Laboratory Studies on The Properties of Marine Soil Blended with Geo Jute And Gypsum

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Abstract- *Generally, clay has undesirable engineering properties like low bearing capacity and high compressibility. Particularly clays exhibit generally undesirable engineering properties, thus the improvement of soil at a site is necessary. They tend to have low shear strengths and loose shear strength further upon wetting or other physical disturbances. The improvement of soil at a site is indispensable due to rising cost of the land, and huge demand for high rise buildings. Soil stabilization involves addition of a binder to improve mechanical and chemical properties of the soil. In the present study, added jute as stabilizer and gypsum as additive to improve the properties of Expansive soil. Locally available expansive soil is used in this study. The objectives of this study are to improve the strength of the expansive soil by making soil- jute and soil-jute-gypsum mixture and evaluating the strength characteristics of virgin as well as blended soil using different percentage of jute and gypsum. Standard proctor test and unconfined compressive strength test are conducted to analyze the optimum moisture content (OMC), Maximum dry density (MDD) and compressive strength of soil mixture.*

Keywords- Marine clay, Coir fibre, bitumen, Atterberg's limit test, CBR test, Un confined compression test, maximum dry density and optimum moisture contenttest.

I. INTRODUCTION

A developing country like India which has a large geographical area and population, demands vast infrastructure i.e. network of roads and buildings. Everywhere land is being utilized for various structures from ordinary house to sky scrapers, bridges to airports and from rural roads to expressways. Almost all the civil engineering structures are located on various soil strata. Soil can be defined as a material consisting of rock particles, sand, silt, and clay. It is formed by the gradual disintegration or decomposition of rocks due to natural processes that includes disintegration of rock due to stresses arising from expansion or contraction with temperature changes. Weathering and decomposition from chemical changes that occur when water, oxygen and carbon dioxide gradually combine with minerals within the rock formation, thus it is breaking down to sand, silt and clay. Transportation of soil materials by wind, water and ice forms different soil formations such as those found in river deltas, sand dunes and glacial deposits. Temperature, rainfall and drainage play important roles in the formation of soils as in the different climatic regions. Under different drainage regimes, different soils will be formed from the same original rock formation.

In India, soils are classified into six groups namely alluvial soil, marine soil, laterite and lateritic deposits, expansive soils, sand dunes and boulder deposits. On an average 1 lakh sq.km area is covered by lateritic soil deposits, 3 lakh sq.km area is covered by black cotton soil, and 5 lakh sq.km area is covered by sand dunes. Encountering land having soft soil for construction leads to an attention towards adopting ground improvement techniques such as soil stabilization.

Soil stabilization is the process which involves enhancing the physical properties of the soil in order to improve its strength, durability etc. by blending or mixing it with additives. The different types of methods used for soil stabilization are: Soil stabilization using cement, Soil stabilization using lime, Soil stabilization using bitumen, Chemical stabilization and a new emerging technology of stabilization that is stabilization of soil by using Geo textiles and Geo synthetic fibers.

This is certainly minatory to mankind and their survival. This problem needs serious attention and alternative solution is to be employed (adopted). Instead of searching a new land, one can go for the betterment for the soil properties by different means such as compaction, use of piles, replacement ol soil, soil reinforcement etc. It can also be done by incorporating different materials such as fly ash, lime, rice husk ash, industrial wastes etc. having least or no production value.

Hence problematic soil like clayey soil must be adequately treated before the erection of structure. Wide range of soil modification method is available. Selection of appropriate method should be based on the type of soil and its characteristics, type of the construction , time available , associated cost.

It has been observed that industrial by-products can cause drastic change in the soil properties in terms of strength characteristics, density, acidity etc, arid also serves agricultural benefits by increasing crop yield. Moreover utilization of these products is a better solution to disposal than heaving them up on land.

In this work it is attempted the study the effect of binary blends jute and gypsum on the properties of weak clay.

1.2 OBJECTIVES OF THE STUDY

The objectives of present experimental study are to develop correlations between engineering characteristics of marine clay. The study is focused on

- Improvement of locally available soil using some eco-friendly and cheap waste materials.
- Evaluation of strength characteristics of virgin as well as blended soil using different length of Jute and Gypsum,
- Determination of appropriate Jute and Gypsum content ratio co achieve the maximum gain in strength of soil.

II. LITERATUREREVIEW

2.1 **Studies on marine clay**

In general, the soils which are existing in the coastal corridors are Soft Marine Clays formed by the deposits and generally weak and possesses high deformation values in nature. It is essential to study the various techniques for the improvement of marine clays, especially in case of infra-structure development.

