PERMEABILITY AND SHEAR STRENGTH CHARACTERISTICS OF ROBOSAND TREATED SOFT-CLAY

[1]Karumanchi Meeravali, [2]Majji Adi narayana, [3]Nune Ravikumar, [4]Y Malasree [5]Kotte Bhagyasri
(Assistant Professor) (B Tech student) (B Tech student) (B Tech student) (B Tech student)
ABR College of Enigineering &Technology, ChinaIrlapadu(V), Kanigiri(M), Prakasam Dt,PIN-523254(Affliated to JNTUK, KAKINADA-Approved by AICTE, NEW DELHI)

ABSTRACT: Expensive soils denote clayey soilscontent (OMC) with different percentages (by dry that not only possess the tendency to increase orweight of the soil) and Specific gravity. The second decrease in volume (compressibility) due to that,phase of the experimental program focuses on shear strength varies and when the prevailingPermeability and shear strength characteristics of the moisture condition is allowed to change but alsosoil. In addition to UCS tests were performed to study measure of the ability of a soil media to support thethe effects of nano-chemical on unconfined formation of a magnetic field within itselfcompressive strength of tested soil. Test results (permeability). Such change of moisture content ofindicated that addition of robosand increased the these soils can emanate from rains, floods or leakagepermeability and shear strength of the soft soil with of sewer lines. The response of expensive soil in formincreasing robosand with respective percentages.
of compressibility and permeability due to change This project ventures to find the feasibility of using a moisture content is frequently expressed superficiallyNano chemical as stabilizer for ground improvement as heaving, settlement and piping (flow in streamand to find an optimum dosage of the stabilizer which lines) of lightly loaded geotechnical structures such asensures maximum strength, controlling permeability pavements, railways, roadways, channel andcharacteristics. Different dosages of robosand will foundations or reservoir lining. This thesis is anbe added into the soil samples collected. The experimental study evaluating the effect of robosandcompaction and unconfined compression (UCS) tests on permeability and shear strength of expansive soil.are to be conducted, followed by consolidation and The initial phase of the experimental programpermeability test to determine the soil characteristics includes the study of the effect of robosand on MDDof controlling permeability and increasing shear (Maximum Dry Density) and controlling moisturestrength.

Keywords: Robosand, , Soil microstructure

INTRODUCTION

The Soil stabilization is the alteration of any inherent property of a soil to improve its engineering performance. The study is aimed to improve the engineering performances of locally available in situ materials by treating it with Robosand. The study is aimed to improve the Engineering performances of locally available in situ materials by treating it with Robosand. Addition of Robosand to soil nanotechnology based product which can provide solutions to prevent moisture migration and process strong bonding in pavement layers. Addition of micro particles to locally available soil as an external factor will result in soil manipulation at micro level and it influences the strength, permeability properties of soil.

Chemical Stabilization

Chemical stabilization is dealing with modification of the actual chemical make-up of the soil matrix. Some of these mechanisms are listed below.

Lime/Cement: Lime stabilization can be explained by three phases with the first phase being hydration of quicklime, the second phase is flocculation, which results in an immediate reduction of plasticity and the final phase of lime stabilization is the long-term cementation phase.

Mechanical Reinforcement

Mechanical reinforcement materials are mostly made of polymers and plastics, but can also be made from wood fibers, glass fibers etc. Due to their highly frictional nature, mechanical reinforcement is used as a stand-alone stabilizer which is limited to coarse-grained materials. Clay soils can be treated with mechanical reinforcement in combination with lime or cement stabilization.

Robosand

Robosand is a waste cloth acquired from crusher plants. It has capacity to be used as partial replacement of natural river sand in soil and concrete. Use of Robosand in soil no longer handiest improves the fine of soil however additionally preserve the herbal river sand for destiny generations. In the existing research, an experimental program turned into achieved to study the workability and compressive strength of soil made using Robosand as partial replacement of satisfactory mixture in the variety of 10%-100%. Typical historic uses for sandstone covered:

• Urban row houses, business homes and church buildings built from the 1840s through the early twentieth century (this became commonly brownstone); frequently determined in North-jap and Mid-Atlantic areas of America.

• Lighter-coloredRobosand had been used extra frequently through the end of the nineteenth century.

