STUDY ON BEHAVIOUR OF FLEXIBLE PAVEMENTS BY USING GEO-MATERIALS AND GEO-SYNTHETICS IN CBR TEST

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ABSTRACT

The term "soil" in soil engineering is a loose unconsolidated material produced by the weathering of rocks and abundantly available in nature. Due to this soil has vast application in foundation, retaining structures, embankments, underground structures (tunnels, hafts and conduits), and pavement design and earth dams. Due to the difference in the weathering process, different soils are formed with different characteristics. Due to this, sometimes, weak soils are also formed in the nature. Weak soil denotes the soil weak in the strength. Another geomaterial, Fly ash is a solid waste generated by thermal power plants where coal is used as fuel. It has been successfully demonstrated that fly ash can be utilized in major construction projects such as dams, ash dyke, landfills, roads and pavements, soil stabilization and for other purposes such as brick manufacture, cement industry, tiles, and paint industry. Many researchers have worked different ways to treat such soils in different ways viz., mechanical modifications, addition of various materials (cement, lime, bitumen, flyash, reinforcement, etc.). Later, with the advent of geosynthetics, they are considered as one of effective method to improve the strength properties of the soil. Also, different studies have showed the use of geotextiles have been used in the construction of unpaved roads over the soft soils. With this in view, the current study is proposed to understand the strength change in the soil when added with different materials such as geotextile, geogrid, geocomposite. A comparison has been made to understand the effect of each inclusion in the soil and flyash. Such a study would be useful in selecting the material based on the different site condition, adaptability and the strength gain along with the economy.

Key words :- Black cotton soil, Geomaterials, fly ash, Geosynthetics,

I INTRODUCTION

Soil is defined as sediments or other accumulation of mineral particles produced by the physical or chemical disintegration of rocks plus the air, water, organic matter and other substances that may be included. Soil is typically a non-homogeneous, porous, earthen material whose engineering behavior is influenced by changes on moisture content and density. Based on the origin, soil can be broadly classified as organic and inorganic. Organic soils are mixture derived from growth and decay of plant life and also accumulation of skeleton or shell of small organism. Inorganic soils are derived from the mechanical or chemical weathering of rocks. Inorganic soil that is still located at the place where it was formed is referred to residual soil. If the soil has been moved to another location by gravity, water or wind, it is referred to as transported soil.

METHODOLOGY

SPECIFIC GRAVITY

Specific gravity of solid is an important parameter to determine the void ratio and particle size. The specific gravity of a soil mass is the indication of its average value of all the solid particles present in the soil mass. The specific gravity of solid particle (G) is defined as the ratio of the mass of a given volume of solids to the mass of an equal volume of water at 4oc. Thus, the specific gravity is given by

$$==(W2 -W1) / (W2 -W1)-(W3 -W4)$$

Where W1 = empty weight of density bottle

W2 = weight of density bottle + soil

W3 = weight of density bottle + soil + water

W4 = weight of density bottle + water

W1 W2 W3 W4

Fig: 3.1 specific gravity bottle

LIQUID LIMIT

The liquid limit of a soil is the moisture content at which the soil changes from liquid state to plastic state. The device used to determine liquid limit is casagrande’s apparatus consists of a brass cup can be drops onto the base by a cam when operated by crank. About 120 g of an air dried soil sample passing through 425 µm IS sieve is taken in a porcelain dish and mixed with distilled water to form a uniform paste. To perform the liquid limit test, one must place a soil paste in the cup. A groove is then cut at the centre of the soil pat with the standard grooving tool with a distance of 12.7 mm. By the use of the crank-operated cam, the cup is lifted and dropped from a height of 10 mm. The moisture content, in percent, required to close a distance of 12.7 mm along the bottom of the groove after 25 blows is defined as the liquid limit.

a) Fig : casagrande's apparatus

b) Fig : sample which is cut into 2 parts

RESULTS AND DISCUSSIONS

The results of various tests performed on clay and fly ash are discussed in this section. With the aim to understand the changes in the CBR values of the soil with the introduction of geo-synthetic material, the CBR test has been conducted on the soil and also fly ash, with different geo-synthetics placed at different layers. The soil in the CBR mould has been divided into 5 layers with equal weights (considering constant density and volume per layer) and the various geo-synthetic material viz., geo-textile, GT, geo-grid, GG, geo-composite, GC (geo-textile and geo-grid) has been placed accordingly to understand the best possible location of the geo-synthetic material to yield maximum CBR value. Also, as the part of this study, polypropylene fibers (PF) in the ratios of 0.1%, 0.2%, 0.3%, 0.4%, 1% and 2% by the weight of the soil and tire powder, i.e. the crushed tire material in the ratios of 2%, 5% and 10% has been mixed thoroughly and the CBR tests have been performed for each combination. The results obtained in all the tests have been analyzed and the discussion has been included herein.

