ENHANCEMENT OF SUB GRADE SOIL BY USING FLYASH AND LIME

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Abstract -In India 15% of land is covered by Black Cotton Soil. The presence of montmorillonite clay mineral in the Expansive soil causes Swelling and shrinking properties which leads to major problems in Construction sites. This can be resolved by using soil stabilization techniques which enhances the engineering properties of soil. The soil stabilization is most important for the construction which is widely used in pavements or any other structures on expansive soil. Utilization of industrial waste materials in the improvement of soils is cost-efficient and eco-friendly method. In the present study an experimental investigation is taken to know the Geotechnical Characteristics of Expansive Soil with the Combination of FLYASH and LIME. In this study soil is mixed with the different proportions of (10%,20%,30% & 40%) FLYASH and (2.5%,5%,7.5%,10%,12.5% & 15%) LIME. The strength gained by soil is investigated by conducting California bearing ratio test & it is also calculated to reduce the thickness of the layer. The maximum dry density increased from 1.38g/cc to 1.54g/cc. The CBR un soaked test value enhances from 1.01% to 6.49% respectively

***Key Words*:** Black Cotton Soil, Fly ash, Lime, Compaction, maximum dry density, CBR

1. INTRODUCTION

Soil is the uppermost unconsolidated material of the earth present naturally in the universe. It is abundantly available and is the cheapest construction material. It is a complex material because of its highly variable composition and characteristics. The characteristics of soil change according to topography and its location. For safer construction the properties of soil should match with the design requirements of an engineering structure. Geotechnical engineer plays an important role in this work for checking whether the requirements of the structure are fulfilled by the soil or not. Construction of engineering structures on poor soil involves a great risk. These soils show settlements, low shear strength and high compressibility. The settlements caused by swelling or shrinkage are notably greater than elastic deformation resulting large scale damages to the overlying structures such as ground cracks, building cracks, heaving and rutting of pavement, falling of canal lining, eave of beds of canal and etc. Because of this these weak soils are also we are using for construction by changing their geotechnical properties with suitable technique. Stabilization of expansive soils without revealing them from construction area is an effective technique for road development. Different types of additives have been used to improve the quality of soils like fly ash, rice husk ash, lime, cement etc., This technique is effectively applied different areas of constructions in all over the world. The stabilized soil shows that increasing in the bearing capacity which practically proved by conducing the laboratory as well as field experiment. Present study fly ash is used as admixture in soil stabilization, which is produced from the thermal power plant by combustion of coal in the process of generation of electricity. Fly ash is chosen for the admixture because of it is low cost and it is a waste material. Lime stabilization is a ground improvement technique that involves adding lime to the soil to improve its properties. Stabilization is achieved when the proper amount of lime is added to a reactive soil and exchanges of ions occur.

2. MATERIALS

Black cotton soil is also rich in lime, iron, and magnesium but contains a low amount of phosphorous, nitrogen, and organic matter. So, it is more fertile in low lands than on the uplands. Due to the weathering or breaking of the igneous rock and cooling and solidification of the lava, the black soil is formed. Since it is formed from lava, it is also known as lava soil. Black soil has a texture like clayey and is highly fertile. Black soil structure is cloddish or sometimes friable. Soil when dry gets a contract and develops deep wide cracks. It expands when they are wet and they are hard to plough. Black soil contains almost 50% of clay and can hold water for a long time. Black Cotton Soil

FORMATION OF BLACK COTTON SOIL Black soil is a sedimentary type of soil that is found in the place of its origin, i.e., it is not transmitted from its original place. Black cotton soil is a result of the wear and tear of the specific rock. The moderate climatic condition and volcanic erupted igneous or basalt rock as a parent rock are required for the formation of black soil. Then, due to the weathering or breaking of the igneous rock and cooling and solidification of the lava, the black soil is formed. Since it is formed from lava, it is also known as lava soil

Properties of black cotton soil

Black soil has a texture like clayey and is highly fertile.

