Effect on CBR of Silty Soil by Partially Replacing with Crusher Dust and Fly Ash

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Abstract:
Disposal of waste is a challenge for all developing countries mainly due to the increasing generation of waste, the high costs associated to its management and the lack of understanding over a diversity of factors that affect the different stages of waste management. Stone dust is a solid waste material that is generated from stone crushing industry, abundantly available in India. Fly ash is a fine powder produced from the gases of burning coal during production of electricity in thermal power plants. These micron-sized earth elements consist primarily of silica, alumina and iron. As silty soil has a relatively less strength, it is a challenge for geotechnical engineers to build a structure on silty soil and to use silty soil as sub grade. There are so many materials available in the world, which increases strength of the silty soil when mixed with it. Fly ash is one of the cheapest materials, which is easily and readily available. Silty soil and fly ash when mixed together gives pozzolanic properties in the mixture. Additionally, if crusher dust is also added in a suitable proportion, the overall properties can be much better, besides addressing the disposal issues of crusher dust and fly ash. Thus an experimental study was taken up to perform California Bearing Ratio (CBR) test with different percentages of fly ash & crusher dust mixed with silty soil in order to observe the effect of fly ash & crusher dust on C.B.R values.

***Index Terms* – Silty soil, Crusher dust, Fly ash, CBR**

I. Introduction

Disposal of all kinds of waste is a challenge for all developing countries mainly due to the increasing generation of waste, the high costs associated to its management.

Crusher dust is a solid waste material that is generated from stone crushing industry which is abundantly available in India. Soosan et al. (2001) identified that crusher dust exhibits high shear strength and is beneficial as a geotechnical material. Stone dust is a material that possesses pozzolanic as well as coarser contents in it while other materials like fly ash possesses only pozzolanic property and no coarser soil particles.

Fly ash is a fine powder recovered from the gases of burning coal during the production of electricity in thermal power plants. These micron-sized earth elements consist primarily of silica, alumina and iron. Fly ash is generally light tan in color and consists mostly of silt-sized and clay-sized glassy spheres. Because of its spherical shape and pozzolanic properties, fly ash is useful in cement and concrete applications. The spherical shape and particle size distribution of fly ash also make it good mineral filler in hot mix asphalt applications and improve the fluidity of flow able fill and grout when it is used for those applications.

The silty soil is generally weak and poses challenges to the geotechnical engineers to design foundations or subgrade etc. resting on it. It may be possible to improve the strength of silty soil by replacing it partially with crusher dust and or fly ash.

The major objective of the present investigation is to determine CBR of plain silty soil, by replacing soil with different percentage of crusher dust, fly ash, crusher dust & fly ash in combination and to compare the results.

II MATERIALS & METHODOLOGY

The silty soil sample was collected locally and basic laboratory tests such as Grain size analysis, Moisture Content, Specific Gravity, Liquid Limit, Plastic Limit, Shrinkage Limit etc. were conducted as per standard procedure. Table 1.0 gives the summary of results.

The required quantity of crusher dust for the experimental work was collected from a local Jaw crusher. Its properties are presented in Table 2.0. The required quantity of fly ash was collected from Nandi Cements Pvt ltd. Its properties are presented in Table 3.0.

Table 1.0: properties of silty soil

Property	**Result**
Avg. moisture content	16.03%
Avg. specific gravity	2.01
Avg. liquid limit	13.66%
Avg. plastic limit	68.42%

Shrinkage limit	9.28%

Table 2.0: properties of crusher dust

Property	**Result**
Gravel size	3%
Sand size	81%
Silt size	16%
Specific Gravity	2.77
OMC	9.4%
MDD	20.1 KN /M3

Table 3.0: Properties of Fly ash

Parameters	**Range**
Specific Gravity	1.90 - 2.55
Plasticity	Non plastic
Maximum dry density (gm/cc)	0.9 - 1.6
Optimum moisture content (%)	38.0 - 18.0
Cohesion (KN/M^2)	Negligible
Angle of internal friction (j)	30^0-40^0
Coefficient of consolidation C (cm^2/sec)	$1.75x10^{-5}$ – $2.01x10^{-3}$
Compression index C_c	0.05-0.4
Permeability (cm/sec)	$8x10^{-6}$ – $7x10^{-4}$
Coefficient of uniformity	3.1-10.7

III EXPERIMENTAL WORK

The California Bearing Ratio (CBR) test specimens were prepared using silty soil at optimum moisture content and soaked for four days in water at room temperature. The CBR test was then conducted and the result obtained at 2.5 mm and 5.0 mm penetration level. Ten percent of the silty soil was replaced by crusher dust and again CBR results were obtained. For this soil, the grain size analysis, specific gravity, liquid limit, plastic limit and shrinkage limit tests were carried out and results obtained. The process and tests were repeated by replacing silty soil by 15%, 20% and 25% crusher dust.

