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Study on Developing Engineering Properties of Marine Clay by Using Tile Waste and Polyster Fibre

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Abstract

Subgrade soil stabilization is one of the primary and major processes in the construction of any highway; also environmental authorities are concerned about the growing amount of polyethylene (PET) bottles produced by household sectors. Presence of poor sub grade conditions and expansive sub grade is one such problematic situation. Marine soils, because of the specific physico-chemical makeup are subjected to volume changes with changes in their ambient environment. This research is intended to study on properties of marine clay with waste tile powder and reinforcing with polyster fibre. Especially shear strength and California Bearing Ratio (CBR). polyester fibers were mixed with soil in three different percentages 2.5%, 5% & 7.5% and combination with ceramic tile powder mixed with soil in three different percentages 5%, 7.5% & 10%. The shear strength, CBR, atterberg limits of treated samples were measured by direct shear test and CBR test and atterberg limits test. Experiments results show this fact that using of polyester and tile powder leads to increasing shear strength and CBR and reduction, plasticity index.

I. INTRODUCTION

Mainly in poor countries the economies in the construction lead to the development of the country. At the same time the durability aspect should also be kept in mind. Need to strengthen the rural economy by providing all weather resistant roads have been emphasized. In countries like India the biggest handicap is to provide a complete

network of road system with the limited finances available to build road by the conventional methods. Therefore there is a need to resort to one of the suitable method of low cost road construction. The construction cost can be considerably, decreased by local material including local soils for the construction of the layers of the pavement such as the sub-base coarse.

Regarding the strength of clay soils air drying in a humid environment produces a hard and strong mass. In the extreme, banking at elevated temperatures converts clay to brick. For most practical purposes the strength of the soil is less important than its resistance to deformation under load. Not all low strengths are associated with increased moisture content. Therefore under traffic loads, an excessively dry soil will became cohesion less and so loses strength.

If the requirements of these soils are not sufficient, then either the soils are to be totally replaced by a better one or modify the properties as required. The former is very costly and generally the later is preferred. To change or modify the soil properties by some means to suit the requirements is known as" STABILIZATION".

II. OBJECTIVES OF THE STUDY

The objectives of the present experimental study are

- To determine the properties of marine clay.
- To evaluate the performance of marine clay when stabilization with polyester fiber and waste tile powder.
- To evaluate the performance of the stabilized marine clay with an optimum of polyester fiber and waste tile powder.

III. MATERIAL USED:

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.

The soil in this study is marine clay, obtained from korangi area, collected at a depth of 1.5 m from ground level.

The index & engineering properties of marine soil are determined as per is code of practice and determined present in table.

Marine Clay

Properties of Marine clay

S.NO	Property	Value
1	Differential free swell	70%
1	Grain size distribution (%) Gravel Sand Silt Clay	 0% 14% 30% 56%
2	Specific gravity	2.38
3	Consistency limit (%) Liquid limit Plastic limit Plasticity index	 74% 27% 42%
4	IS Soil classification	CH
5	Maximum dry density(g/cc)	1.27 gm/cc
6	Optimum moisture content (%)	36%
7	California bearing ratio (%)	1.754%
8	Unconfined compressive strength(KN/m^2)	98

4.1.1 Sub grade Soil:

Soil is a gathering or deposit of earth material, derived naturally from the breakdown of Rocks or decay of undergrowth that can be excavated readily with power.

4.1.2 Desirable Property of Sub grade Soil:

Without interruption soil beneath the pavement is called natural sub grade. Compacted sub grade the supporting soil below pavement and its special under course is called sub grade is the soil compacted by inhibited movement of heavy compactors. The advantageous properties of sub grade soil as a highway material are

- Incompressibility
- Stability
- Ease of compaction
- Permanent strength
- Superior drainage, and
- Minimum changes in volume and stability under adverse conditions.