Structure is cloddish or sometimes friable. When dry gets a contract and develops deep wide cracks expands when they are wet and they are hard to plough. Contains almost 50% of clay and can hold water for a long time

Table -1: chemical composition of black cotton soil

S NO	COMPOUNDS	VALUE (%)
1	SiO2	30.98
2	Al2O3	18.35
3	Fe2O3	12.8
4	CaO	0.2
5	K2O	6.67
6	MgO	0.5
7	Loss on ignition	-

Table -2: Engineering properties of black cotton soil

S.NO	PROPERTY	VALUE
1.	Specific Gravity	2.6-2.75
2.	Liquid Limit	40%-120%
3.	Plastic limit	20%-60%
4.	Dry Density	1300-1800kg/m3
5.	Maximum Dry Density	20%-35%

Flyash: Fly ash is a heterogeneous by-product material produced in the combustion of coal used in power stations. It is a fine grey colored powder and having spherical glassy particles that rise with the flue gases. As fly ash contains pozzolanic materials components which react with calcium hydroxide to form cementations materials. Thermal power plants are the main source of fly ash. In India 100 tonnes of fly ash produced from thermal power plants (Chakravarthi et al., 2007) due to coal combustion for power generation per year. By product of coal combustion is fly ash and it is a waste material. It is a pozzolona material, pozzolonas are siliceous and aluminicious materials, when these react with calcium hydroxide and water they produce cementations compounds. Fly is finer then the Portland cement and lime..

Fig 1.Fly ash

Table-3 Physical properties of fly ash

S.NO	PROPERTY	VALUE (%)
1	Specific gravity	2.2
2	Grain Size Distribution Sand Silt Clay	 23 71 06
3	Compaction Properties OMC MDD	 20 11.9(KN/m3)
4	Liquid Limit	36
5	CBR (Soaked)	7.8

Lime: is a calcium-containing inorganic material composed primarily of oxides and hydroxide, usually calcium oxide and/or calcium hydroxide. It is also the name for calcium oxide which occurs as a product of coal-seam fires and in altered limestone xenoliths in volcanic eject. Lime, or calcium oxide (CaO), is derived from high quality natural deposits of limestone, or calcium carbonate (CaCO3). For soil stabilization purposes, the term lime must mean either quicklime or hydrated lime. Chemically, quicklime is calcium oxide (CaO) and hydrated lime is calcium hydroxide (Ca(OH)2).

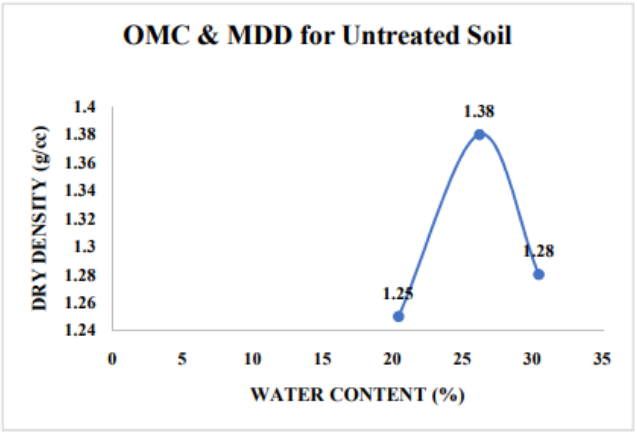
Fig: lime

3. METHODOLOGY

Soil with different percentages of (10%,20%,30% & 40%) fly ash is used for soil stabilization. We conducted different tests on soil & add the fly ash content then we get the peak value of fly ash. We can do the CBR test to that soil. Then we add the (2.5%,5%,7.5%,10%,12.5% &15%) lime content to the peak value of fly ash content. As fly ash and lime is varying in percentage, properties of soil are also varying. Here we are discussing results of free swelling, specific gravity, liquid limit, plastic limit, compaction test and California Bearing Ratios test

