Stabilization on Expansive Soil with Different Sand Layers

K. Venkat Raman, P. Dayakar, R. Vekatakrishnaiah

Abstract: Problematic Soil improves by better root growth, water movement, and also by mixing portions of the soil profile, to provide more uniform texture. As a ground improvement technique to improve the strength of problematic soils and this study is carried out to understand the settlement behaviour of layered soils. The soil which is collected was found to be problematic in nature, which is more swelling in nature. The samples of soil are collected the from Mudichur road, Tambaram. The sand used in this study is taken from nearby site and is used to improve the problematic soil by forming a layer of required thickness. The preliminary tests are conducted on the soil samples to determine their properties as per IS standards. After the preliminary test, the plate load tests are performed on the soil with square plate (10 mm x 10mm) in order to know the bearing capacity of soil. The load tests are performed on sand and clay layers with varying thickness of 5cm, 10 cm and 15 cm of sand over clay soil. From the plate load test the load- settlement behaviour of soil layers are studied. It can be conclude that if different layers of sands are provided over Problematic soil then It gets enough Load bearing resistance which can be further gets implemented during Highways constructions. The results says that of 15 cm layer of sand shows maximum load bearing capacity & shown better load – settlement graphs as well.

Key words: Problematic Soil, Trona, Highways constructions, load bearing capacity, IS standards.

I. INTRODUCTION

One of the attributes of these dirts that have generally low dry thickness and furthermore low normal dampness substance Problematic soil has a high esteem for the shear quality when it's dry - and lose these properties plainly at higher stickiness. Burden – settlement conduct of supporting soil is a significant information valuable to evaluate the bearing limit which is the capacity of different factors to be specific shapes and sizes. In this examination the sand layer arranged in a model tank, which is comprised of fiber sheets shows the Load-settlement conduct by Load testing. Nagaraj, T.K. furthermore, Ullagaddi, P.P. has expressed that by expanding the size of the balance will prompts the improvement of bearing limit of the dirt and in establishment. As the size of the balance expands the bearing limit and the heap settlement conduct of the dirt improves [1]-[5] Dark and Michalowski and Zhao (1996) have presumed that the expansion of polypropylene strands altogether improved the conduct of the dirt by plate load test. From the outcomes it's seen that the settlement increments quickly and clarified through a consolidated impact of the consistent increment in the quality of the material everywhere disfigurements as saw in the triaxial tests, and the increments in the even worries underneath the plate. The outcomes reasoned that there is an augmentation from 30 to 310 of the grinding point which is legitimately influenced by the polypropylene fiber and the heap power increments from around 23 to 122 kN/m².

II. MATERIALS & METHODOLOGY

A. *Clay (Soil 1)*

Soil is the blend of minerals, natural issues, gases, fluids and a heap of small scale and full scale life forms that can bolster vegetation. Soil is a type of normal body that exists as a major aspect of the pedosphere. In development soil assumes a significant job in choosing the kind of establishment to be laid and the bearing limit of the structure. Soil has a different trademark highlights, for example, expanding, contracting, and so on. The dirts utilized in this examination are gathered from the close by site and the locally accessible sand is been utilized to a layer in the dirt stratum. The dirt is chosen in the wake of looking at their physical and designing properties of them[6]-[11]

B. *PLATE LOAD TEST*

Soil is the blend of minerals, natural issues, gases, fluids and a heap of small scale and full scale life forms that can bolster vegetation. Soil is a type of normal body that exists as a major aspect of the pedosphere. In development soil assumes a significant job in choosing the kind of establishment to be laid and the bearing limit of the structure. Soil has a different trademark highlights, for example, expanding, contracting, and so on. The dirts utilized in this examination are gathered from the close by site and the

Revised Manuscript Received on October 22, 2019.

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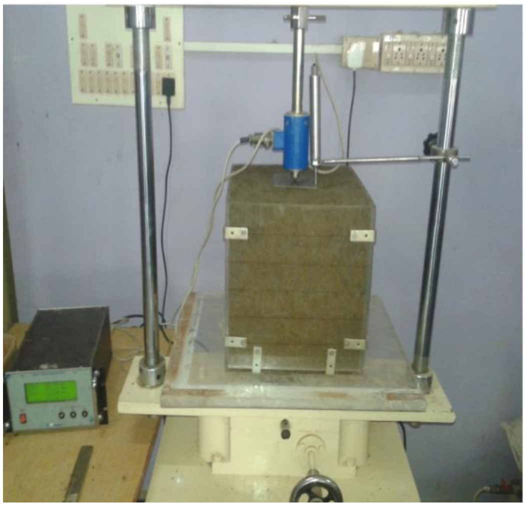