Santhi Krishna K, and Sayida M,K. (2009) conducted studies on the behaviour of black cotton soil reinforced with sisal fibre. The fibres were cut to different lengths (1.5cm, 2.0cm, 2.5cm and 3.0cm) and mixed randomly with soil in varying percentages (0.25%, 0.50%, 0.75% and 1.00%) by dry weight of soil and compacted to maximum dry density at optimum moisture content. The results showed a reduction in the maximum dry density and the optimum moisture content of soil due to ihe addition of sisal fibre. It also indicated an improvement in the CBR value and unconfined compressive strength of soil due to the addition of sisal fibre The optimum CBR value and UCC value were obtained for 2.5cm length of fibre with 0.50% fibre content.

S,A. Naeini and S. M. Sadjadi (2009) studied the effect of waste polymer materials on shear strength of unsaturated clays In the investigation, the waste polymer materials was chosen as the reinforcement material and it was randomly included m to the clayey soils with different plasticity indexes at five diffeient percentages of fibre content (0%, 1%, 2%), 3%, 4%) by weight of raw soil. The main objective of the study was focused on the strength behavior oi the unsaturated clayey soils, reinforced with randomly included waste polymer fibre. The reinforced soil samples were subjected to direct shear tests. The results have clearly shown a significant improvement in the shear strength parameters (C and (p) of the treated soils. The reinforcement benefit increased with an increase in fibre contents.

K,V. Manjunath, HimanshuShekhar, Manish Kumar, Prem Kumar and Rakesh Kumar (2012) reported about the stabilization of black cotton soil using ground granulated blast furnace slag. A series of compaction and unconfmed compression tests were carried out on virgin as well as blended samples prepared. It was observed that with increase of slag, more stability of soil is achieved as compared to using lime alone. UCC strength of ordinary black cotton soil which was found out to be 188.5 kN/m , increased to 3429.37 kPa. The study recommended that for the proportion of (BC soil + 30% slag) + 4% lime @ OMC on 28''' day with proper curing, UCC strength increased up to 18 times that of ordinary black cotton soil and the use of slag as an admixture was recommended for improving engineering properties of the soils as an economical solution to use the locally available poor soil.

2.2 STABILIZATION

Soil stabilization is the process of altering some soil properties by different methods, mechanical or chemical in order to produce an improved soil material which has all the desired engineering properties. Soils are generally stabilized to increase their strength and durability or to prevent erosion and dust formation in soils.. The properties of soil vary a great deal at different places or in certain cases even at one place; the success of soil stabilization depends on soil testing. Various methods are employed to stabilize soil and the method should be verified in the lab with the soil material before applying it on the field.

3.2 METHODS OF SOIL STABILIZATION

- Mechanical Stabilization.
- Soil Cement Stabilization.
- Soil Lime Stabilization.
- Soil Bitumen Stabilization.
- Thermal Stabilization.
- Chemical Stabilization.

III. METHODOLOGY

MATERIALS USED AND THEIR PROPERTIES

3.1 Marine clay

Marine clay is a type of clay found in coastal regions around the world. In the northern, deglaciated regions, it can sometimes be quick clay, which is notorious for being involved in landslides. Clay particles can self-assemble into various configurations, each with totally different properties.

When clay is deposited in the ocean, the presence of excess ions in seawater causes a loose, open structure of the clay particles to form, a process known as flocculation. Once stranded and dried by ancient changing ocean levels, this open framework means that such clay is open to water infiltration. Construction in marine clays thus presents a geotechnical engineering challenge.

The marine clay used in this study and was typical soft clay. The marine clay was collected at a depth of 0.30m to 1.00m from ground level from YETIMOGA area, Kakinada, Andhra Pradesh State, India. The properties of soil are presented in the Table 3.1. All the tests carried on the soil are as per IS specifications.