• New sandstone is generally most usually used for excessive excellent custom-designed buildings. Such stone represents thirteen percentage of the size stone marketplace (Mineral Information Institute).Also, new sandstone is used for recovery tasks if appropriate.

Characteristics of Robosand:

• A sedimentary rock which includes sheets of sand, mineral debris, and binding matrix deposited one atop in water environments and desolate tract formations.

• Very porous and water will penetrate it effortlessly.

• Brown, red, and purple Robosand are generally known as brownstone.

• Available in a selection of floor textures and earth-toned shades.

• Weathers nice when its end-grain faces the weather (certainly bedded).(Face-bedded) stone is situation to extra deterioration. Water damages a face-bedded stone through spelling or flaking off whole sheets of sandstone. Also, freeze/thaw cycles permit water to get into the stone after which freeze and amplify inflicting a number of the pinnacle layer to cut up off.

So excellent sandstone, like Credit Valley, has many blessings over both granite and limestone. Sandstone, or any herbal stone, is also a much better preference than any of the "cultured stone" products which might be presently to be had. These cement – based

building materials aren't similar in appearance or sturdiness, and cannot be expected to closing almost as lengthy a real herbal stone.

General Requirements of Manufactured Sand

1. All the sand particles should have higher crushing strength.
2. The surface texture of the particles should be smooth.
3. The edges of the particles should be grounded.
4. The ratio of fines below 600 microns in sand should not be less than 30%.
5. There should not be any organic impurities
6. Silt in sand should not be more than 2%, for crushed sand.
7. In manufactured sand the permissible limit of fines below 75 microns shall not exceed 15%.

Importance of Robosand:

Robosand is important in many aspects because of the following issues

- The river sand which is available today is very deficient in many aspects because it containing high amount of silt and fine particles.
- Natural sand contains other impurities such as shells, coal, bones, silt and mica. When this sand is used in construction, Decay of these materials occurs due to the weathering effect. This will shorten the service life of a structure.
- Recently the Government if India put a BAN on lifting river sand from river beds. So the availability and cost of natural sand are increased.
- Removing sand from river beds shows some adverse effects on environment such as
- Reduction in water head results in less percolation of rain water into the ground.
- The roots of the trees cannot able to get water.

- The river water containing excess impurities when it is flowing.
- Due to the sand lifting, erosion of sand will occurs at nearby land.

Advantages of Robosand:

- Robosand particles has cubical shape, this will helps in making concrete more cohesive.
- It contains perfect gradation, so it involves less voids in concrete and the compressive strength will increases.
- Due to its well balanced physical and chemical properties the robosand will gives more durability in structures.
- Robosand has very consistent quality and no seasonal fluctuations because it is produced under conditions and with Raw material from single source.
- Robosand will worked out to be very economical because the complete absence of waste materials and silt.

Fig.1. Robosand.

Summary of Literature Review

The literatures disclosed that stabilization of soft clays with fly ash, cement and Robosand improved the engineering properties like UCS, permeability, compressibility and CBR of clay to a great extent. Chemical additives like Robosand significantly transformed permeable soil into impermeable soil while comparing with other chemical additives. Among the chemical additives introduced Robosand is the most effective and economic. Robosand is also found consistent while comparing other additives. None of the authors have so far studied about the effect of Robosand on permeability and shear strength characteristics of soft clay.

MATERIALS USED

Soft Clay

The soft clay sample used for testing program was collected from river near kanigiri region in Andhra pradesh. The soil was taken from a depth of 2m below the ground level in already existing open pit for construction of well. Sample collected was air-dried and pulverized and the basic properties of the soil were found out. and the basic properties of the soil were determined and listed in Table 1.

Table 1 Basic soil properties

Sl. No.	Property	Values
1	Specific Gravity	2.35
2	Consistency limits	
	Liquid limit (%)	36
	Plastic limit (%)	22
	Plasticity Index (%)	14
3	Shrinkage limit (%)	12
4	IS Soil classification	CI
5	Engineering properties	
	IS Light compaction	
	(a) MDD (g/cc)	1.94
	(b) OMC (%)	10
6	UCS (kN/m^2)	37.6
7	Co-efficient of permeability(cm/s)	1.8×10^{-5}

Optimum Dosage of Robosand

As per technical data provided by Industries , the required optimum dosage of Robosand of soil to obtain the higher MDD values. In present work, the Robosand dosages are varied in the range of 5% to 45% of weight of soil in order to obtain the optimum dosage corresponding to MDD value. Totally seven soil combinations were prepared after adding the Robosand amounts of 5%, 10%, 15%, 20%, 25%, 30%, 35%, 40% and 45% into clay soil. Initially, Robosand solution has been prepared after adding predetermined dosage of Robosand agent in the required optimum quantity of water. Further, the soil combinations are prepared by spraying the Robosand solution on loose soil and mixing uniformly.