Typical presumptive CBR values

DESCRIPTION OF SOIL SUBGRADE	IS SOIL CLASSIFICATION	TYPICAL SOAKED CBR VALUE IN (%)
Highly plastic clays	CH, MH	2-3
Silty clays and sandy Clays	ML, MI ,CL, CI	4-5
Clayey sands and Silty sands	SC, SM	6-10

Typical presumptive CBR values

CBR VALUE	SUBGRADE STRENGTH
3% or less	Poor
3% - 5%	Normal
5% - 15%	Good

3.2. POLYESTER FIBER:

A manufactured fiber in which the fiber forming substance is any long-chain synthetic polymer composed of at least 85% by weight of an ester of a substituted aromatic carboxylic acid, including but not restricted to substituted terephthalic units, p(-R-O-CO- C6H4-CO-O)x and par substituted hydroxyl-benzoate units, p(-R-O-CO-C6H4-O-)x .Polyester fiber is obtained from Kakinada reliance industry.

Polyester Fiber

3.2.1 Characteristics of Polyester Fiber

1. Strong
2. Resistant to stretching and shrinking
3. Resistant to most chemicals
4. Quick drying
5. Crisp and resilient when wet or dry
6. Wrinkle resistant
7. Mildew resistant
8. Abrasion resistant
9. Retains heat-set pleats and crease
10. Easily washed

3.3. WASTE TILE POWDER:

The tile dust is obtained from RAK ceramics. The specific gravity of tile dust is found to be 2.62 and the fineness is found to be 7.5%. Tile powder is one of the most active research areas that encompass a number of disciplines including civil engineering and construction materials. The tile industry inevitably produces wastes, irrespective of the improvements introduced in manufacturing processes. In the tile industry, about 15%-30% production goes as waste. This waste creates a problem in present-day

society, requiring a suitable form of management in order to achieve sustainable development.

Waste tile Powder

Properties of tile powder

Oxides	Wt. (%)
SiO_2	67.35
Al_2O_3	19.79
Fe_2O_3	2.52
Na_2O	0.15
K_2O	4.13
TiO_2	0.92
MgO	2.00
CaO	2.32

IV. EXPERIMENTAL PROGRAM

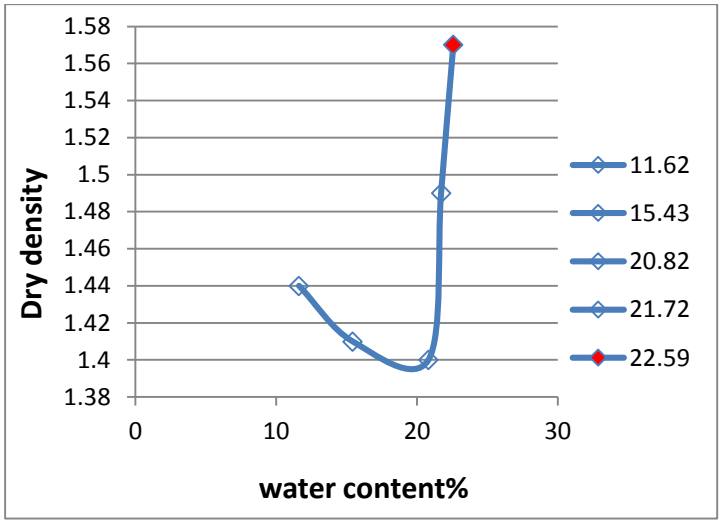
4.1 ATTERBERG LIMITS

PROPORTION	***PLASTIC LIMIT***	***LIQUID LIMIT***	***PLASICITY INDEX***
2.5%, 5.0% of PF & WTP	*17.45%*	*72.00%*	*54.55*
5.0%, 7.5%of PF & WTP	*22.85%*	*70.00%*	*47.15*
7.5%, 10%of PF & WTP	*21.81%*	*69.00%*	*47.19*

