

A Comparative Study on the Effects of Different Waste Materials on Weak Soil for Better Pavement Subgrade

Alina Marcus¹, Fathima Sakeer², Sarath.T.P³, Sheela .J. George ⁴, Dr. Solly George⁵

^{1, 2, 3, 4} Under – Graduate Students,

⁵ Professor

^{1, 2, 3, 4, 5} Department of Civil Engineering, Mar Athanasious College of Engineering, Kothamangalam, Kerala, India

Abstract-Civilization has always developed around the coastal region. These are covered with thick soft marine clay deposits. This clay has only less strength and possesses high deformation, low permeability and limited bearing capacity. Due to the poor engineering properties and characteristics of these clays, they possess several foundation problems to various coastal structures and pavement sub-grade problems. Mixing of glass powder, plastic strips and quarry dust with this weak soil helps to enhance the desired properties of marine clay. Thus materials which were considered as a curse to the environment have turned out to be boon to the civil engineering community.

Key words: CBR, permeability, aspect ratio (AR), marine clay, Glass powder, plastic strips, ferric chloride, quarry dust.

I. INTRODUCTION

With an increase in population the availability of land for construction activities are reduced. So engineers are forced to construct on a given site with given soil conditions like that of marine clay. This is same in case of pavement construction also. With existing environmental regulations, protest from people and other land acquisition problems it is not possible to get suitable site with required soil properties for road construction. So it is necessary to reinforce the available weak soil stratum to get the required strength and other properties.

The objectives of the research include:

- 1) To compare the effectiveness of various additives on marine clay.
- 2) To find a method to improve the strength of marine clay.
- 3) Use of waste materials effectively as soil stabilizer.

1.1 Literature Review

Dr. D SV Prasad(2015) explained the strength behavior of marine clay treated with rice husk ash. The clay was mixed with rice husk ash waste from 0-25% at an increment of 5%.From the analysis of test result it was obtained that, specific gravity decreases, liquid limit and plastic limit increases, compaction parameters such as

maximum dry density and OMC values were increased and CBR values was increased up to the addition of 20% rice husk and beyond that there was no visible effect.

I Olufowobi(2014) studied the stabilization of clay soil using powdered glass with 15% cement. The maximum value for CBR was obtained with 5% glass powder addition. But maximum value of shear test was obtained with the addition of 10% glass powder. It can be concluded that glass powder can be effectively used as an additive.

2. MATERIALS AND METHODOLOGY

2.1 Materials

The major materials which have been used in the experimental investigation include:

A. Soil (Marine clay)

The marine clay was collected from Moolampilly-Pizhala bridge site. It was collected from a depth of 2 to 3 meter. The clay was greyish black in colour.

B. Glass powder

The waste broken glass was collected from a shop at Thankalam , Kothamangalam .It was plane white coloured glass .

C. Plastic bottle strips

The plastic bottles were collected from various catering centres near Muvattupuzha. The bottles were of uniform size.

D. Ferric chloride and Quarry dust

The quarry dust used in this study was brought from a Roy Mathew crushers at Palakkad. Commercial grade anhydrous ferric chloride was used in this study.

2.2 Methods

Preliminary studies were conducted to analyse the geotechnical properties of marine clay such as liquid limit and plastic limit, compaction test to determine the optimum moisture content and dry density from which the optimum moisture content value is used to determine the unconfined compressive strength and California bearing ratio of marine clay. The properties obtained for marine clay is shown in table 1. Compaction tests, unconfined compressive strength and California bearing ratio were also conducted for stabilized soils and results were analysed.

Table-1: Properties of marine clay

Serial No.	Test conducted	Properties	Result
1	Grain size analysis	% Silt	42
		% Clay	38
		% Sand	20
2	Index properties	Specific gravity G	2.64
3	Consistency limits	Liquid limit (w_L) %	41.50
		Plastic limit (w_p) %	26
		Plasticity Index I_p	15.50
		Flow Index I_f	11.31
		Toughness Index I_T	1.37
5	Standard proctor test	Maximum dry density g/cc	1.28
		Optimum moisture content %	32.20
6	Unconfined Compression test	Compressive strength (kg/cm^2)	0.110
		Cohesion(kg/cm^2)	0.505
7	California bearing ratio	CBR value (%)	1.27

