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Stabilization of Black Cotton Soil using GGBS (Ground Granulated Blast Furnace and Slag)

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ABSTRACT

The Black Cotton soils occurs mostly in the central and western parts and covers approximately 20% of the total area of India. Because of its high swelling and shrinkage characteristic, The Black Cotton soil have been a challenge to the highway engineers. The Black Cotton soil is very hard when dry, but loses strength completely when in wet condition. It is observed that on drying, The Black Cotton soil develops cracks at varying depth, It is a well known fact that water is the worst enemy of road pavement, perticularly inexpensive soil areas cause of road failure that water has got easy access into the pavement. A Literature review has been presented that has given me the somewhat direction and point of investigation in the different correlation methods of soil properties. It has also given the effect of various soil properties on CBR value. Experimental Work shows the different types of experiments to be performed to evaluate various soil properties. These properties are Grain Size Analysis, Liquid Limit, Plastic Limit, Plasticity Index, Shrinkage Limit, Maximum Dry Density, Optimum Moisture Content, CBR value. It also shows the summary report of results of various experiment performed on the number of soil sample. Now we are added some material that improve the soil strength so we can used in road pavement consruction. we added GGBS (Ground Granulated Blast Furnace Slag) material to stabilize the black cotton soil we are added suitable proportion of GGBS material in the soil proportion are 3%,6%,9% and 12% and to check at what proportion we get best result. So we started performing test and analysis the result. GGBS (Ground Granulated Blast Furnace Slag) has usually used as stabilizer for developing the engineering properties of soil. GGBS is a byproduct generaed during manufacturing of iron and steel. The GGBS is environmental and ecofriendly by product. GGBS improve the engineering properties and stabilized the soil. It also reduce the cost of pavement.

KEYWORDS: *Stabilization, GGBS, Black Cotton Soil*

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INTRODUCTION:

Soil is an important element. The top layer of earth's surface in which plants can grow, consisting of rock and mineral particles mixed with decayed organic matter and having the capability of retaining water. Soil is varying from location to location. So, soil properties are differing from one place to another. If the soil under a building isn't stable, it will damage the foundation and ultimately it may causes adverse effect on structure.

Especially, expansive soil which spreads approximately 17% of land cover in India. In such states of Gujarat, Andhra Pradesh, Madhya Pradesh, Uttar Pradesh, Tamil Nadu etc. Expansive soils are known for its alternate shrink-swell properties due to Montmorillonite mineral present in the soil particle, which may lead to greater damage in the structure. Soil which expand when they gain water and shrink when they loose water (desiccation).

Soils are composed of a variety of materials, most of which do not expand in the presence of moisture. However, a number of clay minerals are expansive. These include:

- Smectite,
- Bentonite,
- Chlorite,
- Beidellite,
- Vermiculite

An efficient transport system is a prerequisite for sustained economic development. It is not only the key infrastructural input for the growth process but also plays a significant role in promoting national integration, which is particularly important in a large country like India. The transport system also plays an important role of promoting the development of the backward regions and integrating them with the mainstream economy by opening them to trade and investment. In a liberalized set- up, an efficient transport network becomes all the more important in order to increase productivity and enhancing the competitive efficiency of the economy in the world market.

Indian road network of 43 lakh km. is second largest in the world. India has large and extensive transportation system. The country has one of the world's largest roadway network

transporting million of people every year. The total length of road in India is over 33 lakh km, including, both metalled and unmetalled roads. In terms of road length, India has one of the largest road networks in the world. About 65% of freight and 80% passenger traffic is carried by the roads. Number of vehicles has been growing at an average pace of 10.16% per annum over the last five years. The national highway account for less than 2 % of the total road network but carry 40 % of the movement of goods and passengers. The roadworthiness of India's 2.2 million km road networks. Roads may be classified into: National Highway, State Highway, Major District Roads and Other District Roads (urban, village &panchayat Roads).

Properties of GGBS

Ground Granulated Blast Furnace Slag is obtained by quenching Melton iron slag (a by-product of iron and steel making) from a blast furnace in water or stream, to produce glassy, granular product that is then dried and ground into a powder. These operate at a temperature of about 1500 degrees centigrade and are fed with a carefully controlled mixture of iron-ore, coke and limestone. GGBS has cementations properties, which makes a suitable partial replacement additive to Portland cement. GGBS Slag is primarily made of silica, alumina, calcium oxide, and magnesia (95%) and other elements like manganese, iron, sculpture and trace amounts of other elements (5%) of slag. To increase the strength when GGBS is added to the soil, it also reacts with water and produces silica hydrates from its available supply of calcium oxide and silica. Physical and engineering of GGBS materials are shown in table below.