4.2 COMPACTION

4.2.1 STANDARD PROCTOR TEST:

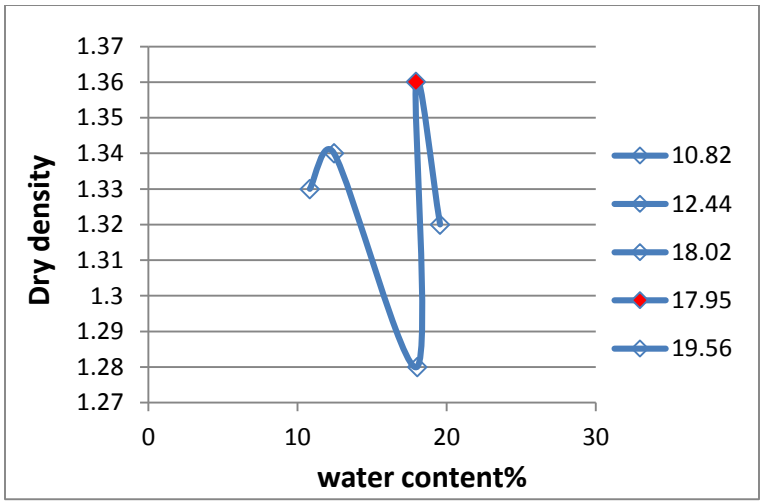
92.5% SOIL+2.5% polyester fiber+ 5% waste tile powder:



Compaction of Standard proctor Curve of2.5%, 5% of PF&WTP

Result: Maximum dry density =**1.57g/cc**

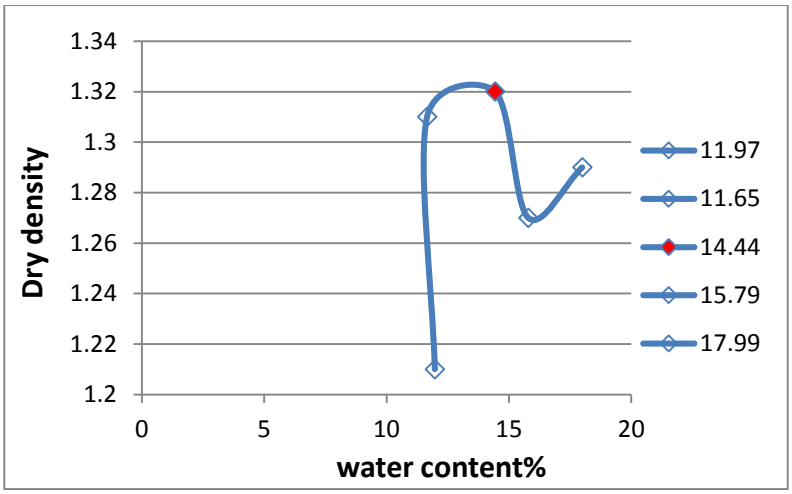
87.5% SOIL+5% polyester fiber+7.5% waste tile powder:



Compaction of Standard proctor curve of5%, 7.5%of PF&WTP

Result: Maximum dry density =**1.36g/cc**

82.5% SOIL+7.5%polyester fiber+10%waste tile powder:

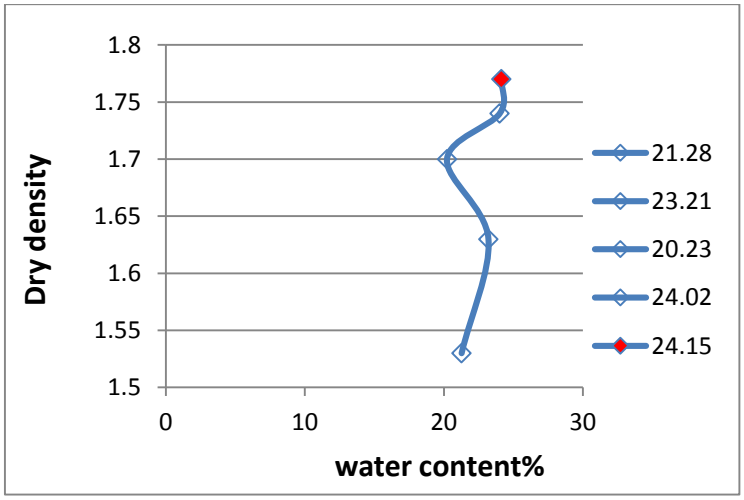


Compaction of Standard proctor curve of7.5%, 10%of PF&WTP

Result: Maximum dry density =**1.32g/cc**

4.2.2 MODIFIED PROCTOR TEST:

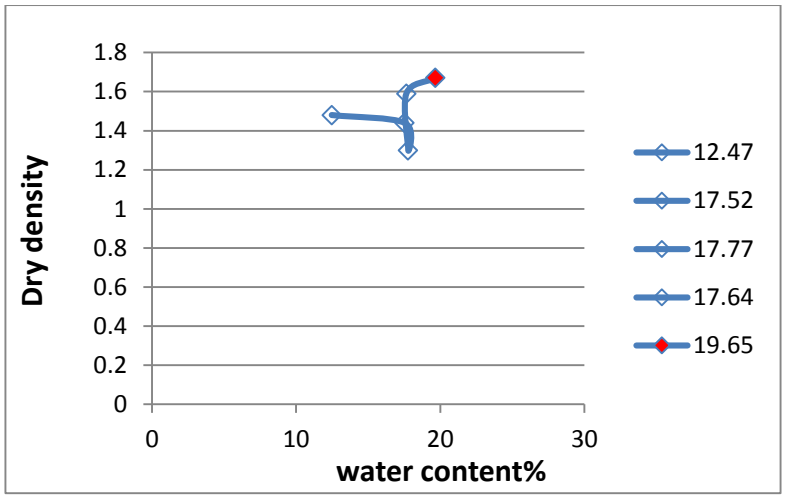
92.5% SOIL+2.5% polyester fiber+5%waste tile powder:



Compaction of Modified proctor curve of2.5%, 5% of PF&WTP

Result: Maximum dry density =**1.77g/cc**

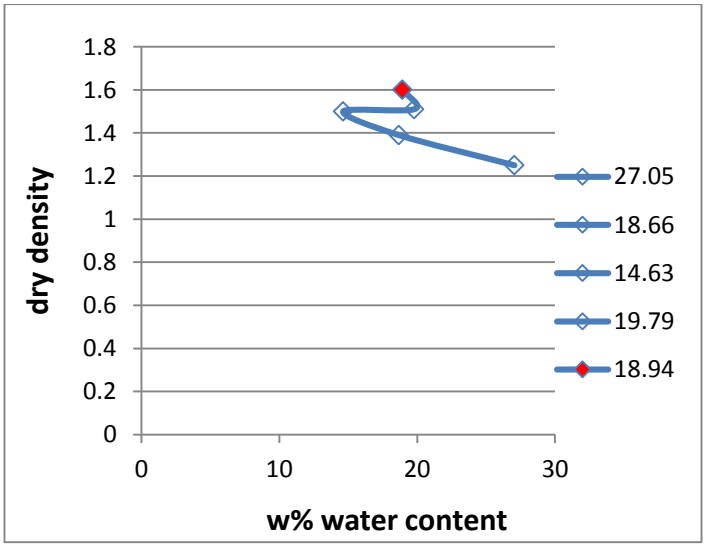
87.5% SOIL+5% polyester fiber+7.5%waste tile powder:



Compaction of Modified proctor curve of5%, 7.5%of PF&WTP

Result: Maximum dry density =**1.67g/cc**

82.5% SOIL+7.5%polyester fiber+10%waste tile powder:



Compaction of Modified proctor curve of7.5%, 10%of PF&WTP

Result: Maximum dry density =**1.60 g/cc**

4.3. CALIFORNIA BEARING RATIO TEST:

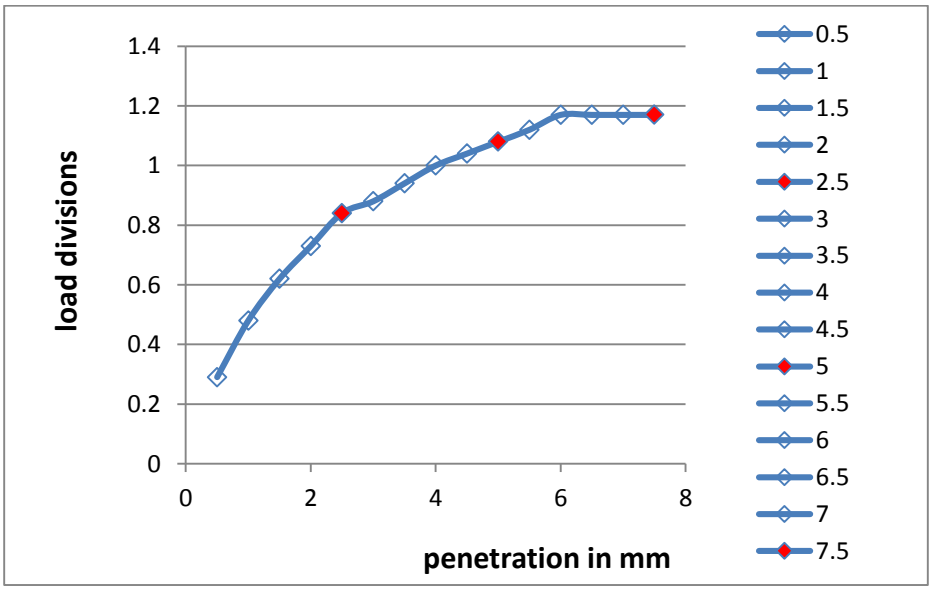
California bearing ratio (CBR) test is developed by the California division of highways in 1929.

The test is used for evaluating the stability of sub-grade and materials used in sub grade &base courses.

The CBR curves for different mix proportion of SOIL, polyester fiber and waste tile powder (0%, 2.5%, 5%, 7.5%of polyester fiber and 5%, 7.5%, 10% of waste tile powder) are shown in fig 4.06 to4.1. For unsoaked. The Optimum mix is obtained from the graphs. As a CBR value is an indication to the strength of the soil sample.

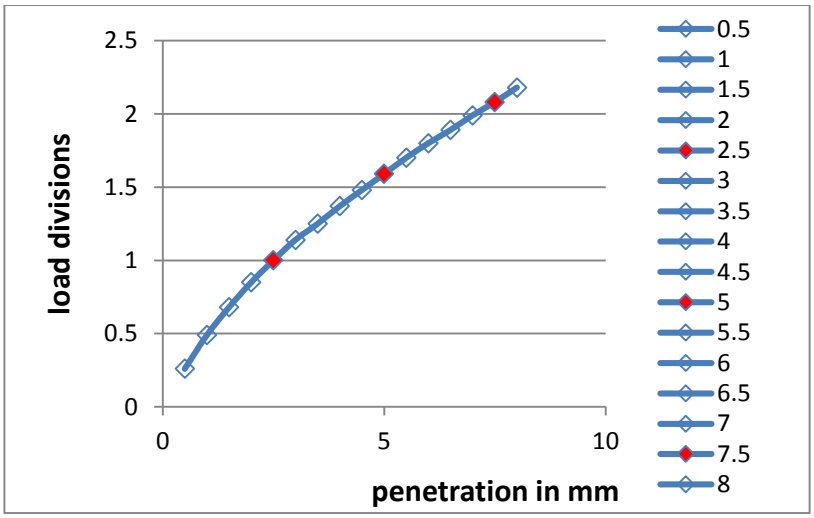
PROPORTION	CBR @PENETRATION	RESULT
2.5%, 5% of PF&WTP:	CBR at 2.5mm	6.25%
	CBR at 5mm	5.35%
	CBR at 7.5mm	4.53%
5%,7.5%,of PF&WTP	CBR at 2.5mm	7.44%
	CBR at 5mm	7.88%
	CBR at 7.5mm	8.06%