Figure 1: Plate Load test setup in Triaxial Loading Frame

The sample which is placed in the acrylic tank is placed in the triaxial loading frame and a steel plate is placed at the centre of the tanks as shown in figure 2. The plate of size 10 cm x 10 cm is placed at the centre and a steel ball is placed at the centre of the loading test plate. The load cell is placed to intake load over a spherical steel ball. LVDT is used to determine the displacement of the plate which terms as the overall displacement of the acrylic tank as shown in Figure 4

Fig 2. Loading on Plate with Load Cell

Fig 3.Data Logger with Load and Displacement

III. RESULT AND DISCUSSION

A. *Soil 1 (Clay)*

Index properties studied of the soil are summarized in Table 1. Index properties include (LL, PL, PI = LL-PL), specific gravity (Gs), Maximum dry density, Optimum moisture content All the other index properties of the natural soils are presented in Table 1.[19]-[25]

Table 1 Index properties of the natural soil

Soil Type	LL (%)	PL (%)	PI (%)	Gs	OMC (%)	MDD kN/m³	UCST kg/m²
Clay	76.85	21.36	52.30	2.63	25	1.39	3.96

B. *Plasticity Index*

The plasticity index of a soil is the numerical difference between its liquid limit and its plastic limit. Both the liquid and plastic limits are moisture contents.

Plasticity Index = Liquid Limit - Plastic Limit

PI = LL-PL

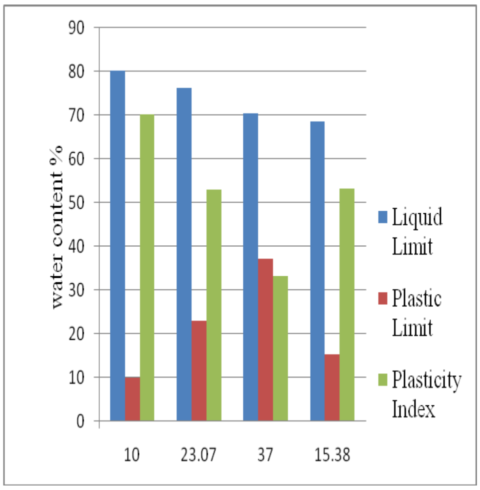

Fig4. Plasticity Index

Compaction on clay

In various constructions and other engineering structure loose soil are to be compacted to form a stable structure to improve their strength various measures are taken. Compaction is one of the effective and efficient methods which remove air voids in the soil by different source. The degree of compaction is measured in the form of dry unit weight.[26]-[34]

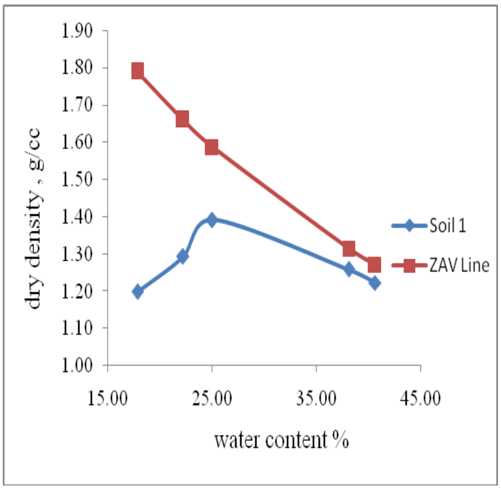

Fig 5. Compactions curves of the studied soils.

The maximum dry density and optimum water contents are summarized in Table 1. Organic silt has the highest optimum water content (25%) and its maximum dry density 1.39 g/cc.

C. *Soil2 (Sand)*

The other composite material used in this study is the sand which is highly variable the sand used in this study is locally available in the site. Sand is selected after examining their engineering properties. From the grain size distribution it is examined that sand sample used in this study is poorly graded it is chosen to stabilize with the clayey soil.

D. *Index properties of Sand*

Table (2) Index properties of the soil 2

Gs g/cm^3	OMC (%)	MDD kN/m^3	Cc	Cu
2.82	10	1.62	0.31	3.2

Gs = Specific gravity
MDD = Maximum dry density
OMC = Optimum moisture content
Cc = Coefficient of Curvature
Cu= Coefficient of Uniformity

Compaction Test on Sand

Sand compaction is a cost-effective method of ground improvement which is commonly used to improve soft seabed soils prior to land reclamation works. The maximum dry density and optimum water contents are summarized in Table 2.the highest optimum water content (10%) and its maximum dry density 1.62 g/cc.