Properties	GGBS (Value)
Liquid limit (%)	40
Plastic limit (%)	NP
Plasticity Index (%)	NP
Specific gravity	2.84
pH value	8.4
Maximum dry density(gm/cc)	19.8
Optimum moisture content (%)	9.3%
CBR value (soaked)	4.1%
CBR value (unsoaked)	11.14%

Objective of Study

- To determine the properties of Black Cotton soil and stabilized soil with GGBS material at different proportions.
- To determine the Compaction Characteristics of soil and stabilized soil with GGBS at 3%, 6%, 9% and 12%.
- To evaluate the strength characteristics of California Bearing Ratio (CBR) values with GGBS.
- Improvement of bearing capacity of the Black cotton soil with the addition of GGBS.
- It can be used economical in road pavement.

Scope of Study

- GGBS is positive due to benefit in durability, strength obtains by partial replacement of ggbs with cement in soil stabilization.
- C B R value increases with increases in percentage of GGBS that may be more suitable for pavement thickness.
- To study of compaction behaviour of soil-GGBS mixes for different percent of GGBS.
- In the near future to study the behaviour of Ground Granulated Blast Furnace Slag on micro level different percentage can be used.

Shear Strength

The shear strength of soil is the resistance to deformation by continuous shear displacement of soil particles or on masses upon the action of a shear stress. The failure conditions for a soil may be expressed in terms of limiting shear stress, called shear strength, or as a function of the principal stresses.

The shearing resistance of soil is constituted basically of the following components:

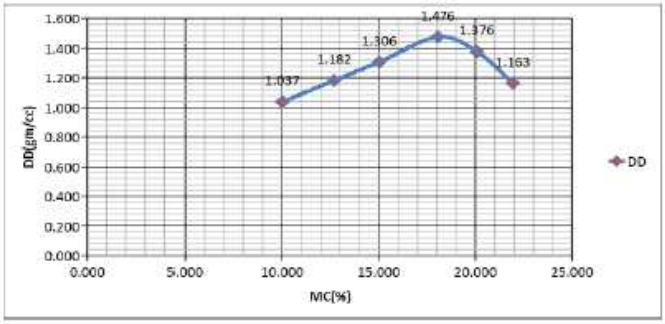
1. The structural resistance to displacement of the soil because of the interlocking of the particles,
2. The frictional resistance to translocation between the individual soil particles at their contact points, and
3. Cohesion between the surfaces of the soil particles.

Details of Laboratory Test

EXPERIMENT	IS REFERENCE
HYDROMETER TEST	IS : 2720 - (1985) part 4
STANDARD PROCTOR TEST	IS : 10074 – 1982
TRIAXIAL TEST	IS : 2720 - (1971) part 11
DIRECT SHEAR TEST	IS : 2720 - (1986) part 13