CBR of Marine clay with 2.5%, 5% of PF&WTP



Penetration Vs Load divisions for Marine Clay&2.5% 5%PF&WTP

CBR of Marine clay with5%, 7.5%, of PF&WTP



Penetration Vs Load divisions for Marine Clay&5%, 7.5%, PF&WTP

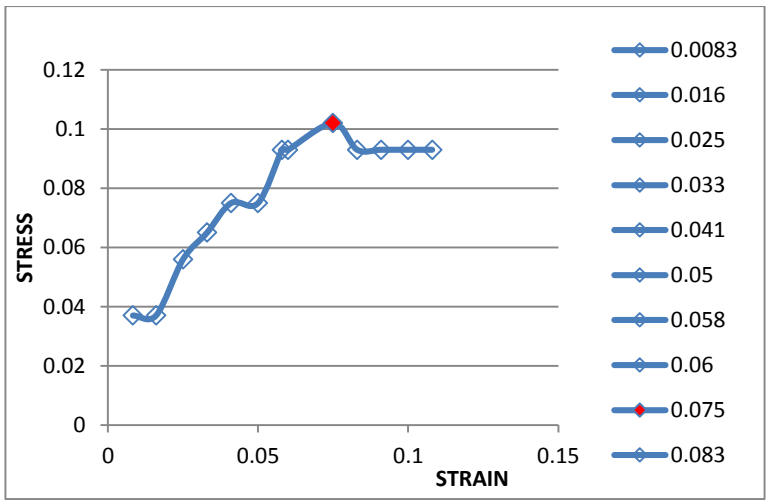
4.4. DIRECT SHEAR TEST

Shear strength of the soil is its maximum resistance to shearing stresses. The shear strength is express as

$$S = C' + \sigma' TAN\emptyset$$

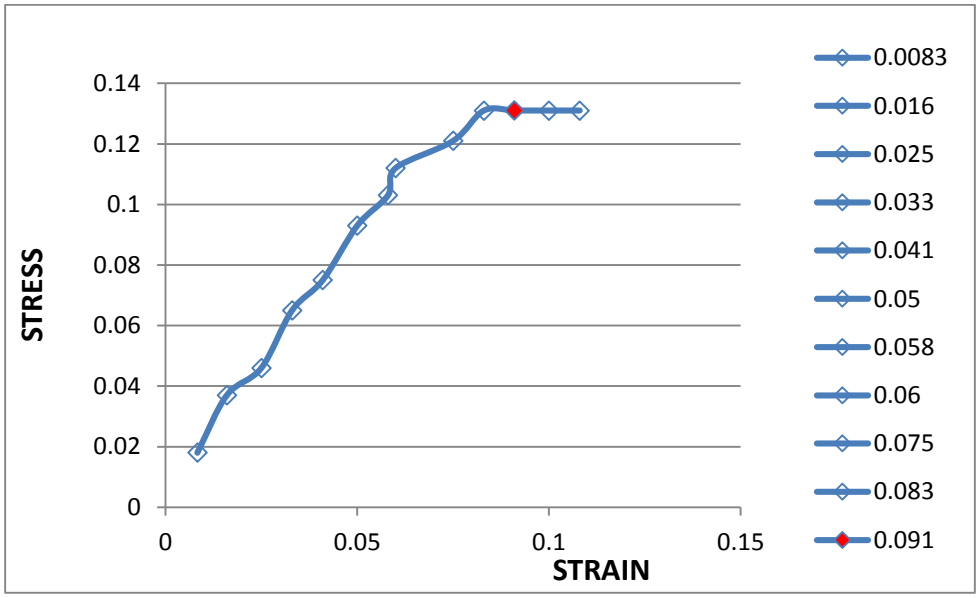
DIRECT SHEAR TEST FOR MARINE CLAY&2.5%, 5%PF&WTP