EXPERIMENTAL INVESTIGATION

The aim of the study is to evaluate the impact of Robosand stabilizer agent on Geotechnical properties of soft clay by possessing low compressibility to minimize settlements or differential settlements. It also planned to find the optimum percentage of additive i.e. Robosandwhere the UC strength is maximum. The strength values of treated soils are measured and compared with strength of untreated clay soil.

ROBOSAND TREATED CLAY SOIL

SOIL - ROBOSAND MIXTURES

Several combinations of soil-Robosand mixtures were prepared. The Robosand is considered as the base additive. Here, the several combinations of Robosand treated clay soil samples were prepared after adding the robosand amounts of 5%, 10%, 15%, 20%, 25%, 30%, 35%,40% and 45% in to the clay soil. Robosand treated has been prepared after adding predetermined dosage of robosand agent in the required optimum quantity of water. Further, the soil combinations are prepared by spraying on loose soil and mixed uniformly. The robosand treated samples were tested for consistency limits, compaction properties. The samples were tested for consistency limits, maximum dry densities at different dosages

Find the optimum content of robosand from these two tests

1) Specific Gravity 2) Compaction Test

1)Specific Gravity

To find the optimum content of robosand with specific gravity values of each chemical treated clay soil mixture, various Specific Gravity tests were performed on samples prepared at different dosages of robosand from 5% to 45% its dry weight of soil, until get maximum value of specific gravity.

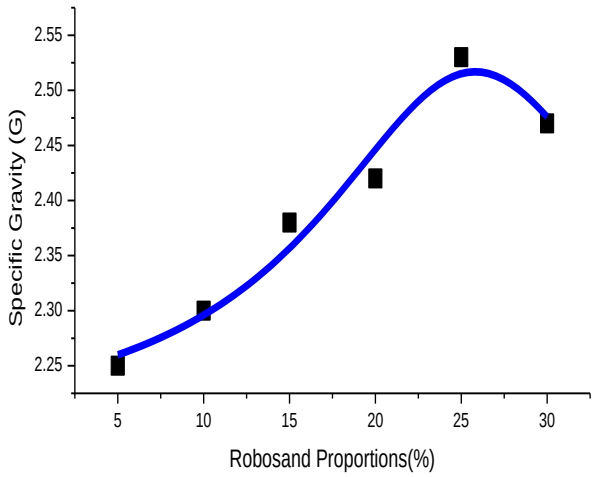

Fig.2 Effect of Robosand dosages from 5% to 30% on Compaction characteristics

The effect of Robosand dosage from 5% to 30% on specific gravity characteristics of clay soil is illustrated in Table 4.1. Irrespective of all dosages, the highest specific gravity obtained with 25% of robosand proportions and specific gravity is increasing from 2.35 to 2.53. It indicates the optimum dosage of Robosand added to the soil is 25%.

2) Compaction Test

To find the optimum content of robosand with maximum dry density values of each chemical treated clay soil mixture, various Compaction tests were performed on samples prepared at different dosages of robosand from 5% to 45% its dry weight of soil, until get maximum dry denisity (g/cc)