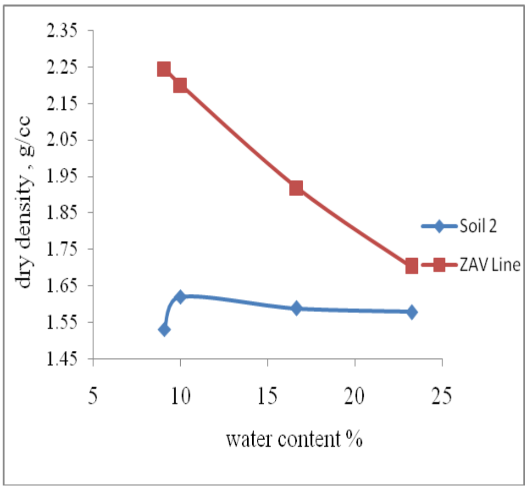

Fig 6. Compactions curves of the studied Sand

E. *Sieve Analysis of Sand*

The grain size analysis is widely used in classification of sand. The ratio of D60 to D10 is called coefficient of uniformity. Cu= D60 / D 10 = D10 represents a particle size in mm such that 10% of the particles are finer than this size. D60 means 60% of the particles are finer than the size of the particle at 60% point on the curve. The shape of the particle size indicated by coefficient of curvature (Cc) = (D30)²/ (D60 xD10). D30 – Particle size corresponding to 30% finer.

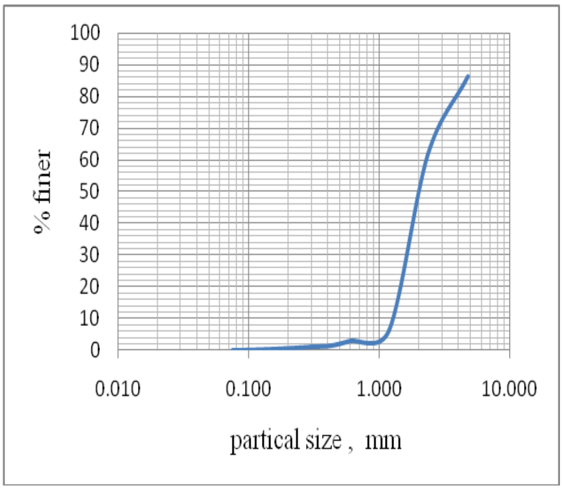

Fig 7. Sieve Analysis graph

F. *Plate load test on clay*

Layer's of different soil is done in an acrylic tank (30 cm x 30 cm x 30 cm) in room temperature of 28 ^{0}C. The tank should be completely dry before filling the Clay. Water content should not be there. Once the tank should be filled with soil 1(clay) and again filled with soil 2(sand). Initially the tank gets fully filled with clay in compacted phase. Secondly the square plate of 10cm x10cm is placed over the compacted clay which is placed in the tank.

Retrieval Number: K133710812S19/2019©BEIESP
DOI: 10.35940/ijitee.K1337.10812S19

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Finally load is to be applied to find out the load-settlement behaviour of the soil. The maximum load obtained 325 kPa at 5.95 mm displacement