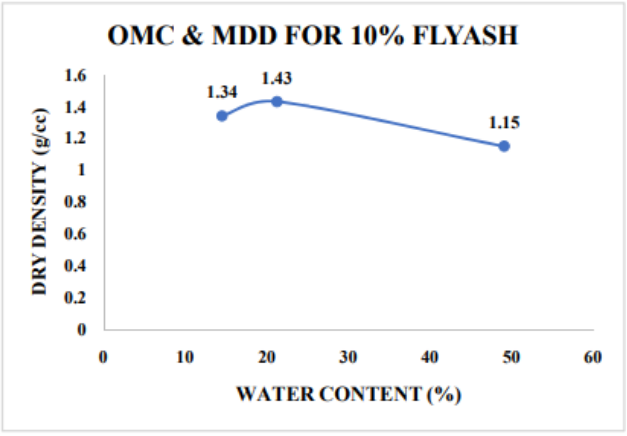
Maximum dry density = 1.38g/cc

Optimum moisture content = 26.1%



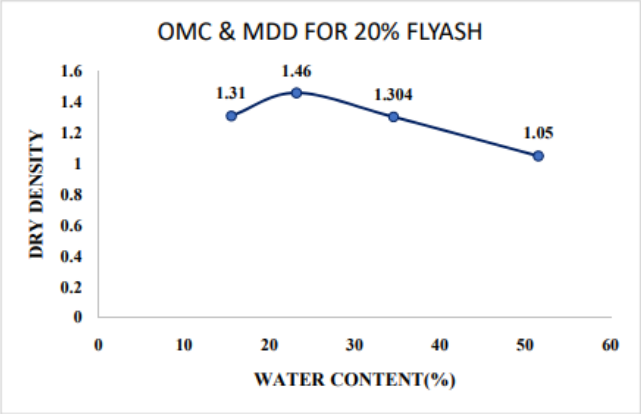
Maximum dry density = 1.43g/cc

Optimum moisture content = 21.26%



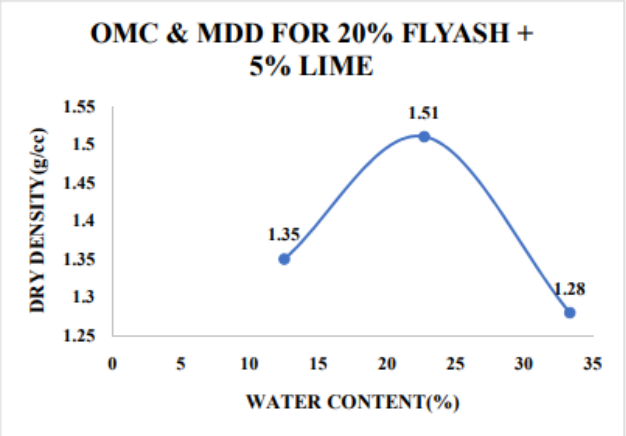
Maximum dry density = 1.46g/cc

Optimum moisture content = 23.1%



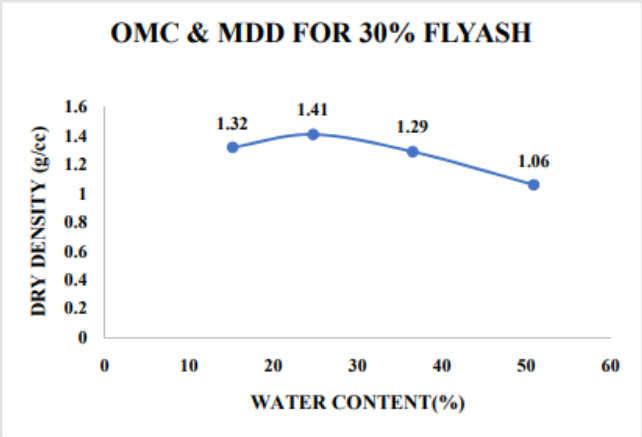
Maximum dry density = 1.51g/cc

Optimum moisture content = 22.7%



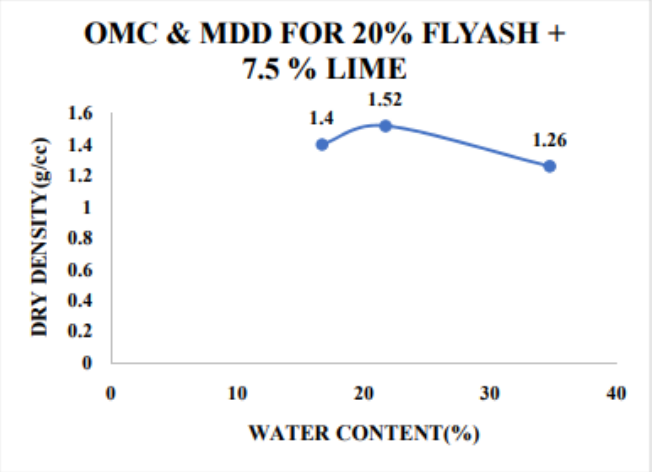
Maximum dry density = 1.41 /cc

Optimum moisture content = 24.67%



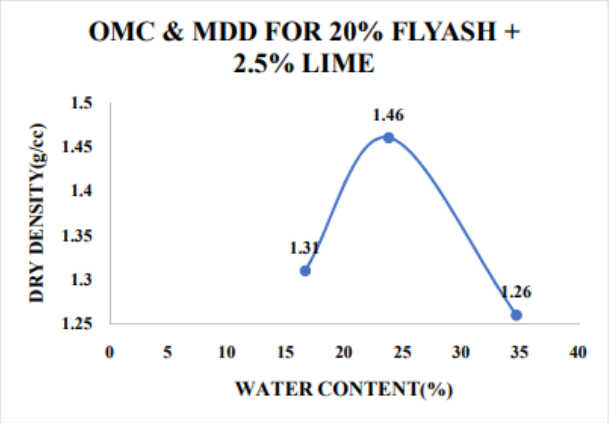
Maximum dry density = 1.52/cc