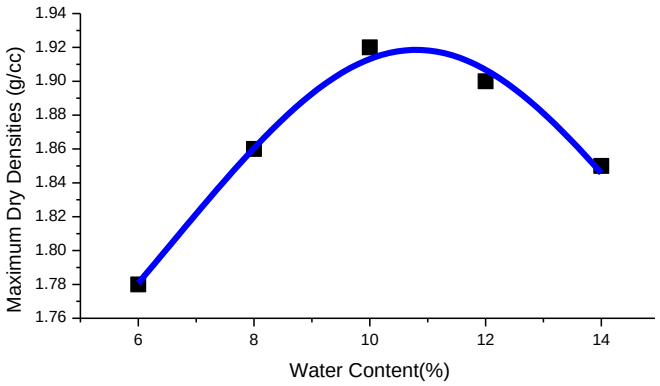

Fig.3 Effect of Robosand dosages of 5% on Compaction characteristics

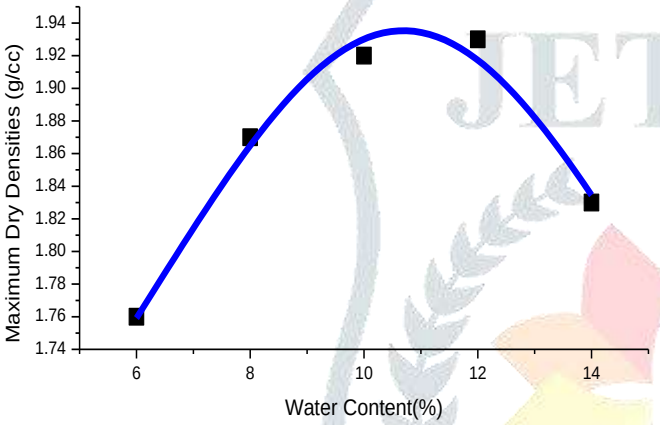

Fig.4 Effect of Robosand dosages of 10% on Compaction characteristics

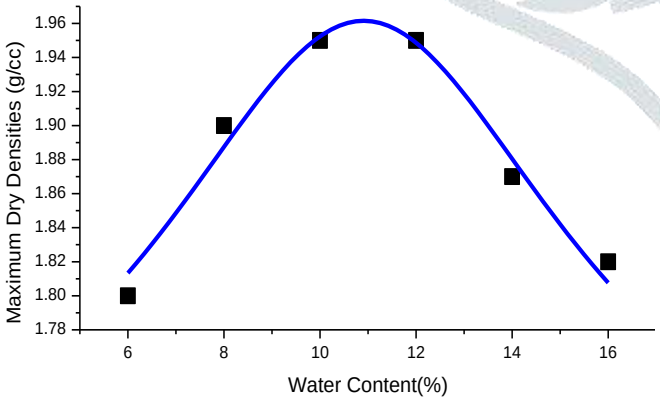

Fig.5 Effect of Robosand dosages of 15% on Compaction characteristics

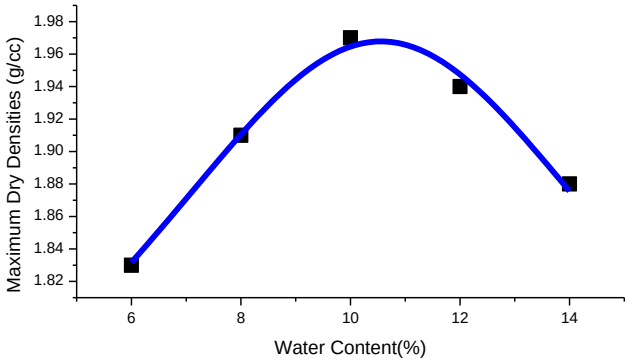

Fig.6 Effect of Robosand dosages of 20% on Compaction characteristics

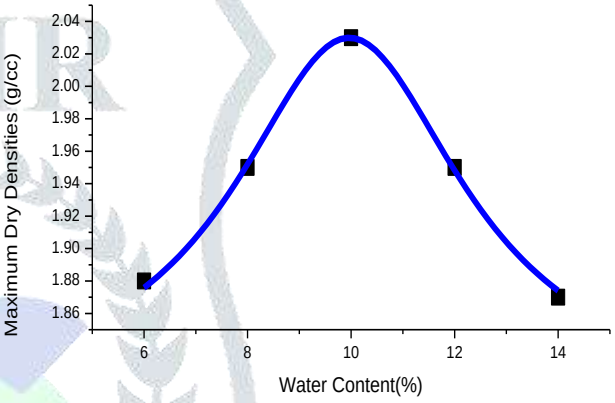

Fig.7 Effect of Robosand dosages of 25% on Compaction characteristics.