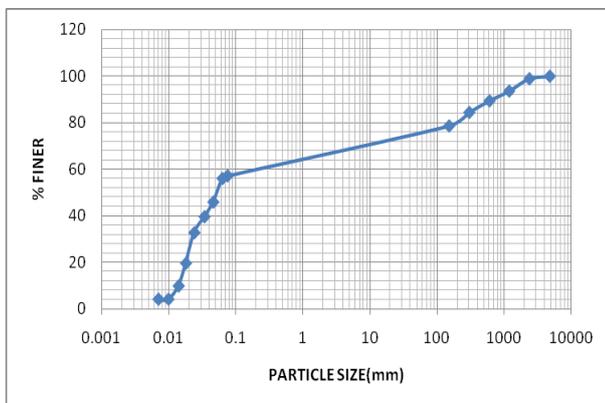


Chart-1: Grain size distribution curve of marine clay

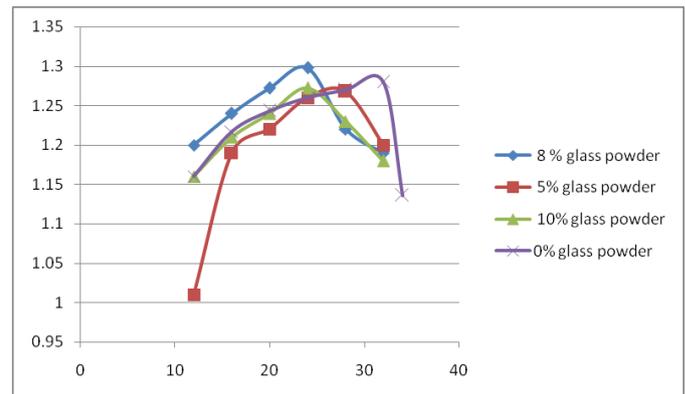


Chart-2: Standard Proctor Compaction curve for marine clay with glass powder.

OMC obtained for untreated sample was 32%. It was seen that by the addition of glass powder to marine clay the OMC goes on decreasing upto 8% glass powder and thereafter increases. So the optimum moisture content at 8% glass powder shows better results.

3.1.2 Unconfined Compressive Strength

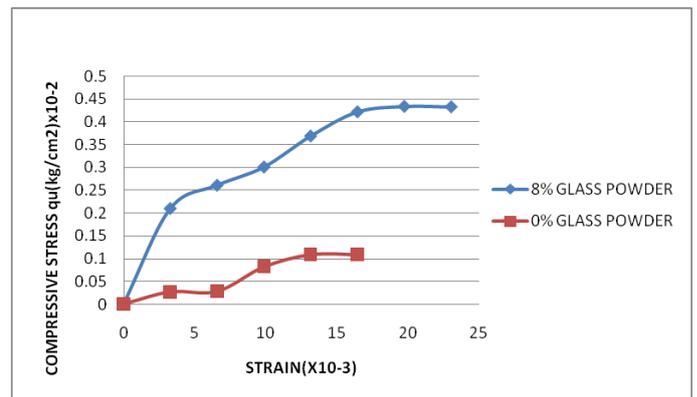


Chart-3: UCC test curve for marine clay with glass powder

3.1.3 California Bearing Ratio

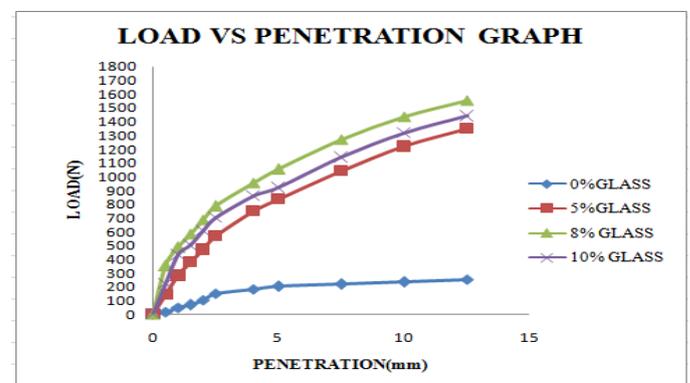


Chart-4: Load Vs Penetration curve for Marine clay with glass powder

3. RESULT AND DISCUSSION

3.1 Effect of Marine Clay on Glass Powder

3.1.1 Optimum Moisture Content and Maximum Dry Density

Standard proctor test was carried out to determine the optimum moisture content and maximum dry density. The test was conducted for clay without addition of glass powder and later with addition of glass powder at 5%, 8% and 10%.

