IMPROVING ENGINEERING PROPERTIES OF MARINE CLAY USING TYRE CHIPS

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Abstract: Clay is a very important material in geotechnical engineering, because it is often observed in geotechnical engineering practice. Generally, this soil type has numerous problems due to its low strength, high compressibility and high level of volumetric changes. Clay needs to be improved before it can be used in road construction, dams, slurry walls, airports and waste landfills. Improved gradation, a reduction in plasticity and swelling potential, as well as an increase in strength and workability, generally improve the stability of clay. The paper aims at assessing the impact of waste rubber inclusion on the geotechnical properties of clayey soil (Marine clay). The Scrap tires are abundant and alarming waste. The aggregates resulting from the crushing of the waste tires are more and more used in the field of civil engineering. Discarded Tyre waste in the form of crumb rubber of size ranging between 0.8 and 2 mm varying from 0 to 10% was used in this investigation.

Keywords: Low strength, high compressibility, volumetric changes, waste rubber inclusion, Improved gradation, increased strength.

1. INTRODUCTION

Soil plays an important role as a construction material, especially as the basic foundation. Soil at a construction site may not always be totally suitable for supporting structures in its natural state. In such a case, the soil needs to be improved to increase its bearing capacity and decrease the expected settlement.

Existence of unsuitable soil for supporting structures in construction sites, lack of space and economic motivation are primary main reasons for using soil improvement techniques with poor subgrade soil conditions rather than deep foundation. Several methods are commonly used to reduce the post construction settlement, enhance the shear strength of the soil system, increase the bearing capacity of the soil, and improve the stability of dams and embankments.

In this present study, an array of laboratory experiments tests were conducted on marine clay soil samples with various proportions of tyre chips. The findings of this experimental investigation were analyzed and discussed for better understanding of the impacts of tyre chips on the engineering characteristics of marine clay soils.

2. MATERIALS USED

2.1 SOIL: Marine clay is a type of clay found in the coastal regions around the world. The soil used for this investigation is taken from coastal region in Ernakulum city , Kerala.

Classification of Soil Depending on the Index Properties:

Properties of soil sample	Values of the different properties
Natural moisture content	68.5%
Liquid limit	128.5%
Plastic limit	42.9%
Specific gravity	2.56
Free swell index	30.76%
Soil type as peris:1498	CH

2.2. STABILIZING MATERIAL:

For this investigation, soil improvement is carried out by addition of water tyre material at various proportions.

3. METHODOLOGY

Laboratory investigations were conducted on the soil without any admixtures and with admixtures with maintaining optimum moisture content of soil. Discarded Tyre waste in the form of crumb rubber of size ranging between 0.8 and 2 mm varying from 0 to 10% was used in this investigation.

4. EXPERIMENTAL INVESTIGATIONS AND RESULTS

4.1. CONSOLIDATION TEST: The test is conducted to determine the settlement due to primary consolidation. The test is conducted as per IS 2720 -15(1986) to determine the following:

1. Rate of consolidation under normal load.
2. Degree of consolidation at any time.
3. Pressure-void ratio relationship.
4. Coefficient of consolidation at various pressures.
5. Compression index.

Datas required:

Dia of sample (mm)	60
Height of sample (mm)	20
Volume of sample (cc)	56.55
Weight of dry soil added (g)	52.6
Dry density of sample (g/cc)	0.93
Dry density of sample (kN/m^3)	9.13
Area of the specimen (mm2)	2827.35
Least count of dial gauge	0.002
Seating pressure	5kpa
Specific gravity	2.56
Initial voids ratio (e-initial)	1.75
Height of solids (Hs) (mm)	7.270
Final height of sample (H) (mm)	20.06
Swell voids ratio (e-swell)	1.76

