A STUDY ON THE INFLUENCE OF ALUMINIUM CHLORIDE FOR IMPROVING THE PROPERTIES OF VITRIFIED POLISH WASTE TREATED MARINE CLAY AS SUBGRADE FOR FLEXIBLE PAVEMENTS UNDER CYCLIC PRESSURES

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Abstract - - Marine Clays are a worldwide problem especially in the regions where climate is arid or semi arid. These soils swell when they are exposed to water and shrink when they dry. Cyclic swelling and shrinkage of clays and associated movements of foundations may result in cracking of structures. Several methods are used to decrease or prevent the swelling potential of such soils like pre-wetting, surcharge loading, chemical stabilization etc. Among these, one of the most widely used methods is using chemical admixtures (chemical stabilization). Vitrified Tiles are the latest and largest growing industry alternate for many filing requirements across the globe with for superior properties compared to natural stones and other manmade tiles. India is one of the largest region in production. Using the vitrified polish waste (VPW) along with Aluminum Chloride in various percentages is studied. Various laboratory tests properties are performed to compare the CBR , DFS and strength parameters.

Key Words: Marine Clay, VPW ,AlCl3, Soil Stabilization, OMC,MDD,CBR, DFS and shear strength

1.INTRODUCTION

The soil found in the ocean bed is classified as marine clay. It can even be located onshore as well. Expansive soils or swelling soils are those because of its mineralogical composition, experiences large volume changes or volumetric strains when subjected to change in moisture content. They expand and shrink on wetting and drying respectively. (Bolt,1955; Jennings and Knight, 1957). These soils are commonly referred in literature as active clays, swelling clays or volumetrically active soils. In this thesis, they are called marine clay (Gromko, 1974; Gens and Alonso, 1992). The ability of the clay mineral to adsorb and absorb water is its inherent property,which results from its mineral composition.

This property of clay poses a great challenge to civil engineer to make any construction on it. improve the strength and stiffness of the soil. There are many methods are available to improve the properties and performance of the soil.

1.1 Methods to Improve

Different measures have been proposed and methodologies adopted for overcoming the problems associated with these kind of soils. One of the methods is to strengthen foundation to reduce the effect of expansiveness on the former, which include belled piers, granular pile anchors, sand cushion techniques etc. (Phanikumar 2009)..

Another efficient method for stabilization is the use of additives that helps to curtail the volume change due to swelling. The different additives used for stabilizing expansive soil include aluminium chloride, calcium chloride,lime, cement, cohesionless material like sand and fly-ash. Among these, treatment with aluminium chloride has gained a lot of popularity due to its capability in reduce swelling.

1.2 Objectives of Study

- To determine the properties of marine clay.
- To evaluate performance of VPW treated marine clay.
- To evaluate the performance of VPW treated marine clay along with Aluminium chloride.
- To evaluate the performance of treated marine clay as pavement sub-grade for flexible pavements under cyclic pressures.

2. MATERIALS USED

A. Marine Clay(MC)

The soil used in this study is marine clay soil, obtained from Yetimoga, Kakinada Urban, Collected at a depth of 0.5m from ground level. The Index & Engineering properties of marine clay soil are determined as per IS code of practice

B. Vitrified Polish Waste(VPW)

Vitrified tiles are the latest and largest growing industry alternate for many tiling requirements across the globe with far superior properties compared to natural stones and other man made tiles. The Vitrified Polish Waste used in this investigation was brought from Rack Ceramics Limited, Samalkot, East Godavari District, Andhra Pradesh, India. The VPW mainly consisting of 1.40% of Cao and 49.52% Silica was used in the investigation. The quantity of VPW was varied from 0% to 30% by dry weight of soil.

C. Aluminium Chloride (AlCl3)

Commercial grade Aluminum chloride was used in this study. Aluminum Chloride (AlCl3) in varying percentages of 0.5%, 1.0%, 1.5%, 2.0% of the expansive soil. The quantity of Aluminum chloride was varied from 0 to 2% by dry weight of soil.

3. LABORATORY INVESTIGATION

The Physical Properties M.C and particle size distribution of MC were presented in table No.1 & 2

Table -1: Properties of V.P.W

Sl. No.	Property	Value
1	Specific Gravity	2.46
2	Grain Size Distribution	
	Coarse sand (%)	0.00
	Medium sand (%)	1.43
	Fine sand (%)	97.5
	Silt & Clay (%)	1.07
3	Composition Properties	
	Maximum Dry Density (g/cc)	1.58
	Optimum Moisture Content (%)	19.4
4	Atterberg Limits	NP

Table-2:Particle Size distribution of Untreated Marine Clay

SI. No	Property		Marine Clay	M.C + 15%VPW
1	Gravel %		0	0
2	Sand %		5	14
3	Fines	67	Silt %	69
		28	Clay %	17

OMC & MDD of air dried untreated and treated Marine clay with VPW and AlCl3 are presented in the table No.3&4 & Fig.1&2.