The CBR value of marine clay increases on the addition of glass powder. The maximum CBR value of 5.74% was obtained on adding 8% glass powder.

Table-2: Effect of Glass powder on properties of Marine Clay

PROPERTY	0% GLASS	5% GLASS	8 % GLASS	10% GLASS
CBR Value (%)	1.27	4.164	5.74	5.12
OMC (%)	32.20	28.2	23.6	24
Dry density (g/cc)	1.28	1.27	1.3	1.272
UCC (Kg/cm ²)				
q_u	0.112	-	0.434	-
c_u	0.505	-	0.217	-
Atterberg limits (%)				
LL	41.50	50.50	49.5	51.00
PL	17.05	46.67	46.84	46.70
PI	24.45	3.83	2.66	4.30

3.2 Effect of Plastic Strips on Marine Clay

From the studies it was found that plastic strips of aspect ratio 30mmX10 mm added at 0.5% to red soil showed improved result. So plastic strips of same aspect ratio and percentage is added to marine clay to analyse its effect on weak soil.

3.2.1 Effect on maximum dry density and optimum moisture content

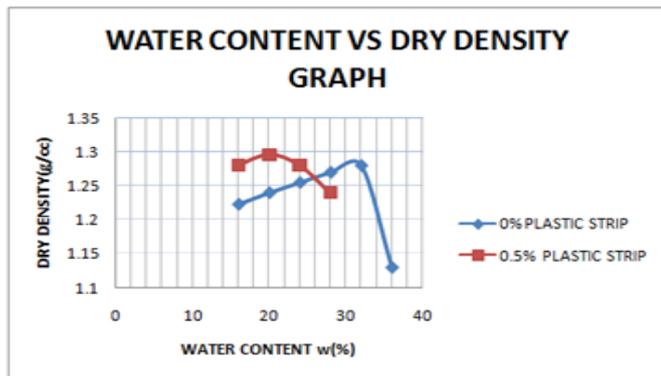


Chart-5: Standard Proctor Compaction curve for marine clay with plastic strips.

The maximum dry density increases on adding plastic strips from 1.28 g/cc to 1.30 g/cc and the OMC decreases.

Effect on CBR value

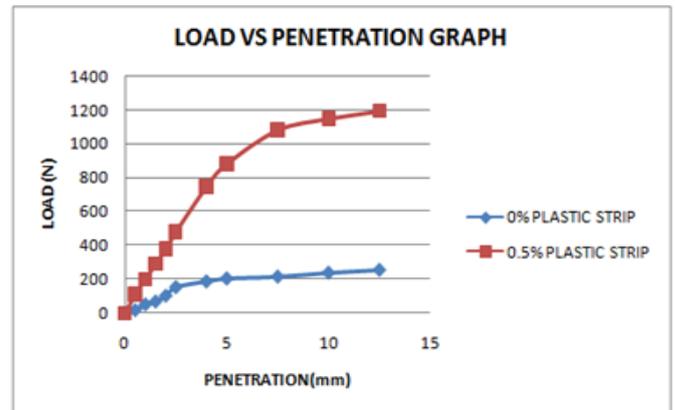


Chart-6: Load Vs Penetration curve for Marine clay with plastic strips.

The CBR value of marine clay treated with 30mmX10mm plastic strips at 0.5% increases to a value of 4.3%.

Table-3: Result of marine clay with plastic strip

Properties	untreated marine clay	marine clay with 0.5% plastic strip
maximum dry density	1.28	1.3
Cbr	1.24	1.43