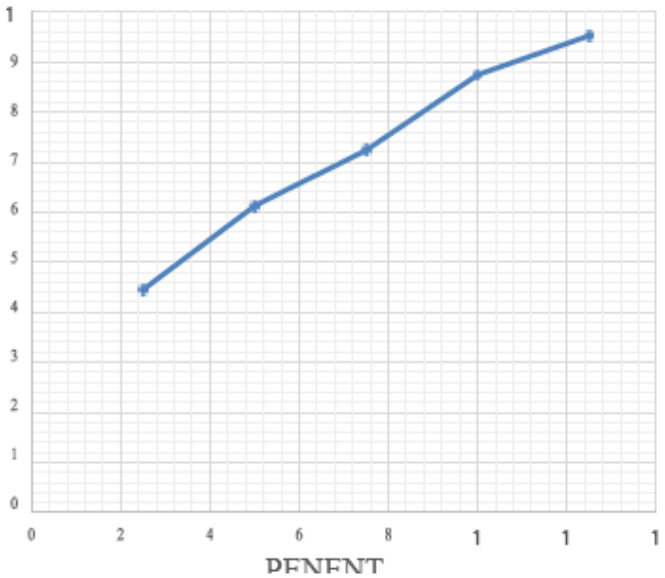
RESULTS AND DISCUSSION

OMC MDD CURVE

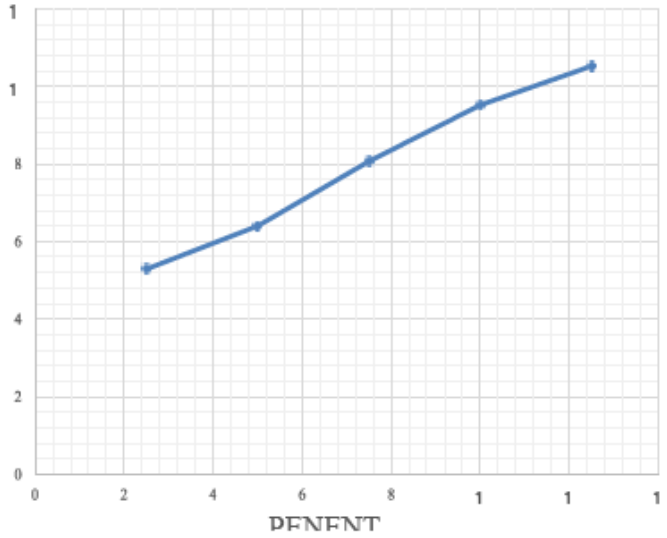


CBR GRAPH FOR NORMAL SOIL

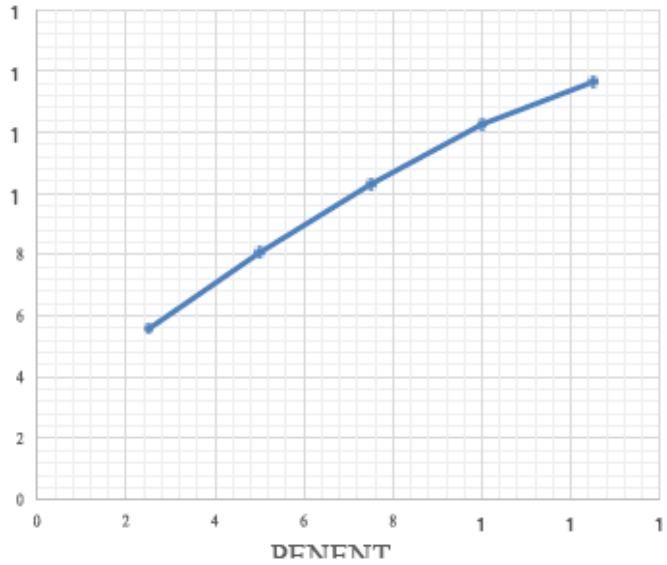
LOAD VS PENENTRATION CURVE OF CBR FOR



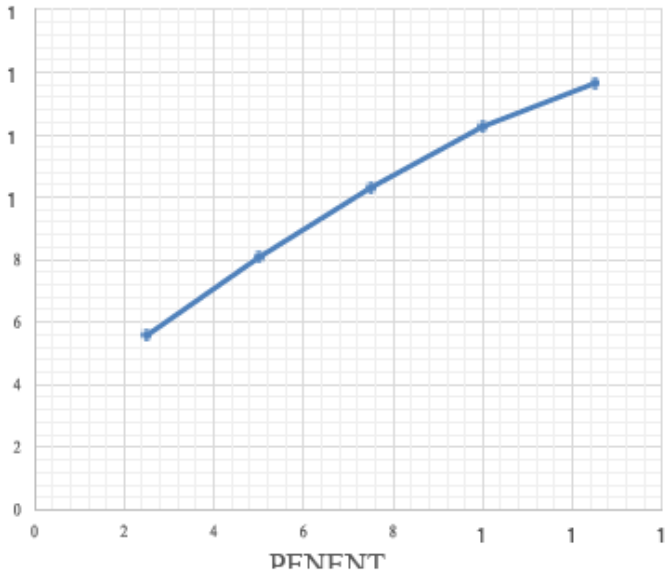
CBR GRAPH OF 2% GGBS BY WEIGHT OF NORMAL SOIL



CBR GRAPH OF 4% GGBS BY WEIGHT OF NORMAL SOIL



CBR GRAPH OF 6% GGBS BY WEIGHT OF NORMAL SOIL



Results

	Grain Size Analysis (%)			Atterberg Limit (%)		
	G	S	M&C	WL	Wp	PI
Normal Soil	0.0	25.86	74.14	52.80	16.38	36.42
Soil+GGBS (2%)	-	-	-	51.00	15.62	36.38
Soil+GGBS (4%)	-	-	-	49.00	14.82	34.18
Soil+GGBS (6%)	-	-	-	47.00	13.76	33.24

	Standard Proctor Test		Free Swell Index (%)	CBR Value (%)
	OMC (%)	MDD (%)		
Normal Soil	17.90	1.49	33.33	6.38
Soil+GGBS (2%)	17.80	1.78	-	6.36
Soil+GGBS (4%)	17.34	1.76	-	12.60
Soil+GGBS (6%)	16.2	1.8	-	13.51

Conclusion

- This study has been carried out to study the effects of GGBS on the physical and engineering properties of the soft soil.
- With the increase of GGBS content liquid limit, plastic limit, and plasticity index decreased, which makes the soil have less plastic, and plasticity index reduces.
- With the increase of GGBS content Optimum Moisture Content (OMC) decreasing, while Maximum Dry Density (MDD) increasing, hence the compact ability of soil increases and making the soil denser a hard.
- CBR value increases with increases in percentage of GGBS that show the densification of soil takes place and more suitable for pavement thickness.
- Densification of soil (clay) takes place with increases in percentage of GGBS and plasticity index is more than 17% thus making the soil suitable for embankment and for pavement of light and medium traffic. The pavement thickness will be reduced considerably with increases in percentage of GGBS With the increases in % of coarse particles causes increases in permeability and reducing the influence of pore water pressure and enhance the self-strength of soil, so stability of soil increases.

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