soil at site

Improving an in-situ soil's engineering properties is called "soil stabilization". Soils containing significant levels of silt or clay have changing geotechnical characteristics they swell and become plastic in the presence of water, shrink when dry, and expand when exposed to frost. Site traffic is always a delicate and difficult issue when projects are carried out on such soils. The soil can be stabilized by using various processes of stabilizers such as chemical stabilization in which chemically active compounds.

1.1Stabilization With Lime

Lime stabilization is done by adding lime to soil. this is useful for the stabilization of clayey soil. When lime reacts with soil there is exchange of cations in the adsorbed water layer and a decrease in the plasticity of the soil occurs. The resultant material is more friable than the original clay, and is more suitable as subgrade lime is produced by during of lime stone in kiln .the quality of lime obtained depends on the parent material and the production process and there .

1.2stabilization With Rice Husk Ash

Soil Stabilization is being used for a variety of engineering works, the most common application being in the construction of road and pavements, where the main objective is to increase the strength or stability of soil and to reduce the construction cost by making best use of the locally available materials. Over the times, cement and lime are the two main materials used for stabilizing soils. These materials have rapidly increased in price due to the sharp increase in the cost of energy. Thus the use of agricultural waste (such as rice husk ash -RHA) will considerably reduce the cost of construction and as well reducing the environmental hazards they causes. Rice husk is an agricultural waste obtained from milling of rice. About 10^8 tons of rice husk is generated annually in the world. Hence, use of RHA for upgrading of soil should be encourage.

Table 3.2. Properties of commercial limes—Quicklime				
Constituent	High Calcium Range, %		Dolomitic Range, %	
CaO	92.25 - 98.00		55.50 - 57.50	
MgO	0.30 - 2.50		37.60 - 40.80	
SiO_2	0.20 - 1.50		0.10 - 1.50	
Fe_2O_3	0.10 - 0.40		0.05 - 0.40	
Al_2O_3	0.10 - 0.50		0.05 - 0.50	
H_2O	0.10 - 0.90		0.10 - 0.90	
CO_2	0.40 - 1.50		0.40 - 1.50	
Specific Gravity	3.2 – 3.4		3.2 - 3.4	
Specific Heat at 100°F (38°C)	0.19 BTU/lb	442 J/kg	0.21 BTU/lb	488 J/kg
Bulk Density, pebble lime	55 - 60 lb/ft^3	880 - 960 kg/m^3	55 - 60 lb/ft^3	880 - 960 kg/m^3

Table : Oxide composition of RHA

Constituent	Composition (%)
SiO2	75.2
Al2O3	5.2
Fe2O3	1.02
CaO	1.4
MgO	1.75
Loss on Ignition	15.43

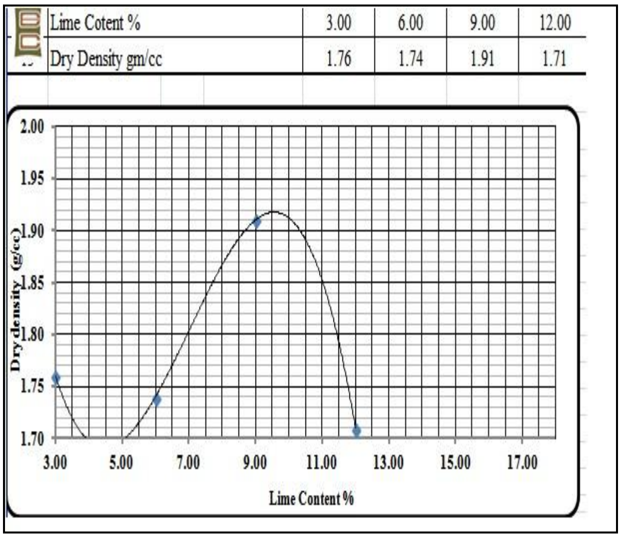
III.LABORATORY INVESTIGATION USING STABILIZERS (LIME & RSH)

After adding suitable proportions of soil& lime for improving the soil properties, we have to re-test the soil's index properties to find out the extent to which their properties have been improved. The following tests were conducted.