Property		Clay	Fly ash
Specific Gravity	G	2.67	2.39
Gravel (%)		0	0
Sand (%)		18	48
Silt (%)		65	47
Clay (%)		17	5
Consistency limits			
Liquid Limit	LL	26	0
Plastic Limit	PL	21	0
Plasticity Index	PI	5	0

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Material Properties

Fly ash

S No	Details	Trial 1	Trial 2	Trial 3
1	Weight of empty bottle with stopper (W1) (g)	53.43	53.43	53.44
2	Weight of bottle with stopper +dry soil (W2) (g)	73.56	73.41	73.92
3	Weight of bottle with stopper +dry soil +water (W3) (g)	159.12	159.06	159.53
4	Weight of bottle with stopper +water (w4) (g)	147.47	147.47	147.47
	Specific gravity	2.37	2.38	2.43
	Specific gravity average		2.39	

4.2 Wet Sieve analysis

Table 4.2.1

Clay

S No	Sieve size	Weight of retained (g)	Percentage of retained	Cumulative Percentage of retained	Percentage of fine (N)
1	4.75 mm	0.3	0.30	0.3	99.70
2	2.36 mm	0.2	0.20	0.50	99.50
3	1.18 mm	1.1	1.10	1.60	98.40
4	600 µ	4.9	4.90	6.50	93.50
5	300 µ	4.5	4.50	11.00	89.00
6	180 µ	4.1	4.10	15.10	84.90
7	150 µ	0.2	0.20	15.30	84.70
8	75 µ	2.5	2.50	17.80	82.20
9	pan	82.2	82.20	100.00	0.00

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Properties of the soil

Table 4.

4.1 Specific Gravity

Table 4.1.1

Clay

S No	Details	Trial 1	Trial [illegible]	Trial 3
1	Weight of empty bottle with stopper (W1) (g)	53.46	53.51	53.52
2	Weight of bottle with stopper +dry soil (W2) (g)	73.20	73.45	73.55
3	Weight of bottle with stopper +dry soil +water (W3) (g)	159.36	159.48	159.55
4	Weight of bottle with stopper +water (w4) (g)	147.97	147.06	147.06
	Specific gravity	2.69	2.65	2.66
	Specific gravity average		2.6[illegible]	

Table 4.2.2 Dry sieve analysis

Fly ash

S No	Sieve size	Weight of retained (g)	Percentage of retained	Cumulative Percentage of retained	Percentage of fine (N)
1	4.75 mm	0	0	0	0
2	2.36 mm	0.1	0.02	0.02	99.98
3	1.18 mm	0.3	0.06	0.08	99.92
4	600 µ	0.8	0.16	0.24	99.76
5	300 µ	1.8	0.36	0.6	99.40
6	180 µ	60	12	12.6	87.40
7	150 µ	0.8	0.16	12.76	87.24
8	75 µ	169.3	33.86	46.62	53.38
9	pan	266.9	53.38	100	0.00

Table 4.3.1

Liquid limi[illegible] of cla[illegible]

S No	Can no	Empty can (w1) (g)	Empty Can+ Wet soil (w2) (g)	Empty Can+ Dry soil (w3) (g)	Moisture content (W) %	No o[illegible] blow[illegible]
1	14	17.8[illegible]	23.[illegible]	22.1[illegible]	21.8[illegible]	3[illegible]
2	20	20.2[illegible]	25.1[illegible]	24.2[illegible]	24.1[illegible]	2[illegible]
3	8	17.8[illegible]	30.[illegible]	27.7[illegible]	29.4[illegible]	2[illegible]
4	10	17.8[illegible]	25.[illegible]	23.6[illegible]	36.1[illegible]	1[illegible]
	Liquid limit (LL			25.[illegible]		

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Properties of geo-synthetics

In the present study, the three geo-synthetics used are geo-textile; geo-grid and geo-composite have been considered.

