A COMPARATIVE STUDY OF INDEX PROPERTIES AND FREE SWELL RATIO OF CLAY-SAND MIXTURE

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Abstract

Soil being a widely used material in the field of civil engineering, hence, its study is very important. Cohesive soil (especially black cotton soil) often does not fully satisfy the engineering properties a requirement for their use in sub grade of pavements or as a base to lay foundations. Such soils are generally not preferred in the construction industry due to their high shrink-swell property. In this experimental program, a study of index properties and free swell ratio of clay-sand mixture with varying percentages of sand ranging from 10% to 50%. A study of the variation of the liquid limit, plastic limit, specific gravity and free swell ratio with increase in addition of cohesion less soil is studied in cohesive soils containing kaolinite and montmorillonite clay minerals. It is observed that the Liquid Limit, Specific Gravity and Free Swell Ratio decrease with the addition of sand whereas Plastic limit increases.

Keywords: *montmorillonite, kaolinite, Liquid Limit, Plastic Limit, Specific Gravity, Free Swell Ratio*

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1. INTRODUCTION

Fine grained soils have high water content, large compressibility and low bearing strength. Finely textured soils clay soils are difficult to work with. Clays especially have the shrink-swell property which classifies them as detrimental material on which the construction has to be done. The swelling of soil mainly depends on the clay mineral present in the soil. The swelling seen in the soils is very predominant in the soils which contain montmorillonite clay mineral and less swelling in soils containing kaolinite clay mineral.

Kaolinite is a clay mineral which has a low shrink swell property and low cation exchange capacity. It is the weathering product of feldspar. Since kaolinite is electrically balanced, its ability to attract ions is less when compared to other clay minerals, which reduces its shrink-swell property. This mineral is predominantly seen in red soils.

Montmorillonite is usually present in black cotton soil. The lattice of this clay mineral consists of layers in which silicon and aluminum ions have tetrahedral coordination with respect to oxygen. Exchangeable cations are on the surfaces of the silicate layers, and their amounts are determined by the excess negative charge within the layer. These exchangeable cations have affinity for water molecules and hence show considerable shrink-swell property.

In view of overcoming the difficulty caused by the shrink-swell properties of clays containing kaolinite and montmorillonite, a cohesion less substance such as sand is mixed with it and the behavior of the two clay mineral is studied.

2. EXPERIMENTAL PROGRAM

An experimental program was planned, in order to study the index properties and free swell ratio of clay-sand mixture . With this intention soils containing kaolinite (Red soil) procured from Dodaballapur and montmorillonite (Black cotton soil) procured from Vijayawada having extreme engineering behavior were selected and clay- sand mixtures were prepared by adding sand with clay in a controlled way up to 50% in increments of 10%. index properties specific gravity and free swell index of Red soil-sand mixtures and B.C. soil-sand mixtures are presented in Table 1 and 2.

Table 1: Index properties specific gravity and free swell of red soil-sand mixture used in present study

Sl no	% By weight of clay added	% By weight of sand added	Liquid Limit (%)	Plastic Limit (%)	Specific Gravity	Free Swell Ratio
1	100	0	36.84	17.63	2.875	1.154
2	90	10	35.71	17.73	2.84	1.146
3	80	20	33.33	18.05	2.792	1.131
4	70	30	32	19.04	2.71	1.123
5	60	40	27.27	20.56	2.625	1.11
6	50	50	23	21.67	2.5	1.1

Table 2: Index properties specific gravity and free swell of Black cotton soil-sand mixture used in present study

Sl No	% By weight of clay added	% By weight of sand added	Liquid Limit (%)	Plastic Limit (%)	Specific Gravity	Free Swell Ratio
1	100	0	51.5	11.11	2.68	1.36
2	90	10	47	16.67	2.65	1.27
3	80	20	45	18.18	2.59	1.23
4	70	30	42	20.34	2.55	1.18
5	60	40	34.61	23.4	2.47	1.09
6	50	50	28	25.27	2.38	1.09

3. RESULTS AND DISCUSSIONS

Figures 1 through 4 show the variation of liquid limit, plastic limit, specific gravity and free swell ratio with the addition of varied percentages of sand to red soil and black cotton soil. It is seen that the Liquid Limit of the clay-sand mixture reduces as the percentage of sand is increased due to the water holding capacity of the mixture. The Plastic Limit of the clay-sand mixture is found to increase in the mixture as the amount of sand added makes the soil less plastic and more solid. Specific Gravity of the clay-sand mixture decreases with the increase in percentage of sand added due to reduction in the clay particles available for flocculation. The Free Swell Ratio of the clay-sand mixture when determined is found to decrease as the percentage of sand added increases as the amount of clay mineral which is responsible for the shrink-swell property decreases.