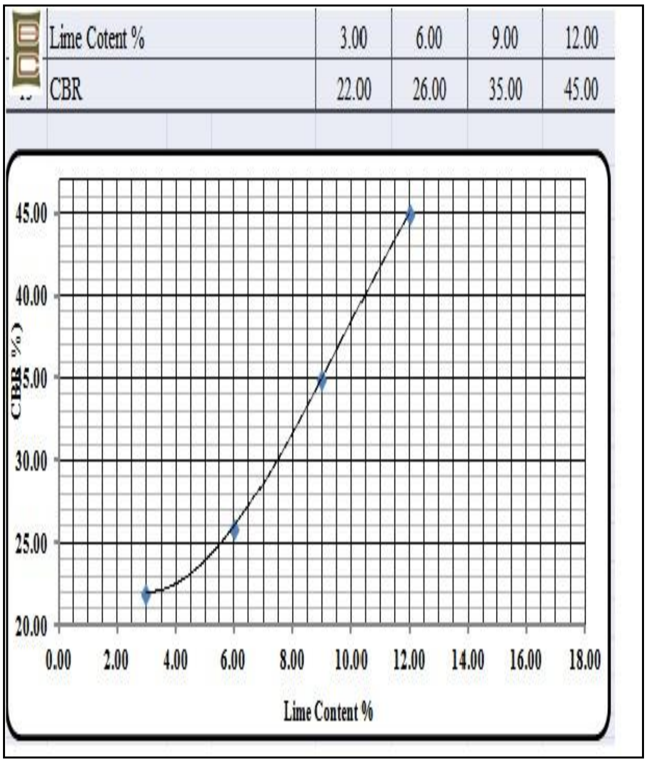
Test-1: Free swell index
Test-2: Atterberg limits
Test-3: Compaction test
Test-4: CBR test
Test-5 Triaxial Test

Table : Test Results Summary for Lime Stabilization

S:No	% of Lime	Atterberg Limits [IS :2720-Pt-V]			Modified Proctor Test (IS:2720-Pt-VIII)		Free Swell Index (%)	4 days soaked CBR (%)		shear stress (KN/M2)
		Liquid Limit %	Plastic Limit %	Plasticity Index (PI)	MDD gm/cc.	OMC (%)		MDD	97% MDD	
1	0% Lime	54	33	21	1.85	11.3	25	5.4	5.2	160
2	3% Lime	59	35	24	1.76	15.1	40	25.5	22.0	240
3	6% Lime	42	31	11	1.74	16.1	50.0	27.7	26.0	210
4	9% Lime	43	35	8	1.91	22.6	60	42.5	35.0	270
5	12% Lime	42	31	12	1.71	19.8	65	47.5	45.5	340



Compression of Dry Density Variation with the % of Lime



Compression of CBR Variation with the % of Lime

Test Results Summary for RHA Stabilization

S:No	% of RHA	Atterberg Limits [IS :2720-Pt-V]			Modified Proctor Test (IS:2720-Pt-VIII)		Free Swell Index (%)	4 days soaked CBR (%)		Shear stress (KN/M2)
		Liquid Limit %	Plastic Limit %	Plasticity Index (PI)	MDD gm/cc.	OMC (%)		MDD	97% MDD	
1	0% RHA	54	33	21	1.85	11.3	25	5.4	5.2	`160
2	3% RHA	51	31	20	1.63	14.2	22	6.3	5.9	180
3	6% RHA	48	29	19	1.61	16.1	19.84	6.6	6.2	194
4	9% RHA	47	24	23	1.60	17.40	15.20	7.9	7.2	210
5	12% RHA	45	21	24	1.56	18.1	13.2	9.6	9.2	224

IV.CONCLUSIONS

In general black cotton soils have poor bearing strength. Such soils when come into contact with water undergo swelling. On the other hand such soils tend to undergo shrinkage in dry seasons when the water gets evaporated. During this swell and shrink cycle if heavy loads are imposed on such soils, they will definitely deteriorate and may cause failure of pavement or super-structure. To avoid this, such kind of soils are to be either replaced from its Sub-grade or to be treated by the process of stabilization..

The conclusions of the project study are listed down as follows;Such a kind of black cotton soils are collected for the project study, and the Plasticity Index and CBR value was recorded as 21 & 5.23 respectively.Based on the study soil physical properties, the best suitable stabilizer (Lime) and Rice husk ash was selected as per the Indian Roads Congress (IRC) guidelines.The stabilizers was added to the black-cotton soil at various content (like 3%, 6%, 9% & 12%), to understand the improvement of physical & strength properties. 3% & 12% lime & RSH addition gives the relatively maximum strength. With that, the soil is stabilized and cost of post is reduced.Hence, from both results we conclude that 3% of lime addition to the sub-grade soil is the optimum solution for project construction.

% Lime	**0%**	**3%**	**6%**	**9%**	**12%**
Liquid Limit	54	59	42	43	42
Plasticity Index	21	24	11	8	12
CBR (%)	5.2	22.0	26.0	35.0	45.5
Shear stress	160	240	210	270	340

% Rsh	**0%**	**3%**	**6%**	**9%**	**12%**
Liquid Limit	54	51	48	47	45
Plasticity Index	21	20	19	23	24
CBR (%)	5.2	5.9	6.2	7.2	7.9
Shear stress	160	180	194	210	224

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