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AN ALTERNATE ENVIRONMENT FRIENDLY MATERIAL FOR LIME STABILIZATION IN RAJASTHAN STATE

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ABSTRACT: This paper is based on one of the cost effective technology discussed in M Tech. thesis study on alternate, environmental friendly material, for lime stabilization. To address the problem of black cotton soil in Kota zone of Rajasthan, various possible stabilization techniques discussed in IRC SP 72 are explored. However the test results indicates the lime stabilization being the most suitable technique but the problem of availability of natural lime is the biggest constrain. Hence for research sample of available materials/industrial waste in Kota zone are collected and tested. Lime carbide sludge, a byproduct in the process of making acetylene gas is found to be a good alternate to natural lime. Lime stabilization through Lime carbide sludge (factory waste) is studied and tested at different percentages to arrive at optimum value to be mixed. Methodology also needs to be modified as the Lime carbide sludge is available in semi solid/paste form. Test results of existing soil, soil mixed with lime carbide sludge, methodology for construction of subgrade with soil mixed with lime carbide sludge & environmental advantages of using lime carbide sludge are discussed in this paper.

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1 INTRODUCTION

Rajasthan state has a vast network of roads with total length 2.15 lac km. Out of which village roads are 1.54 lac km (around 70% of the network). The present work is primarily focused recommend cost effective technologies for village roads. Rajasthan state is rich in minerals, due to which many of the commercially available materials are not found cost effective.

Kota zone of Rajasthan generally have very week, black cotton soil, with CBR as low as 1-3 %. Hence to achieve the minimum warranted 5% CBR for low trafficked roads as per IRC SP 71 2015, it was crucial find out some material which can be mixed with locally available marginal materials (low CBR soil) to suffice the minimum requirement of code.

Desk study of available literature highlight the fact that lime stabilization is most effective, environmental friendly and time tested. However sources of natural lime are limited and widely used for pharmaceutical products. Hence finding an alternate material to natural lime was crucial. Author collected various byproducts/industrial waste material and tested for their usefulness as a construction material and in particular an alternate to

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natural lime.

2 SAMPLE COLLECTIONS & TESTING

Four districts falls under Kota zone, Bundi, Baran, Kota and Jhalawar. Soil in these district is expensive clay having CBR<4% and PI>10. Due to wide reach of the expensive clay, good soil having CBR>5 is not available within economical lead. Hence stabilization of existing soil is more feasible. Test results of the soil shows, lime stabilization or lime stabilization with fly ash is best suited among the seven stabilization techniques mentioned in IRC SP 73 2015. Good quality Lime is not available commercially due to its more profitable use in pharmaceutical companies. Nearest quarry is located at Gotan, which is 300km away from Kota.

Kota being a hub of small industries including fertilizer plan. Hence efforts were made to look for an alternate to free lime, in factory waste or byproducts. During the discussion with many factory owners and PWD officials at Kota region, we discovered one factory at Kota city, which produces lime carbide sludge as waste in the process of making acetylene gas.

Lime Carbide sludge is a factory waste in semi solid form. We took the samples in semi-solid form from factory's lagoons.

Chemical analysis is done on X-Ray analyzer on dry basis indicated following chemical composition of Lime Carbide Sludge.

Para meter	Unit	Avg	MIN
CaO	%	66	65
SiO2	%	3.7	3.3
Al2O3	%	0.9	0.5
Fe2O3	%	0.15	0.12
MgO	%	0.7	0.6
K2O	%	0.10	0.09
Na2O	%	0.06	0.05
Cl	%	0.10	0.02
SO3	%	2.3	2.2

Locally available soil is mixed with lime carbide sludge, free lime from Gottan, mix of lime carbide sludge and fly ash and tested for Atterberg limits, MDD, OMC, Soaked CBR, Free Swelling Index (FSI) and Unconfined Compressive Strength (UCS). Additives are mixed at different proportion to

arrive at the optimum value to achieve minimum desire strength in terms of CBR and UCS.