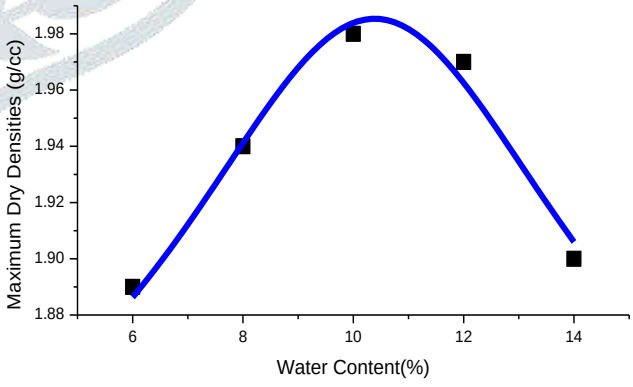

Fig.8 Effect of Robosand dosages of 30% on Compaction characteristics

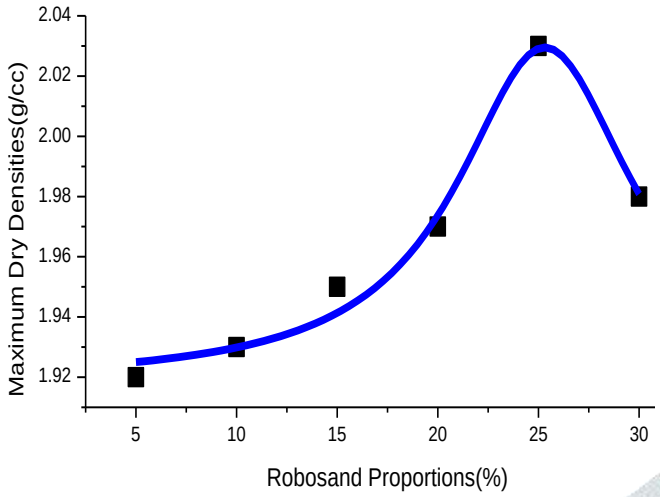

Fig.9 Effect of Robosand dosages from 5% to 30% on Compaction characteristics

Table 4.2 Compaction characteristics of Robosand treated clay soils at different dosages

Robosand Propotions(%)	Maximum Dry Densities(g/cc)	Optimum Moisture Content (%)
5	**1.92**	**10**
10	**1.93**	**11.5**
15	**1.95**	**11**
20	**1.97**	**10.5**
25	**2.03**	**10**
30	**1.98**	**10.5**

Robo-sand dosage %	coefficient of Permeability (cm/sec)		
	untreated clay	Treated clay Trail-1	Treated clay Trail-2
25	1.8×10^{-5}	Nil	Nil

The effect of Robosand dosage from 5% to 30% on Compaction characteristics of clay soil is illustrated in Table 4.3. Irrespective of all dosages, the highest maximum dry density obtained with 25% of robosand proportions and MDD is increasing from 1.94 to 2.03g/cc. It indicates the optimum dosage of Robosand added to the soil is 25% which one leads to maximum dry density and respecting optimum moisture content is 10%.

Further testing follow on mixing with MDD is 2.03g/cc, OMC is 10% and optimum dosage robosand is 25% of its dry weight of soil.

SOIL - 25% ROBOSAND MIXTURES

Seven Optimum combination of soil-Robosand mixtures were prepared. The Robosand is considered as the base additive. The dosage of Robosand is fixed at an optimum dosage of 25% which was obtained after testing on soil-Robosand mixtures. Then the experimental tests were conducted on soil-cement-Robosand mixtures to examine the combined effect of Robosand and cement on improvement of permeability, strength properties of clay soil.

Permeability

Each chemically treated test sample was compacted in the permeameter mould at a density of 2.03 g/cc after adding the optimum moisture content of 10% to the soil. The sample was drained at both end faces of mould to saturate the sample. The test results are indicating that as the dosage of Robosand increases there is a drastic decrease in permeability. The chemical reaction leads to permanent siliconization of the surfaces and this made the soil lightly waterproof. The test results show that the permeability of all chemical treated soils is almost insignificant.