The process was repeated by replacing silty soil by 10%, 15%, 20% and 25% fly ash. Similarly, the process was again repeated by replacing silty soil by 10%, 15%, 20% and 25% of crusher dust and fly ash in combination in equal proportions. The summary of results obtained is presented in Table 4.0. The results are also presented graphically in Fig.1.0.

Table 4.0: summary of test results

CBR %		**Silty Soil Replaced with Crusher Dust in different percentage**				**Silty Soil Replaced with Fly Ash in different percentage**				**Silty Soil Replaced with Crusher Dust and Fly Ash in different percentage**			
at	Plain Silty Soil	10%	15%	20%	25%	10%	15%	20%	25%	10%	15%	20%	25%

2.5 mm	4.90	9.10	11.60	10.10	13.70	7.27	22.9	15.64	16.00	17.82	21.80	15.20	20.00
5.0 mm	7.76	14.8	14.55	10.60	15.30	16.90	19.40	16.97	19.40	18.43	20.37	16.90	20.60

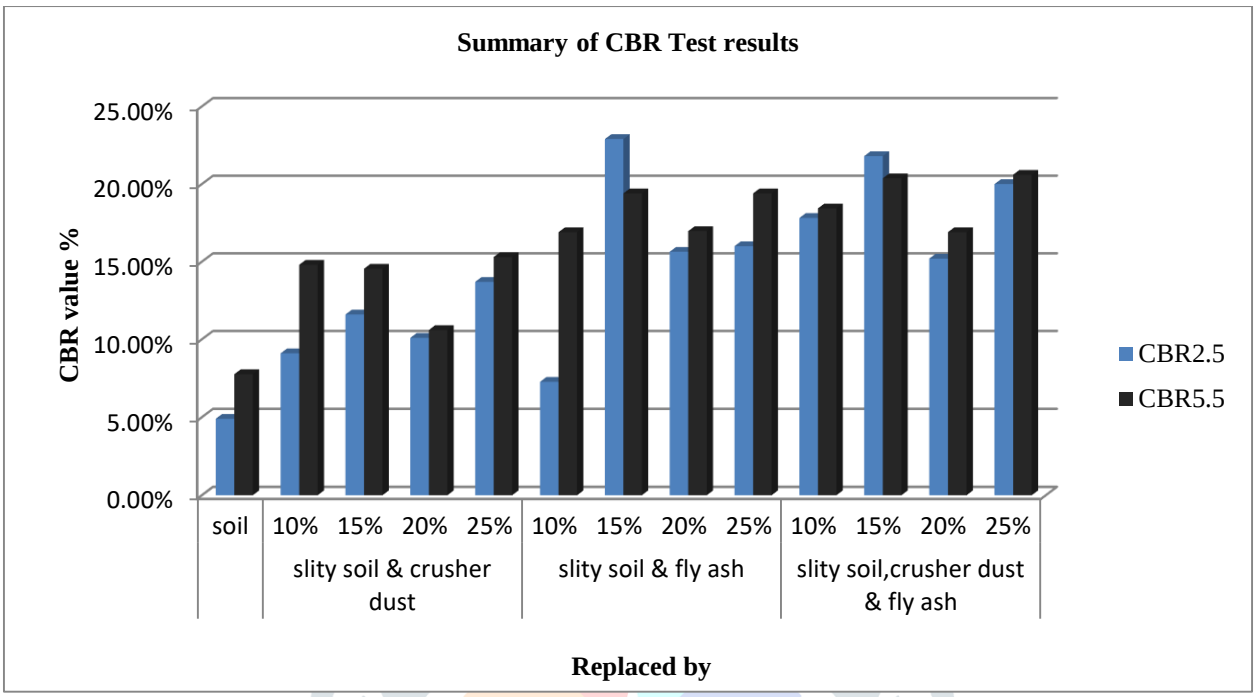

Fig-1.0: bar graph of CBR test results

IV CONCLUSIONS

1. It is observed that the California Bearing Ratio (CBR) value of the silty soil increases when crusher dust and fly ash separately as well as in combination replace the soil by 10%, 15% and 25%. However, Its value at 20% replacement in all the three cases has decreased.
2. The CBR value is found to be higher at 15% and 25% replacement by only crusher dust and crusher dust and fly ash combined respectively while it is higher at 15% replacement by fly ash alone.
3. The CBR value of silty soil can be increased by replacing it with crusher dust, fly ash separately as well as in combination.

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