Optimum moisture content = 21.7%



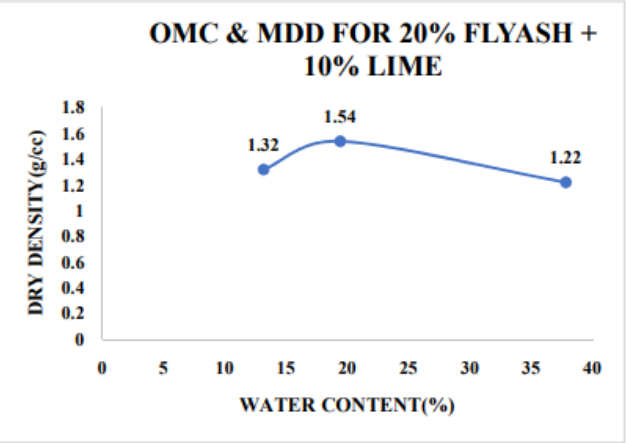
Maximum dry density = 1.46g/cc

Optimum moisture content = 23.8%



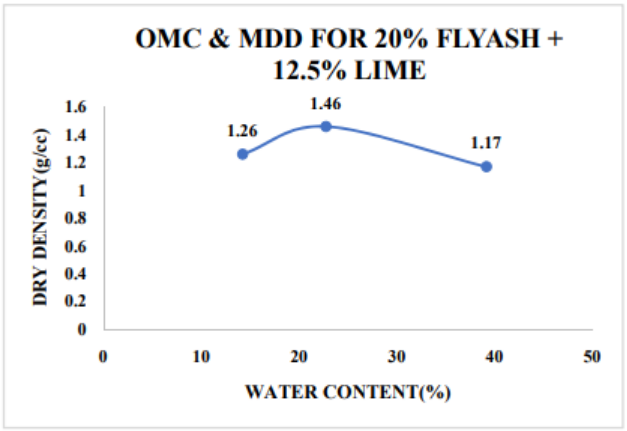
Maximum dry density = 1.54g/cc

Optimum moisture content = 19.4%



Maximum dry density = 1.46g/cc

Optimum moisture content = 22.72%



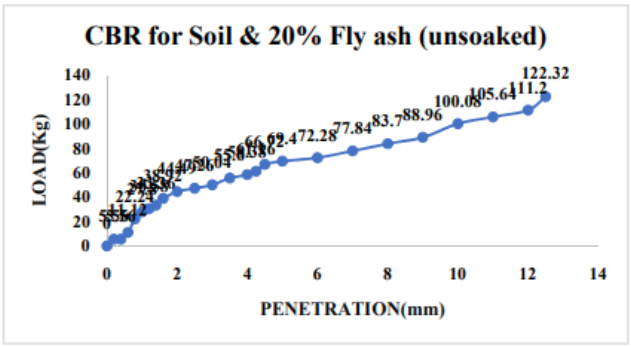


Fig-6.17 CBR for soil & 20% fly ash (unsoaked)

C.B.R%	(TEST LOAD/STANDARD LOAD)*
For 2.5mm penetration	(Test load/1370)* 100
	2.63%
For 5mm penetration	(Test load/2055)* 100
	2.29%

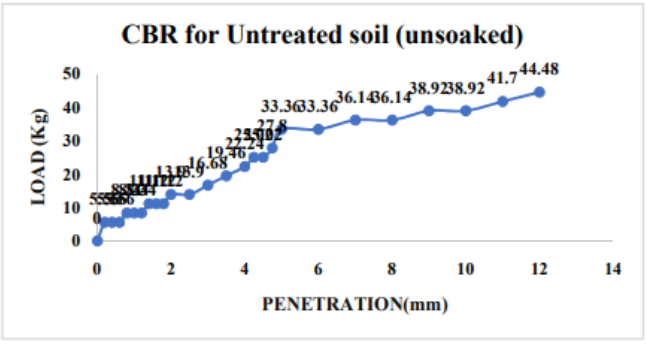


Fig-6.15 CBR for Untreated soil (unsoaked)