Effect of Soil type

Fig. 4.2 depicts that the results obtained from CBR test conducted on clay and fly ash without any admixture. From the above graph, it can be observed that fly ash has higher CBR values compared to that of black cotton soil

California bearing ratio test

		CBR values of Clay		
sl.no	strain gauge reading	penetration (mm)	proving ring reading	load (kg)=PRR* 1.176)
1	50	0.5	1.3	1.53
2	100	1.0	2.1	2.47
3	150	1.5	2.6	3.06
4	200	2.0	3.1	3.65
5	250	2.5	3.4	4.00
6	300	3.0	3.6	4.23
7	350	3.5	3.8	4.47
8	400	4.0	3.9	4.59
9	500	5.0	4.1	4.82
10	750	7.5	4.4	5.17
11	1000	10.0	4.7	5.53
12	1250	12.5	5.0	5.88
CBR AT 2.5mm	=4.82/2055*10(	=0.29%		
CBR AT 5.0mm		=0.23%		

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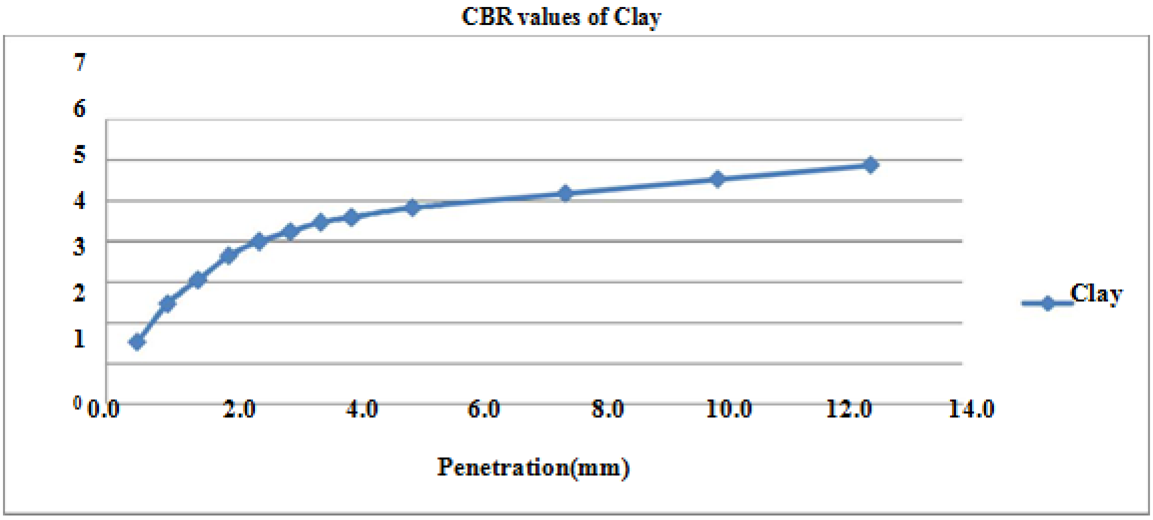

CONCLUSION

From the project work, we got to know that we have limited quantity of good quality of earth soil is available. It is not possible to provide good quality soil for every construction, in such circumstances we need to go for the modification methods. An attempt has been made to use the waste materials such as fly ash to modify the properties of the soil which is available in bulk quantity with inclusion of GT, GG, GC. The disposal of these materials are utilizing several acres of land which can be used for agriculture, buildings, transportation, commercial complexes' etc.,

- The CBR values of BC soil and FA without addition of materials, FA gives more CBR values compared with BC soil.
- With inclusion of geosynthetics (such as GT, GG, GC) in Black cotton soil and FA in layers within the soil sample in different combination, it proved that GT gives more CBR values in both the cases.
- With inclusion of GT in layers within the soil sample such as layer 1, layer 2, layer 3, layer 4 from the study it shows that GT at layer 2 in BC soil and GT at layer 1 in FA gives more CBR values.
- With inclusion of GG, GC in layers within the soil sample from the study it shows that GG and GC at layer 3 in BC soil and FA gives more CBR values
- By increasing the CBR we can reduce the pavement thickness. By doing the modification we can reduce the excessive usage of the good quality earth materials thus avoiding the pollution.

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