TABLE 3.1 Properties of Marine clay

S. No.	Property	Value
1	Specific gravity	2.61
2	Differential free swell Index (%)	33
3	Atterberg's Limits	
	i) Liquid limit (%)	72.2
	ii) Plastic limit (%)	25.1
	iii) Plasticity index (%)	47.1
5	Grain Size Distribution	
	i) Sand Size Particles (%)	10
	ii) Silt &ClaySize Particles (%)	90
6	IS soil classification	CH
7	Compaction Parameters	
	i) Max. Dry Density (g/cc)	1.36
	ii) Optimum Moisture Content (%)	29.5
8	Penetration Parameters	
	ii) CBR - Soaked (%)	1.5
	i) CBR - Unsoaked (%)	3.2
9	Shear Parameters at OMC & MDD	
	i) Cohesion, Cu (kPa)	37
	ii) Angle of Internal Friction, Øu (Degrees)	0

3.2 JUTE

Jute is a long, soft, shiny vegetable fiber that can be spun into coarse, strong threads. It is produced from plants in the genus Corchorus, which was once classified with the family Tiliaceae more recently with Malvaceae, and has now been reclassified as belonging to the family Sparnnanniaceae. The primary source of the fibre is Corchorusolitorius, but it is considered inferior to Corchoruscapsularis. "Jute" is the name of the plant or fiber that is used to make burlap, Hessian or gunny cloth.

Jute is one of the most affordable natural fibers and is second only to cotton in amount produced and variety of uses of vegetable fibers. Jute fibers are composed primarily of the plant materials cellulose and lignin. It falls into the bast fiber category (fiber collected from bast, the phloem of the plant, sometimes called the "skin") along with kenaf, industrial hemp, fiax (linen), ramie, etc. The industrial lerin ior jute fiber is raw jute. The fibers are off-white to brown, and 1-4 metres (3-13 feet) long. Jute is also called "the golden fiber" for its color and high cash value.

Jute Fibres have been purchased from the market. The Fibres are cut into pieces of approximately 20mm lengths and are mixed in percentage of 0.5%, 1%, 1.5% and 2% by dry weight of soil.

3.2 GYPSUM

Gypsum is a mineral which has properties that have long been familiar to man. The property of gypsum rock which enables it, after losing its water of crystallization through heating. to recombine with water to set into its original hard, rock-like state has increased its usefulness. Its widespread occurrence in nature has directed much attention towards its use for many industries. Historically, gypsum was first applied in ancient Ethiopia as a preserving material for the dead. Ancient Egyptians utilized gypsum in the construction of their pyramids. Later years saw France, Portugal, Greece, and Spain use gypsum to treat wine which made it ripen earlier. And so the use of gypsum in the early days became well known. Today, gypsum is quarried and produced commerically in many countries.

IV. LABORATORY EXPERIMENTATION

The soil was initially air dried prior to the testing. The tests were conducted in the laboratory on the marine clay to find the properties of virgin marine clay.

- Grain size distribution
- Specific gravity
- Index properties –liquid limit, plastic limit

- Compaction tests
- Penetration tests-California bearing ratio test.
- Unconfined Compression Test-Tri axial

V. RESULTS AND DISCUSSIONS

5.1GENERAL

In the laboratory, various experiments were conducted by replacing different percentages of Jute fiber (JF) in the Weak marine Soil and also further stabilizing it with Gypsum as a binder. Liquid Limit, Plastic Limit and Compaction, CBR and Triaxial shear tests were conducted with a view to determine the optimum combination of Jute fiber (JF) as replacement in weak marine soil and Gypsum as a binder. The influence of the above said materials on the Index, Compaction and Strength properties were discussed in following sections. In the laboratory, all the tests were conducted per IS codes of practice

5.2 EFFECT OF % JUTE FIBER (JF) AS REPLACEMENT ON THE PROPERTIES OF WEAK MARINE SOIL

The individual influence of Jute fiber (JF) on the Index, Compaction and Strength properties of marine soil are clearly presented. The percentage of Jute fiber (JF) was varied from 0%, to 20% with an increment of 5%. From the above graphs, it was observed that the treatment as individually with 15% JF has moderately improved the marine soil. It can be inferred from the graphs, that there is a gradual improvement in the Plasticity index with an increment in % replacement of JF up to 20% with an improvement of about 12%. Also maximum dry density is improved by an amount of 2% and it was about 34% for cohesion and 34%, 66% for UnSoaked, Soaked respectively. Cohesion is increased from 00 – 20 for the increment of JF in marine soil from 0-20%.

4.4 EFFECT OF GYPSUM CONTENT ON THE PROPERTIES OF WEAK MARINE SOIL + JUTE FIBER (JF) MIXES

The influence of Gypsum as binder on the Index, Compaction and Strength characteristics of weak marine Soil + Jute fiber (JF) mixes are clearly presented .For different percentages of Gypsum respectively. The percentage of Gypsum was varied from 0%, to 9% with an increment of 3%. In the laboratory, tests were conducted by blending different percentages of Gypsum to Weak Marine Soil + Jute fiber (JF) mixes with a view to determine its optimum blend. It is observed from the graphs, that there is an improvement in plasticity & Strength characteristics with an increase in the Gypsum content from 0% to 9% with an improvement of 90% for plasticity, 10% for MDD, 134% for cohesion and 120%, 644% for Unsoaked, Soaked respectively for an optimum of 6% gypsum. Also there is an improvement in Angle of internal friction by 7 times. From the above results it is evident that the addition of Gypsum to the JF– Weak Marine Soil mix had improved its characteristics.