Test results of natural soil

Name of District	Bundi
Description of soil	Clayey Silt
Soil Classification as per IS: 1498	CH
Gradation: % by wt retained on the Sieve (IS:2720-IV)	
10.0 mm	0
4.75 mm	0.64
2.0 mm	3.02
425 micron	6.39
75 micron	2.57
Clay & silt content %	87.38
Atterberg Limits [IS :2720-Pt-V]	
Liquid Limit (LL) %	58
Plastic Limit (PL) %	33
Plasticity Index (PI)	25
Standard Proctor Test (IS:2720-Pt-VII)	
Max. dry density gm/cc.	1.76
OMC (%)	16
Soaked CBR (%)	1
FSI (%)	55.6

Test Results with Lime Carbide Sludge (Factory Waste)

Lime Carbide Sludge content (%)	5	9	11
Atterberg Limits [IS :2720-Pt-V]			
LL%	59	62	64
PL %	36	37	41
PI%	23	25	23
Standard Proctor Test (IS:2720-Pt-VII)			
MDD gm/cc.	1.75	1.73	1.71
OMC (%)	17	19	20
Soaked CBR (%)	10	17	15
FSI (%)	50	50	30
UCS (7 Days) (Kg/cm2)	–	6.45	–

Similarly on testing the sample with natural lime (from Gotan) we obtain 3% as the optimum value to improve the strength parameters of existing soil to acceptable levels. Similar results are obtained when test are conducted with 5%lime sludge plus 15% fly ash, however primafacie transporting 20% of material for mixing found uneconomical.

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Above results conclude three options of achieving strength of CBR > 15% are as follows.

- 3% of free lime from Gotan
- 9% of Lime Carbide Sludge
- 5% of Lime Carbide sludge and 15% fly ash.

Non-availability of good quality free lime, leads to the 2nd option of using 9% Lime Carbide Sludge (LCB) instead. LCB is produced as a waste material during the process of making of acetylene gas from lime stone

3. METHODOLOGY

As a new material three important processes of stabilization need to be addressed, which includes transportation, spreading & mixing. These three process of stabilization are different as compared with stabilization process with natural lime. This is primarily due to the availability of Lime Carbide Sludge in semi solid form.

Lime carbide sludge can be transported through dumpers. After draining of free water, the material is in a semi solid state and is very convenient for loading and transportation. Lime carbide sludge falls under hazardous rating 1 under the NFPA and HMIS rating system. Hence transportation of Lime Carbide sludge does not require any special permission or special safety precautions.

Spreading of lime carbide sludge to be done in slurry form. Code allows the lime to be mixed with soil in slurry form. To convert lime sludge into slurry, check the water requirement (OMC) of the mix. First check the existing moisture content of the soil and the optimum moisture content of the soil. The difference in the moisture content is added into the lime carbide sludge after reducing the existing moisture content of lime carbide sludge at site.

Mixing of the lime carbide sludge with the soil has to be homogeneous for pulverization. Local machinery in the form of rotavator is available in market for small works.

Rotavator

Other that these three processes of transportation in semi solid form, spreading in slurry form & mixing of slurry with soil, remaining processes are same as in lime stabilization.

4. ENVIRONMENTAL BENEFITS

Use of byproduct / Industrial Waste, which requires large area of precious land for disposal.

Converting waste into wealth

Preserving / saving the gradual depletion of natural resources

Reduction in carbon emission

Provides cost benefit in the rage of 8% to 10% on unit cost of stabilized soil.

5. CONCLUSION

The present study highlights the need to save on the natural resources by using industrial waste in its place.

Methodology & chemical process of stabilization of lime carbide sludge is same as that of lime stabilization, except few processes briefed in methodology.

Use of lime carbide sludge shall be economical and have many direct and indirect environmental benefits.

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