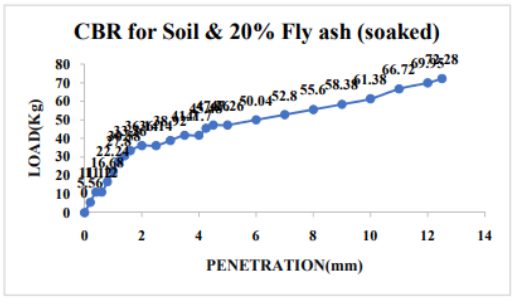
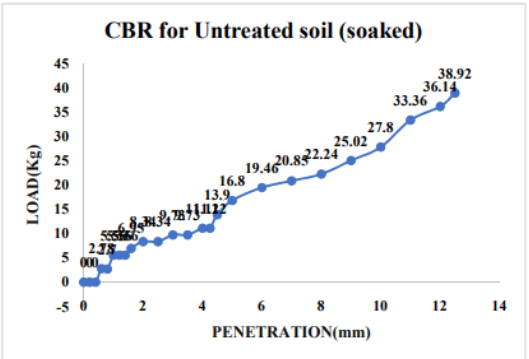
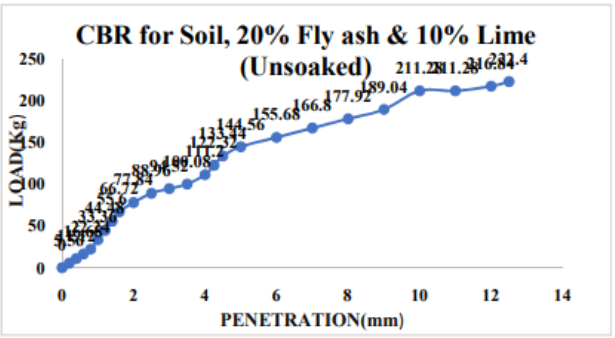


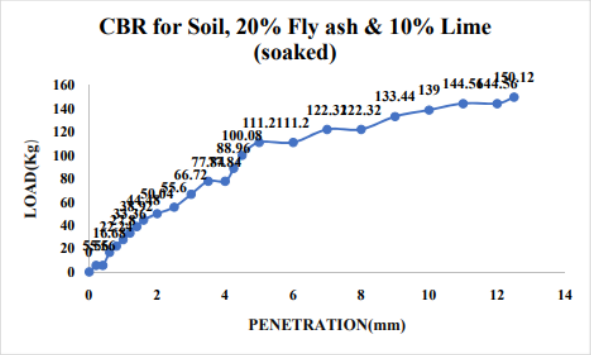
Fig-6.18 CBR for soil & 20% fly ash (soaked)

C.B.R%	(TEST LOAD/STANDARD LOAD)*
For 2.5mm penetration	(Test load/1370)* 100
	0.608%
For 5mm penetration	(Test load/2055)* 100
	0.817%





C.B.R%	(TEST LOAD/STANDARD LOAD) *
For 2.5mm penetration	(Test load/1370) * 100
	4.05%
For 5mm penetration	(Test load/2055) * 100
	5.41%



3. CONCLUSION

In this study we have done an investigation on the stabilization of expansive soil with different proportions of Fly ash & Lime i.e., 10%,20%,30%,40% & 2.5%,5%,7.5%,10%,12.5%,15% respectively. A Correlative analysis was made to evaluate the different percentages of Fly ash and Lime to the untreated soil. Depending on this study we conclude that:

- On the addition of 20% Fly ash and 10% Lime to the soil, the swelling and shrinkage¬ properties has been diminished.
- The optimum value of Fly ash to be used work as 20%, the OMC is decreased from 26% to¬ 23% and MDD is increased from 1.38g/cc to 1.46g/cc.
- The maximum CBR value at 20% Fly ash increased from 1.01% to 3.64%.¬ The peak value of Fly ash content is 20% is mixed with the 10% Lime content then OMC is¬ decreased from 23% to 19% and MDD is increased from 1.46g/cc to 1.54g/cc.
- Then the best ratio obtained from 70% soil, 20% Fly ash¬ & 10% Lime. The Un-soaked CBR value at 20% Fly ash and 10% Lime is 6.493%¬ & soaked CBR value is 4.058%.
- With these percentages CBR value increased when compared to untreated soil.
- Using Fly ash for soil stabilization not only reduces environmental pollution, but it can also¬ be effective method for increasing strength of expansive soil.
- As the CBR value increases the thickness of pavement can be decreased and strength¬ increases.

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