Finally from the above discussions, it is clear that there is improvement in the behaviour of Weak Marine soil stabilized with Jute fiber (JF) + Gypsum. It is evident that the addition of Jute fiber (JF) to the virgin Marine soil showed an improvement in plasticity, compaction and strength properties to some extent and on further blending it with Gypsum, the improvement was more pronounced. This made the problematic weak marine soil which if not stabilized is a discarded material, a useful fill material with better properties. The Jute fiber (JF) replacement in the weak marine soil has reduced the plastic nature of the clay and upon further blending with Gypsum, the plasticity was even reduced. It can be summarized that the materials Jute fiber (JF) and Gypsum had shown promising influence on the properties of marine soil, thereby giving a two-fold advantage in improving problematic marine soil and also solving a problem of waste disposal.

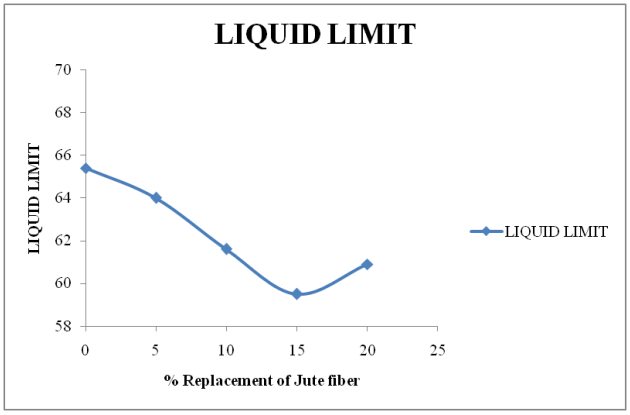

Fig. 5.1 Plot showing the variation of Liquid Limit with % of JF as replacement of Marine Soil for 6% Gypsum content.

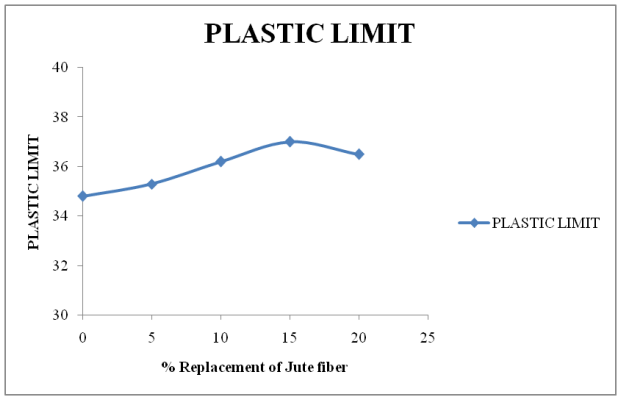

Fig.5.2 Plot showing the variation of Plastic Limit with % of JF as replacement of Marine Soil for 6% Gypsum content.

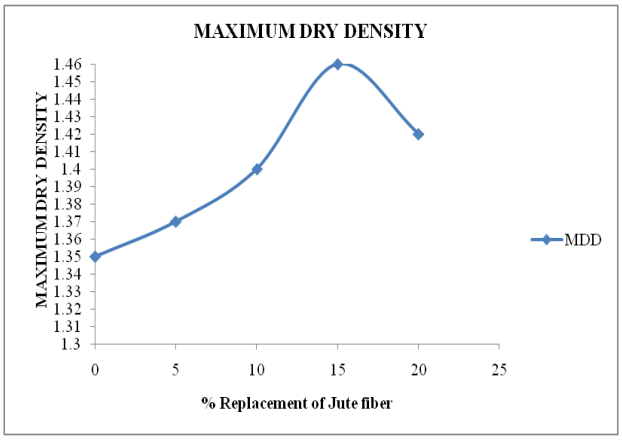

Fig.5.3 Plot showing the variation of Maximum Dry Density with % of JF as replacement of Marine Soil for 6% Gypsum content.