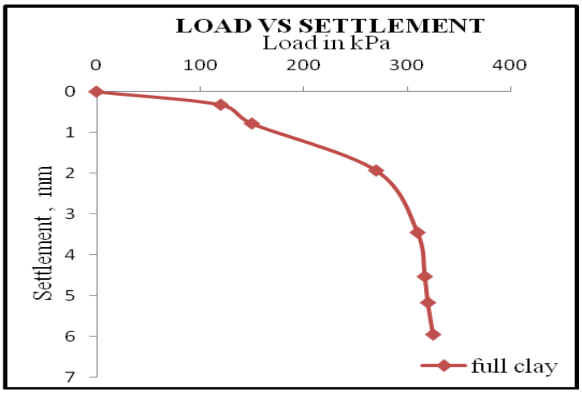

Fig8. Load vs Settlement curve of full clay

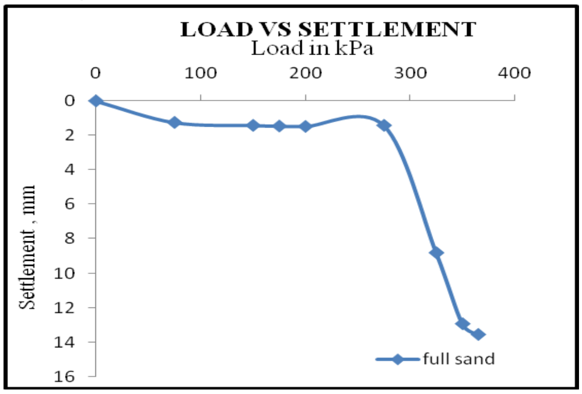

Fig 9. Load vs Settlement curve of full Sand

Plate load test on fully sand

Tank filled with fully soil 2(sand) having a square plate of (10cm x 10cm) for plate load test, in order to find out the load- settlement behaviour of sand. The maximum load obtained 365 kPa at 13.55 mm displacement.

Plate load test on clay with 5cm thick sand layer

Tank filled with mostly soil 1(clay) i.e upto 25cm layer and partially filled with 5cm of thick layer with sand on the top having a square plate of (10cm x10cm) to perform the plate load test, in order to find out the settlement behaviour of problematic soil. The maximum load obtained 217 kPa at 2.41 mm displacement.

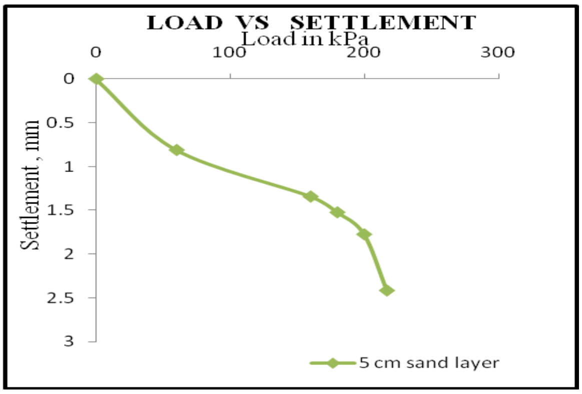

Fig 10: Load vs Settlement curve of 5cm thick

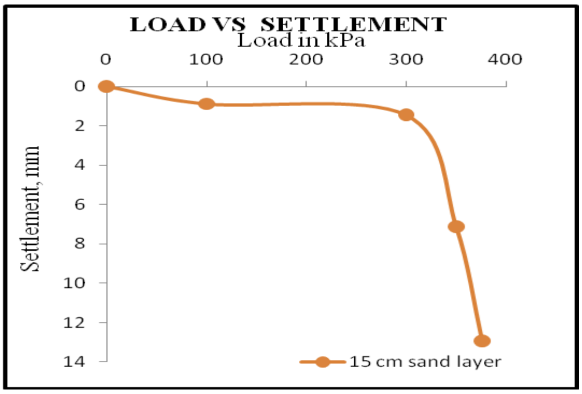

Fig 11: Load vs Settlement, 15cm sand layer

Tank filled with equally soil 1(clay) i.e. upto 15cm layer and in same quantity i.e 15cm of thick layer of sand having a square plate of (10cm x 10cm) to perform the plate load test, in order to find out the settlement behaviour of problematic soil. The maximum load obtained 376 kPa at 12.93 mm displacement.

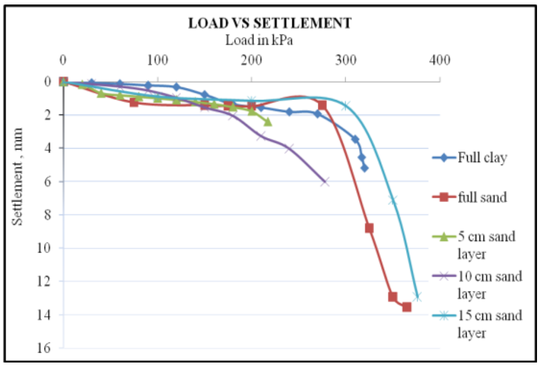

Fig 11: Load vs Settlement of sand layer.