Cell pressure at 0.5kg/cm2



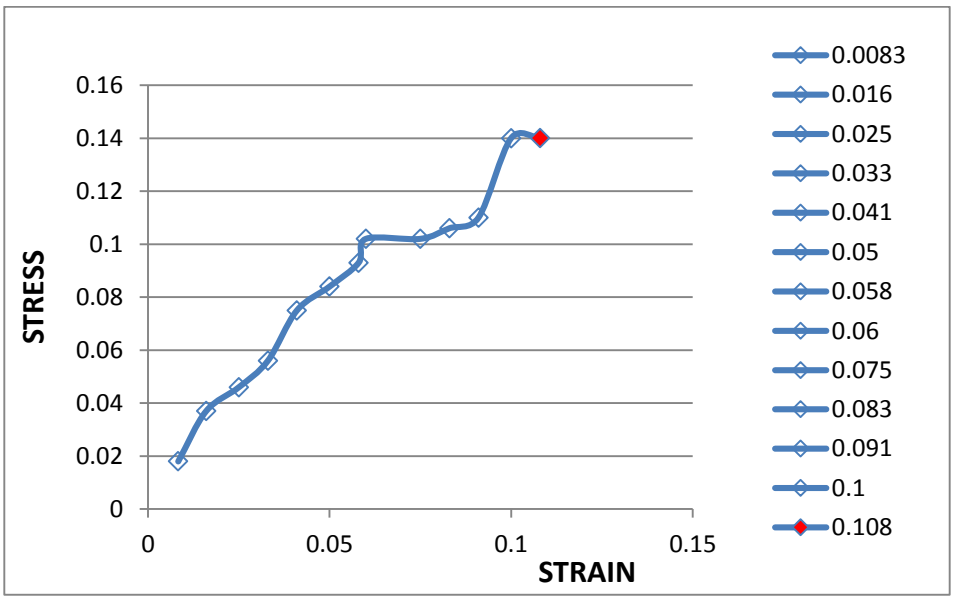
Shearing stress Vs strain for 2.5%, 5% PF&WTP

Cell pressure at 1.0 kg/cm2



Shearing stress V_s strain for 2.5%, 5% PF&WTP

Cell pressure at 1.5kg/cm2



Shearing stress V_s strain for 2.5%, 5% PF&WTP

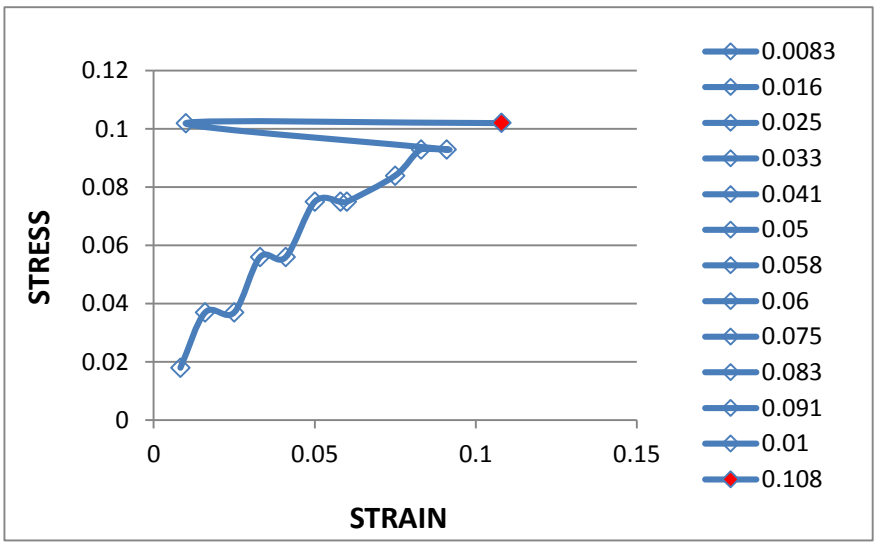
RESULT:

Cohesion C=**0.06**

Angle of Shearing stressØ = **54°**

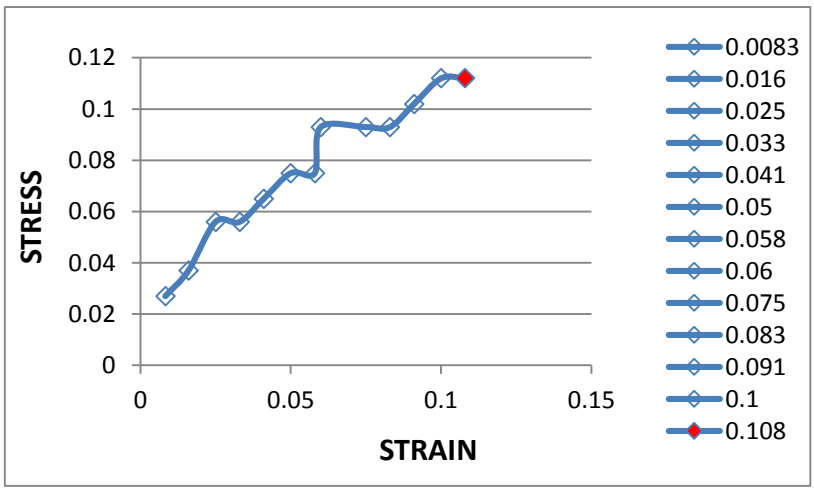
DIRECT SHEAR TEST FOR MARINE CLAY & 5%, 7.5%PF&WTP