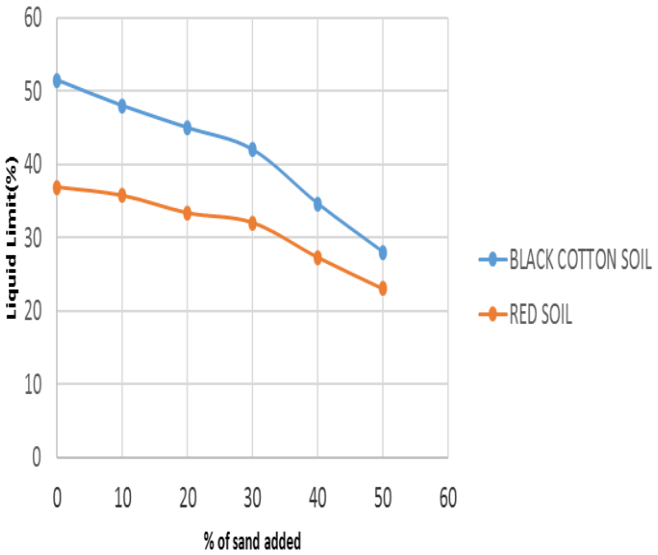

Fig 1 Comparative study of Liquid Limit

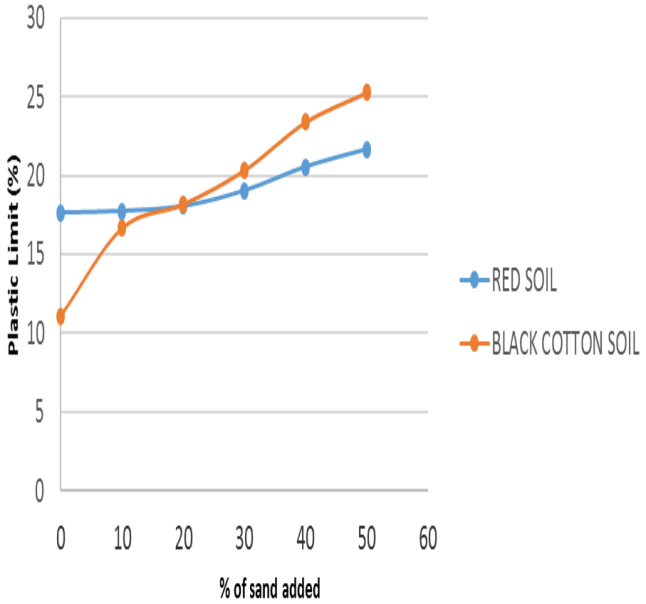

Fig 2 Comparative study of Plastic Limit

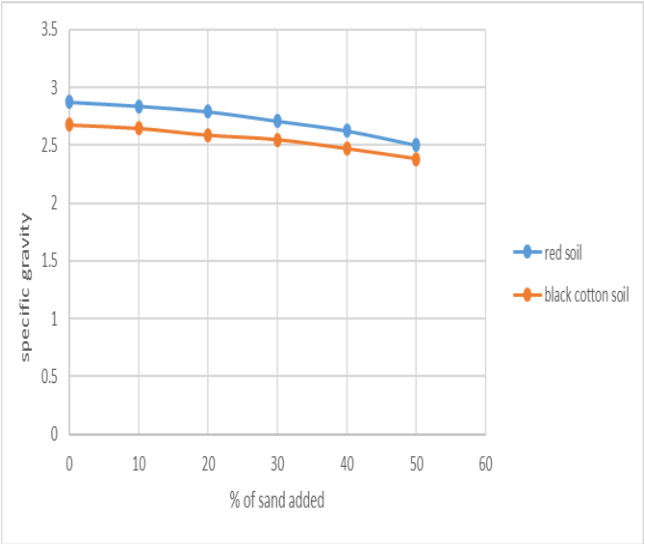

Fig 3 Comparative study of Specific Gravity

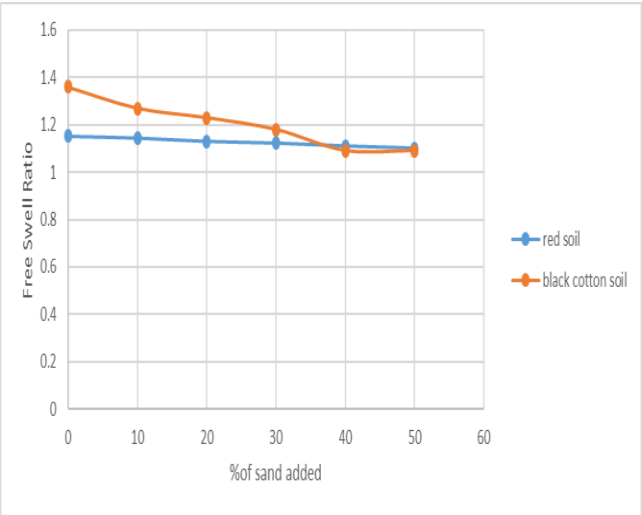

Fig 4 Comparative study of Free Swell Ratio

4. CONCLUSION

1. Liquid Limit of cohesive soils is mainly due to soil fabric as governed by inter particle attractive forces. As the proportion of sand increases, the particle to particle contact increases, leading to an increase in frictional resistance. Addition of sand reduces Liquid Limit of the mixtures, thereby reducing the water holding capacity at Liquid Limit and hence increases the strength of the clay particle.
2. Soil becomes plastic when mixed with water, plasticity is due to clay minerals. Clay particles carry negative charge, water molecules being dipolar in nature are attracted towards the clay surface and the water remains adsorbed. Clay particles are separated by layers of adsorbed water which allows them to slip over one another. When subjected to deformation, particles do not return to their original position, that is deformation is plastic. As the sand is added to the soil increases the water holding capacity of the soil mixture reduces making the soil mixture solid.
3. As the proportion of sand increases, the amount of fine particles of the cohesive soil containing the clay mineral reduces, which reduces the flocculation thereby reducing the specific gravity.
4. When the sand content is increased in the soil mixture, the water holding capacity decreases thereby leading to reduced shrink swell property.

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