Load Comparison of each layer at 2 mm displacement

Load intensity retains the maximum at 15cm thick sand layer for 2 mm displacement

Load Intensity kPa				
Clay	Sand	Sand layer thickness (5 cm)	Sand layer thickness (10 cm)	Sand layer thickness (15 cm)
271.84	278.92	206.1	180	304.77

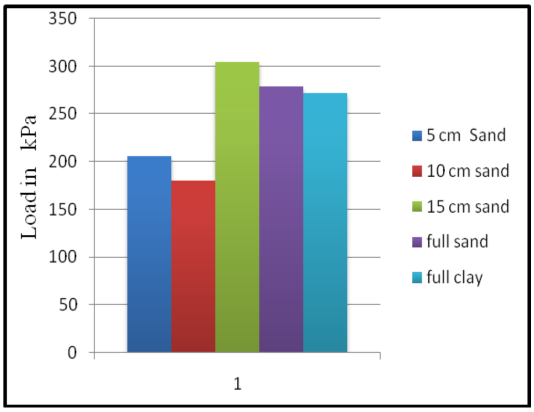

Fig 12. Load Comparison at 2 mm displacement

Load Intensity increase in percentage

Following table and graphs shows percentage increment will be maximum at 15 cm thick sand layer for the same amount. Load intensity remains the maximum at 15cm thick sand layer which is 304.77kpa, although it is tested for 5cm thick layer, then for 10cm thick layer for which we got the values as 206.1kpa and 180kpa respectively

	Clay	Sand	Sand layer thicknes s (5 cm)	Sand layer thickness (10 cm)	Sand layer thickness (15 cm)
Load Intensity	271.84	278.2	206.1	180	304.77
Percentage %	16.36	23.58	24.18	33.78	45.90

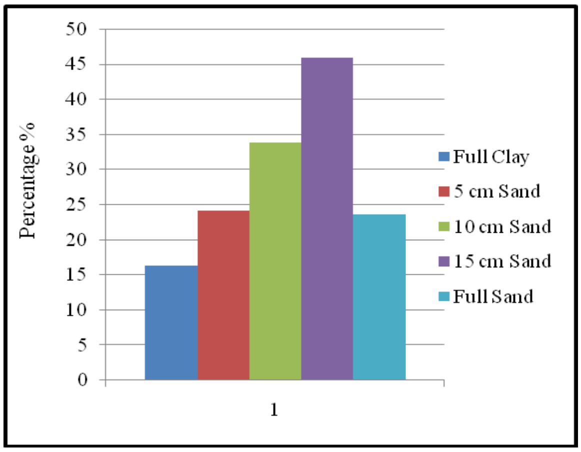

Fig 13. Load Intensity increase in percentage

Load intensity Comparison with Ultimate Bearing Capacity

Ultimate Bearing capacity also retains to be maximum at 15 cm thick sand layer and for which its load intensity remains the most. Ultimate Bearing Capacity also remains to be the most at 15 cm thick layer only and that is 320kpa. In percentage terms also Load intensity remains the maximum and i.e percentage increase almost 3times over entire clay.

	Clay	Sand	Sand layer thickne ss (5 cm)	Sand layer thicknes s (10 cm)	Sand layer thickness (15 cm)
Load Intensity	271.84	278.2	206.1	180	304.77
Ultimate Bearing Capacity	308	285	191	205	320

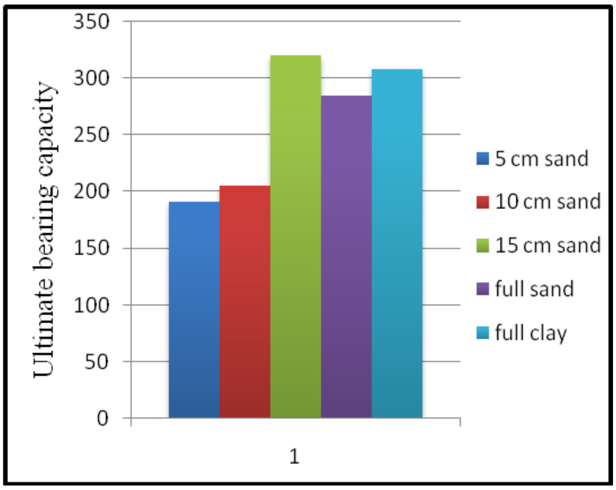

Fig 14. Ultimate Bearing Capacity

IV. CONCLUSION

Hence it can be concluded that regarding improvement in problematic soil is provided with the thickness of 15 cm of sand layer, the load caring capacity is greater comparatively. At 5 cm thick sand layer, much load bearing capacity have been noticed and with 10cm thick sand layer then load bearing capacity got enhanced comparatively grater, again when the process carried further with 15 cm thick sand layer then it has reached the maximum bearing capacity and this being the half layer stage for both sand and clay as 30 cm tank is been taken.

In this study it is justified that the process and methodology being carried out and finally it attains the maximum value for the load bearing capacity, with which when compared with the result i.e during 15 cm thick sand layer the load bearing capacity retains the maximum.

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