Cell pressure at 0.5kg/cm2



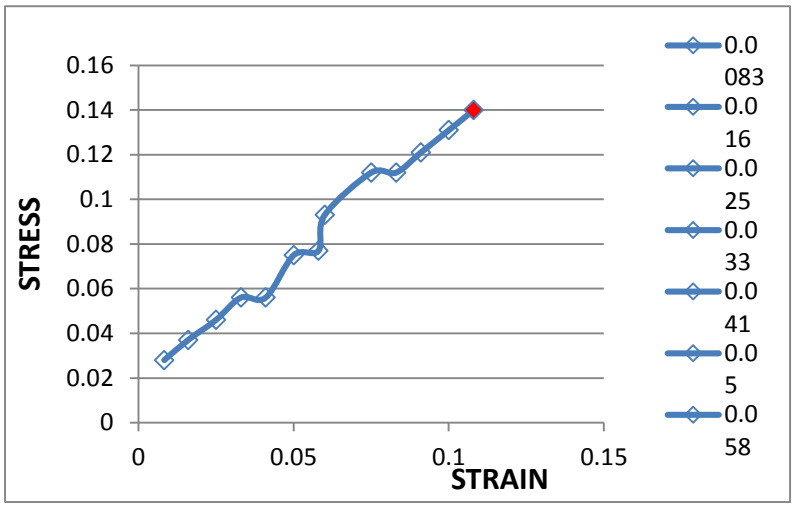
Shearing stress V_s strain for 5%, 7.5% PF&WTP

Cell pressure at 1.0 kg/cm2



Shearing stress V_s strain for 5%, 7.5% PF&WTP

Cell pressure at 1.5kg/cm2



Shearing stress V_s strain for 5%, 7.5% PF&WTP

RESULT:
Cohesion C=**0**
Angle of Shearing stressØ =**57.5°**

V. CONCLUSIONS

The following conclusions are drawn based on laboratory results to study the use of polyester fiber and waste tile powder as an admixture for the sub grades in expansive soils.

- Free swell index is **45%** (High expensive clay)
- The liquid limit of marine clay increased considerably with addition of polyester fiber and waste tile powder up to**2.5%, 5%** then it will decreased.
- The Plastic limit of marine clay increased considerably with addition of polyester fiber and waste tile powder up to**2.5%,5%** then it will decreased
- As increase in OMC and MDD is observed and this variation is moderate incase of soil and polyester fiber and waste tile powder.
- When soil is mixed with various percentages of polyester fiber and waste tile powder and optimum value is noticed at**2.5%, 5%**polyester fiber and waste tile powder.
- The optimum values of unsoaked CBR are obtained at **2.5%, 5%** polyester fiber and waste tile powder.

- The CBR value is increased from **6.10%to 6.25%.**When the polyester fiber and waste tile powder is added then the changes from poor condition to normal condition
- The direct shear test also increased for cohesion value from 0.05 to0.06 and shearing angle ∅ from 52.5° to 54°When the polyester fiber and waste tile powder is added then the changes from poor condition to normal condition.

VI. FURTHER SCOPE OF WORK

The following areas are identified as those having scope for further research

1. Similar work can be done using other additives and also admixtures to arrive the optimum combination used in construction of pavements on black cotton soil sub grades.
2. The reinforcement technique can be adopted for higher load carrying capacity of the pavement sub grades.
3. The technique can also be done with a combination of chemical like potassium chloride, ferric chloride etc.,

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