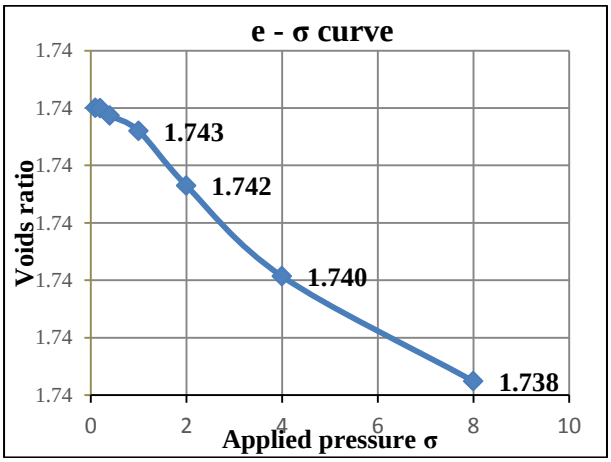

Fig. 1 e - σ curve

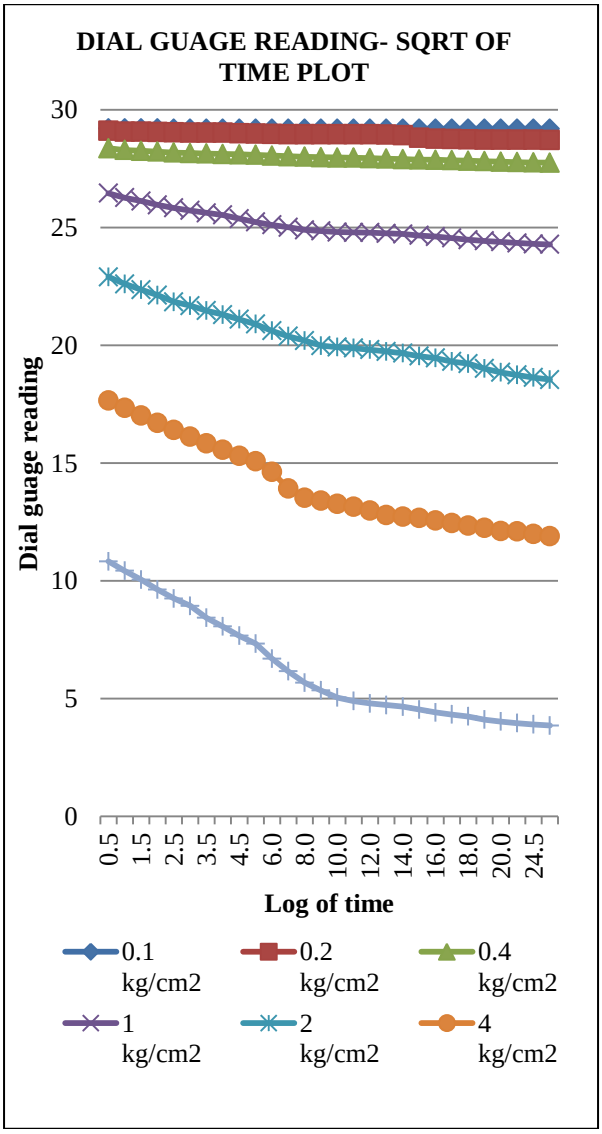

Fig. 2 Dial guage reading- sqrt of time plot

Calculation of coefficient of compressibility and volume change:

1. **Coefficient of compressibility:**
   $a_v = -de/d\sigma$
   = - (1.738 - 1.74) / (8-4)
   The Coefficient of compressibility of the soil taken is **5 x 10^{-4} cm^2/kgf**.

2. **Coefficient of volume change:**
   $m_v = - [\Delta e/(1 + e_o)] / \Delta\sigma$
   (or) $m_v = a_v/(1 + e_o)$
   m_v =5 x 10^{-4}/ (1 + 1.743)

The Coefficient of volume change of the soil taken is **1.82 x 10^{-4} cm^2/kgf**.

4.2. COMPACTION TEST: The major aim of compaction of soil is to increase shear strength, decrease compressibility, to reduce permeability & control swelling and shrinkage of soil. It is measured in terms of its dry density. The maximum dry density of soil occurs at optimum moisture content (OMC). The test is conducted as per IS 2720-8(1983).

Determination of density	12%	15%	18%	21%	24%
Wt of mould	3642	3642	3642	3642	3642
Wt of mould+ compacted soil	5341	5466	5539	5573	5534
Wt of compacted soil	1699	1824	1897	1931	1892
Volume	1000	1000	1000	1000	1000
Bulk density (W/V) (g/cc)	1.699	1.824	1.897	1.931	1.892

Table 1. Bulk density of soil at various % of water content

Water content %	Dry density
12.17	1.515
15.3	1.582
18.8	1.596
22.3	1.579
26.3	1.498
Optimum moisture content (OMC)	**18.5%**
Maximum dry density (MDD)	**1.596**

Table 2. Dry density of soil sample at various % of water content

4.3 CBR TEST: The California bearing ratio is conducted for evaluating the suitability of the sub-grade and the materials used in sub-base of a flexible pavement. The experiment is conducted as per IS 2720-16(1987).

% Of Tyre Chips	Penetration (mm)	Test Load (kgf)	CBR Value
2.5%	2.5	3.0	1.77
	5.0	5.0	1.96
5.0%	2.5	5.0	**2.95**
	5.0	7.0	**2.75**
7.5%	2.5	1.5	0.88
	5.0	2	0.787
10.0%	2.5	0.5	0.295
	5.0	1	0.393

Table 3. CBR value

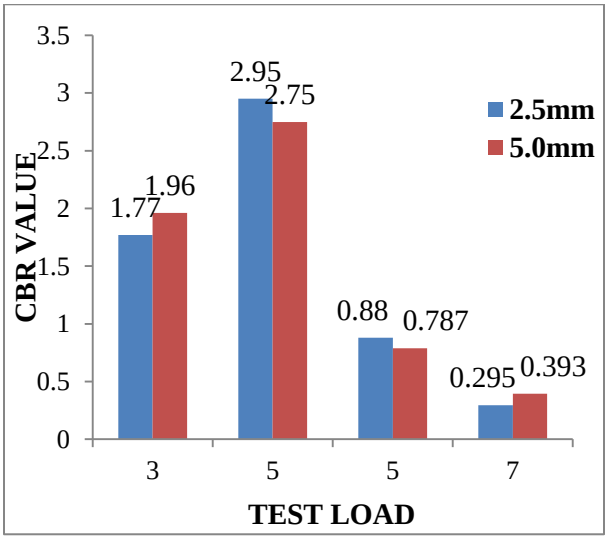

Fig. 3 Graph showing CBR value at 2.0mm and 5.0mm penetration.

5. CONCLUSION

The Marine clay is tested with addition of waste tyre chips at different proportions. Initially the soil is tested without any addition of admixtures the California bearing capacity is found out to be 1.18. In order to increase the bearing capacity, the tyre waste is added with soil sample at different proportions. It has been found that the California Bearing Ratio is increased when 5% of tyre chips at an optimum moisture content of 18.5% is added to the soil sample.

6. REFERENCES

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