Table-3.:OMC & MDD Values of Untreated Marine Clay

Sl. No	Water Content (%)	Dry Density(g/cc)
1.	25.72	1.275
2.	30.00	1.377
3.	34.00	1.350
4.	38.60	1.303

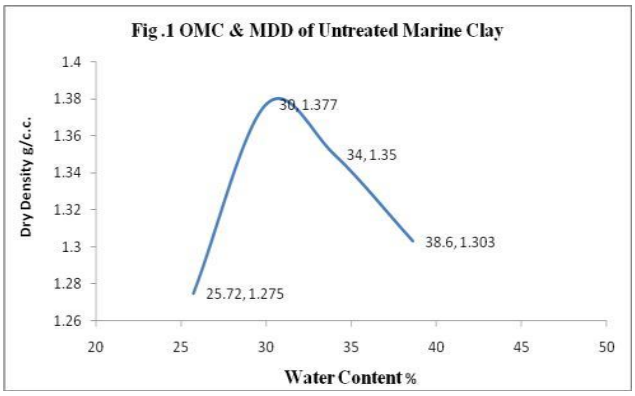

Chart -1:OMC & MDD Values of Untreated Marine Clay

Table-4.:OMC & MDD Values of VPW treated Marine Clay+ AlCl3

Sl. No	Water Content (%)	Dry Density(g/cc)
1.	19.98	1.56
2.	20.52	1.63
3.	22.64	1.59
4.	23.86	1.58

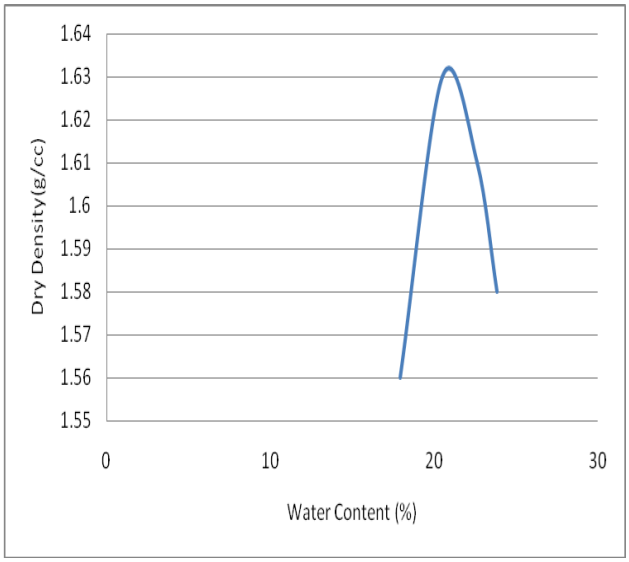

Chart -2:OMC & MDD Values of VPW treated Marine Clay+ AlCl3

CBR test results of optimum of VPW treated Marine clay with AlCl3 are presented in the table No.5 & Chart 3.

Table -5:CBR values of VPW treated Marine Clay with % variation of AlCl3

Sl. No.	Mix proportion (%)	Soaked CBR (%)
1	85%soil+15%VPW+0% AlCl3	4.789
2	85%soil+15%VPW+0.5% AlCl3	5.249
3	85%soil+15%VPW+1% AlCl3	6.286
4	85%soil+15%VPW+1.5% AlCl3	5.742
5	85%soil+15%VPW+2% AlCl3	5.755

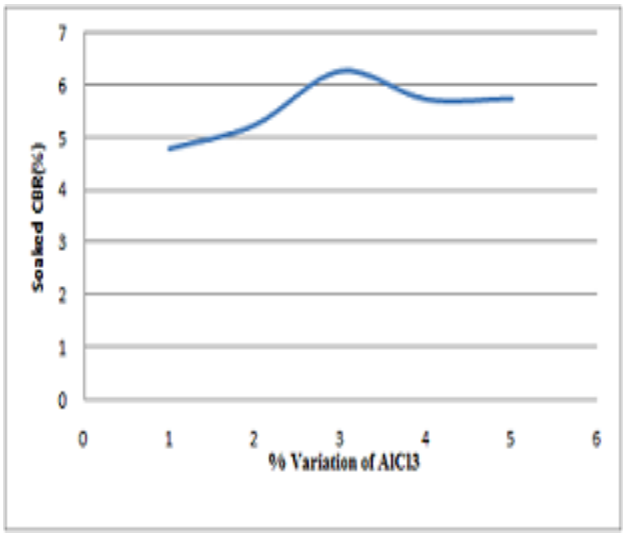

Chart -3: CBR values of VPW treated Marine Clay with % variation of AlCl3

Laboratory cyclic plate load test results of untreated & optimum of VPW treated Marine clay with AlCl3 are presented in the chart – 4 & 5