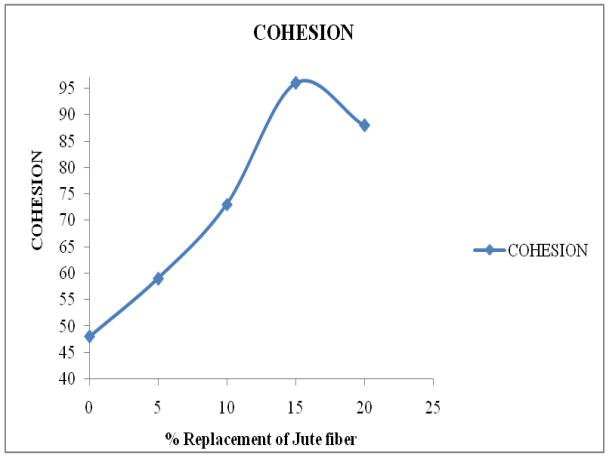

Fig. 5.4 Plot showing the variation of Cohesion with % of JF as replacement of Marine Soil for 6% Gypsum content.

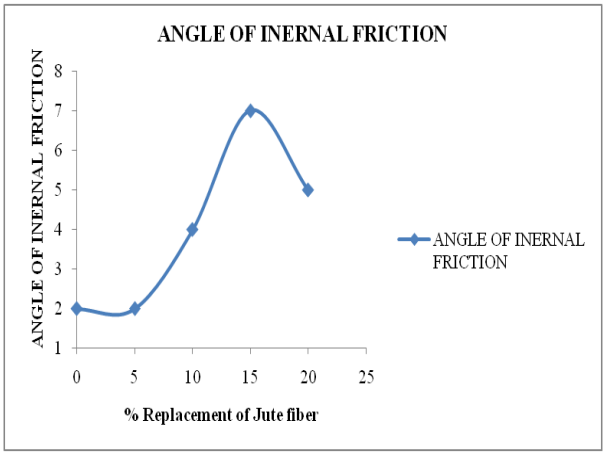

Fig. 5.5 Plot showing the variation of Angle of Internal Friction with % of JF as replacement of Marine Soil for 6% Gypsum content.

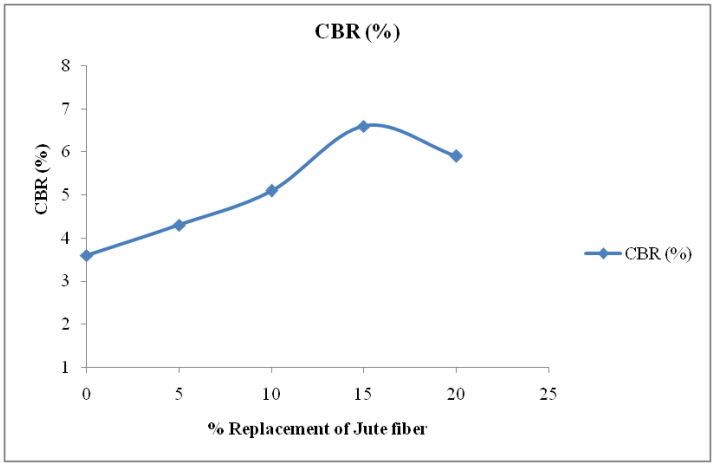

Fig. 5.6 Plot showing the variation of UnSoaked with % of JF as replacement of Marine Soil for 6% Gypsum content.

VI. CONCLUSIONS

The following conclusions are made based on the laboratory experiments carried out in this investigation.

- From the laboratory studies, it is observed that the Marine Soil chosen was a problematic soil having high swelling, and high plasticity characteristics.
- It was observed that the treatment as individually with 15% of JF and 6% gypsum has moderately improved the marine soil.
- There is a gradual increase in maximum dry density with an increment in the % replacement of JF up to 15% with an improvement of about 2% and it was about 12% for plasticity characteristics.
- There is an improvement in CBR, Shear parameters also by an amount of 34% for cohesion and 34% for UnSoaked. Cohesion is increased from 00 – 20.
- There is an improvement in plasticity & Strength characteristics with an increase in the Gypsum content from 0% to 9% with an improvement of 90% for plasticity, 10% for MDD.
- There is an improvement by an amount of 134% for cohesion and 120%, 644% for Unsoaked, Soaked respectively. Cohesion is increased from 00 – 70.
- It is evident that the addition of Jute fiber (JF) to the virgin Marine soil showed an improvement in properties to some extent and on further blending it with Gypsum, the improvement was more pronounced.
- Finally it can be summarized that the materials Jute fiber (JF) and Gypsum had shown promising influence on the properties of Weak Marine soil, thereby giving a

two-fold advantage in improving problematic expansive soil and also solving a problem of waste disposal.

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