Effect of quarry dust with ferric chloride on marine clay

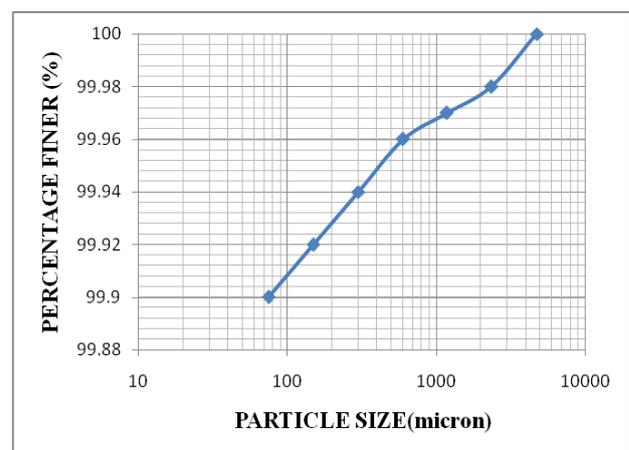


Chart-7: Particle size distribution curve of quarry dust

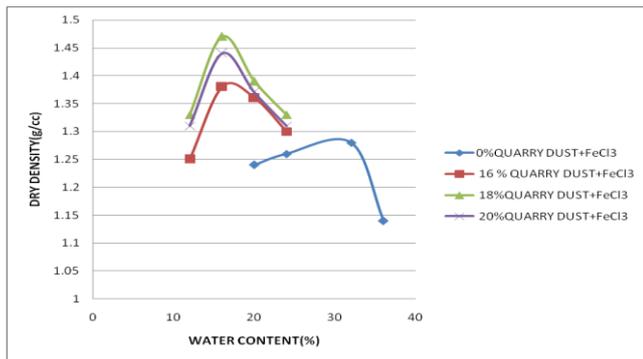


Chart-8: Standard Proctor Compaction Curve for Quarry Dust with FeCl3

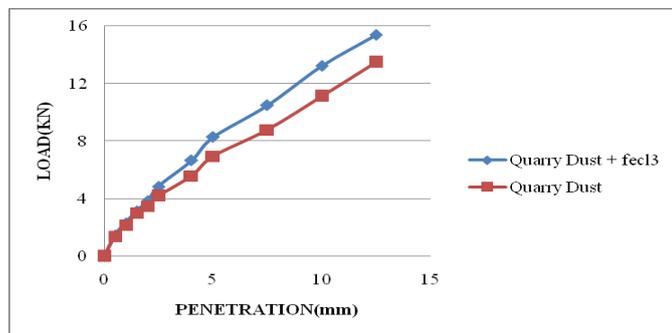


Chart-9: Load Vs Penetration for Quarry Dust(18%) with FeCl3(1%)

Table-4: Effect of Different Additives on Marine Clay-a Comparison

Properties	Blank	With 8% glass powder	With 0.5% plastic strip	With quarry dust and FeCl3
CBR(%)	1.27	5.74	4.3	3.6
UCC(kg/cm ²)				
i)Compressive stress	0.110	0.434	-	0.14
ii)Cohesion	0.505	0.217	-	0.07
OMC(%)	32.20	23.6	20	16
Max dry density (g/cc)	1.28	1.3	1.3	1.47

4.CONCLUSIONS

- 1.Glass powder,plastic strips and quarry dust with FeCl₃ can be effectively used for the stabilization of weak soil like marine clay.
- 2.Glass powder in 8% gives the better result among varying percentage addition of glass powder.
- 3.Marine clay shows better improvement of properties by the addition of plastic strip than in red earth.
- 4.The properties of marine clay was improved on adding 18% Quarry dust and 1% FeCl₃.
- 5.Among the three additives, addition of 8% glass powder increased the CBR value more than others.
- 6.The maximum dry density was obtained by adding quarry dust with FeCl₃.
- 7.Glass powder proved as a better additive than plastic strip and quarry dust.

ACKNOWLEDGEMENT

I express my sincere gratitude and thanks to Dr.Soosan George T , our principal and Dr. Mini M.I , Head Of the Department, Dr.Binoy Alias, for providing the facilities and all the encouragement and support. I express my sincere gratefulness to Prof. Solly George, for her effective motivation, helpful feedback and great support. I express my sincere gratitude to all the faculties of the Department of Civil Engineering, CERD for providing the necessary financial support and all my dear friends for their help and encouragement .Above all I thank the Almighty for all his blessings else this would be difficult to accomplish.

REFERENCES

- 1) I Olufowobi, A Ogundoju, B Michael,(2014),'*Clay soil stabilization using powdered glass,,* Journal of engineering science and technology(IJEST) volume 9,no.5
- 2) Dr.D.S.V Prasad et al, (2015), '*Strength behaviour of marine clay treated with rice husk ash*', International journal of latest trends in science and technology(IJLTET)volume 6,no.3
- 3) B.M.N Kiran,D.V.S Prasad,(2016),'*Stabilization of marine clay using ferric chloride and quarry dust*',IJLTET,volume4,no.3.
- 4) Teresa Sunney,Annie Joy,(2016),'*Effect of marine clay stabilized with banana fiber*', International; journal of science and research(IJSER) Vol:4,no 3