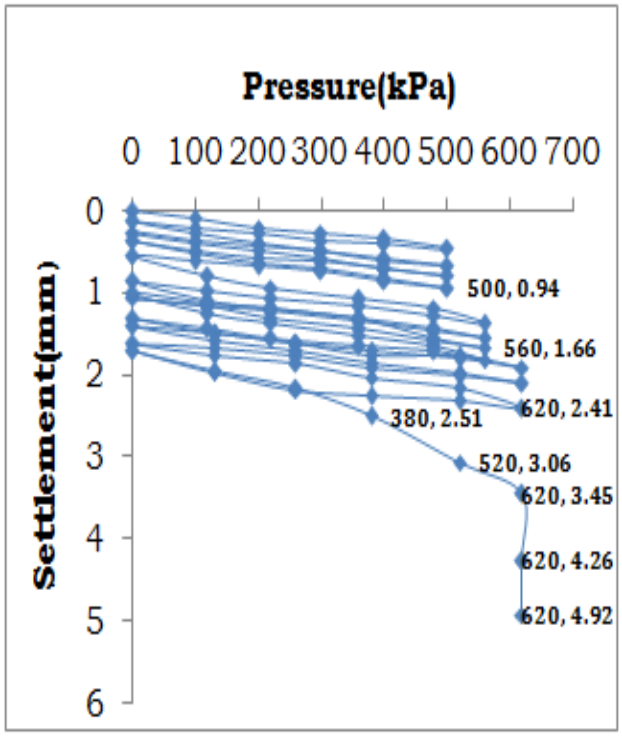

Chart -4: Laboratory cyclic plate load test values of untreated Marine Clay

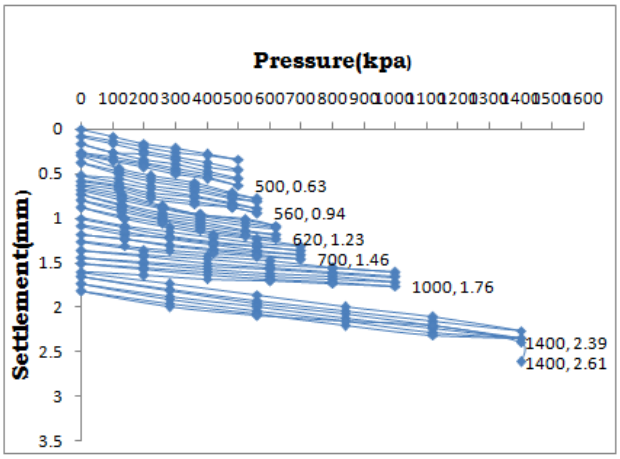

Chart -5: Laboratory cyclic plate load test values of untreated Marine Clay

Physical properties of untreated & optimum of VPW treated Marine clay with AlCl3 are presented in the table- 6

Table -6: Physical Properties of Untreated and treated marine clay with AlCl3

SI. NO.	Property	Marine Clay	MC+15 %VPW	MC+15%VPW+1% AlCl3
1	Liquid Limit %	72.96	46.98	38.66
2	Plastic Limit %	42.59	27.95	24.42
3	Plastic Index %	30.37	19.03	14.24
4	Soil Classification	CH	CI	CI
5	Specific Gravity	2.33	2.62	2.71
6	F. S %	100	40	20
7	O.M. C	30 %	23.42	20.52
8	M. D. D gm/cc	1.377	1.56	1.63
9	Cohesion t/m2	14.42	10.505	8.865
10	Angle of Internal Friction (0)	2	5	6
11	CBR Value %	1.25	4.789	6.286

Courtesy to RAC Ceramics

4. CONCLUSIONS

Based on the study , following conclusions were drawn:

From the laboratory studies, it was observed that the Differential Free Swell of the marine clay has been decreased by 10% with the addition of 15% VPW when compared with the untreated marine clay.

A further decrease of Differential Free Swell of the expansive clay by 13% was observed with addition of Aluminium Chloride with 15% VPW treated marine clay.

From the laboratory studies, it was observed that the liquid limit of the expansive soil has been decreased by 35% with the addition of 15% VPW when compared with the untreated marine clay.

It was also observed that the liquid limit of the expansive clay has been decreased by 17% with the addition of Aluminium Chloride to the 15% VPW treated marine clay.

From the laboratory studies, it was observed that the plastic limit of the marine clay has been decreased by 34% with the addition of 15% VPW when compared with the untreated expansive clay.

It was also observed that the plastic limit of the expansive clay has been further decreased by 8% with the addition of Aluminium Chloride to the 15% VPW treated marine clay.

It was observed that the CBR value increased by 87% on addition of 15% VPW and further improvement was observed with 46% and 86% when treated with optimum values of Aluminium Chloride to the 15% VPW treated marine clay.

It was observed from the laboratory results that the shear strength parameters of marine clay are improved with the addition of VPW along with optimum percentages of Aluminium Chloride.

It was observed from the laboratory Static Plate Load Test results, that the ultimate load carrying capacity of the 15%

VPW treated marine clay foundation bed has been improved by 81%when compared with the untreated marine clay foundation bed.

It was observed from the laboratory Static Plate Load Test results, that the ultimate load carrying capacity was further improved by 71% with 15% VPW + 1% AlCl3 treated marine clay foundation bed when compared with the untreated marine clay foundation bed.

Hence, from all the above observations, it was concluded that the 1% AlCl3 along with 15% VPW treated marine clay exhibits better and satisfactory results than untreated marine clay.

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