Table 7 permeability test results for untreated and treated soils

Unconfined Compression Strength

The samples were prepared after adding the Robosand chemical in the optimum dosage of 25% in to the clay soil. The chemical treated samples were compacted at maximum dry density 2.03g/cc after mixing the chemical with optimum water content of 10%. The unconfined compressive strength of soil increased from 37.6kPa (untreated soil) to 119.2kPa.The UC strength of soil mixed with optimum dosage of 25% Robosand is improved about 3.1% higher than the strength of clay soil. This improvement

is due to the reaction of the chemical with the soil particles and as a result it restricts water entering the surface.

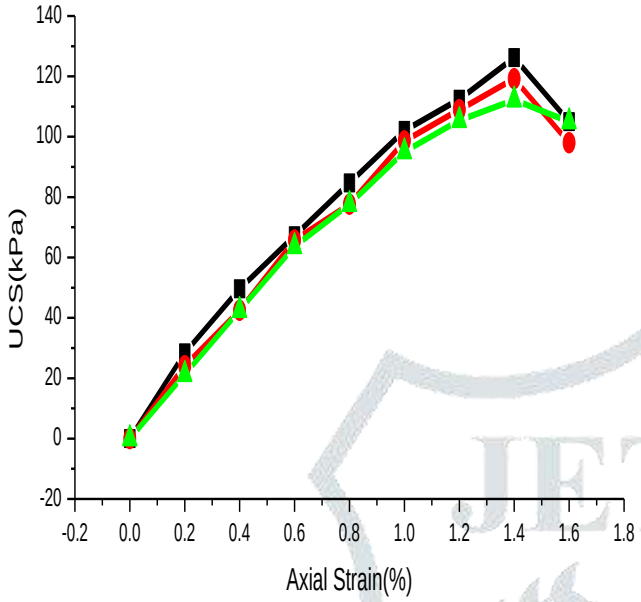

Fig.10 Effect of robosand dosages on UC Strength

CONCLUSIONS

Based on discussion of experimental test results, a few of major conclusions can be listed with regards to the effect of Robosand additives on consistency limits, compaction, UCS and permeability.

- The soil is has specific gravity is 2.35. The soil is classified as intermediate compressible clay (CI) as the plasticity index of untreated soil is 11.68%, compaction characteristics like maximum dry density and optimum moisture content are 1.94 g/cc and 10% respectively and unconfined compressive strength as 37.6kPa

- The coefficient of permeability is about 1.8×10^{-5} cm/sec.

- Robosand is introduced into the clay soil from 5 to 45% weight of soil. The specific gravity increased from 2.35 (untreated) to 2.53 (for optimum Robosand at 25%). It indicates that the soil become less plastic state with the addition of optimum level of 25% robosand into the clay soil. So it is clear that the chemical makes the soil stiff.

- Robosandis added into the clay soil from 5 to 30% weight of soil. The maximum dry density of soil increased from 1.94g/cc (untreated soil) to 2.03g/cc (for optimum Robosand at25% its dry weight of soil).The maximum dry density of soil mixed with optimum dosage of 25% Robosand is improved about 1.1% higher than the strength of clay soil. This improvement is due to the reaction of the chemical with the soil particles and as a result it restricts water entering the surface.

- The soil is found impermeable at optimum dosage of Robosand for every curing period.

- The unconfined compressive strength of soil increased from 37.6kPa (untreated soil) to 119.2kPa.The UC strength of soil mixed with optimum dosage of 25% Robosand is improved about 3.1% higher than the strength of clay soil. This improvement is due to the reaction of the chemical with the soil particles and as a result it restricts water entering the surface.

In conclusion, the soil- 25% Robosand is the best soil combination which is exhibiting the high maximum dry density, higher UC strength and less permeable value. The stabilized soil-Robosand mixture is very useful as an embankment material, unlined canals, structural backfill, and other compacted fills. Also the mixture is very useful as a subgrade material.

SCOPE OF FUTURE WORK

1. Sustainability of Robosand treated soil can be studied by carryingout durability test.
2. The application of Robosand treated soil in pavement construction can be studied by

conducting fatigue analyses and tri-axial tests for both treated and untreated soil.

3. The application of Robosand treated soil in pavement construction can be studied by conducting fatigue analyses and Consolidation tests for both treated and untreated soil.

4. The effectiveness of Robosand treated soil in various aspects of geo-technics like landfills, embankments, unlined canals etc. can be studied.

5. The present study can be extended with different Robosand agents and different soil types.

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