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IJIEMR Transactions, online available on 30th Jul 2020. Link :http://www.ijiemr.org/downloads.php?vol=Volume-09&issue=ISSUE-07

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Volume 09, Issue 07, Pages: 298-305

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International Journal for Innovative Engineering and Management Research
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A STUDY ON STRENGTH PROPERTIES OF EXPANSIVE SOIL TREATED WITH VITRIFIED POLISH WASTE AND FERRIC CHLORIDE

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ABSTRACT: Expansive soils have problems to civil engineers in general and to geotechnical engineers in particular. In India, expansive soils popularly known as black cotton soils are highly problematic, as they swell on absorption of water and shrink on evaporation thereof. Because of this alternate swell and shrinkage, distress is caused to the foundations of structures laid on such soils. There have been many methods available to controlling the expansive nature of the soils. Various remedial measures like soil replacement, pre-wetting, moisture control, lime stabilization etc. have been practiced with varied degree of success. A methodical process, involving experimentation in the laboratory under controlled conditions is done. It is observed form the laboratory studies that maximum improvement in the properties of Expansive soils for Vitrified Polish Waste treatment with FerricChloride tried in this investigation. A methodical process, involving experimentation on Atterberglimits(liquid limit, plastic limit), Proctor compaction test, California Bearing Ratio(CBR), Unconfined Compressive Strength(UCS) tests were conducted by adding 5%, 10%, 15% & 20% of Vitrified Polish Waste to the expansive soil by dry weight under controlled conditions in the laboratory. The percentages of Ferric chloride by dry weight of soil was taken as 0.5%, 1.0%, 1.5% and 2.0%. The first series of compaction, CBR and UCS tests were conducted on the Expansive soil and the same tests were conducted in the second series on soil samples mixed with vitrified polish waste and similarly tests were conducted in the third series on soil samples mixed with Vitrified Polish Waste and ferric chloride. Laboratory experiments favorably suggest that mixing Vitrified Polish Waste and ferric chloride with soil would be effective in improving soil properties.

Keywords: Expansive soil, CBR, UCS, FerricChloride, Vitrified Polish Waste

I.INTRODUCTION

Expansive soil is one among the risky soils that has a high potential for contracting or swelling because of progress of dampness content. Far reaching soils can be found on practically every one of the landmasses on the Earth. Dangerous outcomes brought about by this kind of soils have been accounted for in numerous nations. In India, huge tracts are secured by extensive soils known as dark cotton soils. The significant zone of their event is the south Vindhyachal range covering nearly the whole Deccan Level. These darts spread a region of around 200,000 square miles and consequently structure about 20% of the complete territory of India. The essential issue that emerges concerning sweeping soils is that distortions are altogether more prominent than the flexible misshapenness and they can't be anticipated by the old style versatile or plastic hypothesis. Development is more often than not in an uneven example and of such an extent to make broad harm the structures laying on

them.
Appropriate healing measures are to be embraced to change the dirt or to decrease its unfavourable impacts if sweeping soils are distinguished in an undertaking. The therapeutic measures can be diverse for arranging and structuring stages and post development stages. Numerous adjustment systems are by and by for improving the extensive soils in which the qualities of the dirts are modified or the risky soils are evacuated and supplanted which can be utilized alone or related to explicit structure choices. Added substances, for example, lime, concrete, calcium chloride, rice husk, fly fiery debris and so forth are likewise used to change the attributes of the broad soils. The qualities that are of worry to the plan designers are piousness, compressibility and solidness. The impact of the added substances and the ideal measure of added substances to be utilized are reliant chiefly on the mineralogical arrangement of the dirt's. The paper centres about the different adjustment strategies that are practically speaking for improving the broad soil for diminishing its swelling potential and the constraints of the technique for adjustment there on.

In India, the region secured by far reaching soil is almost 20% of the absolute zone. The far reaching soils regularly spread over a profundity of 2 to 20m. In stormy season, they experience hurl and shed pounds. In summer, they psychologist and increase thickness and become hard. This substitute swelling and shrinkage harm the structures harshly. This is increasingly extreme for the light structures.
During summer, polygonal breaks are show up at the surface, which may stretch out to a profundity of about 2m demonstrating the dynamic zone wherein volume change happens. The profundity of dynamic zone characterized as the thickness of the dirt beneath the ground surface inside which dampness content varieties and subsequently volume changes dotake place. Sustained endeavours are being made everywhere throughout the world on thruway research field to develop additionally encouraging treatment strategies for appropriate structure and development of asphalts running over broad soil sub grade.

Characterization of Expensive soil

- Color: May be dark, dim, yellow dim.
- During summers, side and profound guide type splitting is watched.
- During overwhelming downpours, when such soils get immersed, it would be extremely hard to work through these dirts in view of high stickiness.
- Normally the incline of territories level in the scope of 00 to 20.
- Drainage is poor.

In India, the vegetation in such region may comprise of thistles, hedges, prickly trees (babul) desert flora and so on. Structures built on such stores displays hurling of floor lifting of segments and dividers generally joined by splitting. Entryways typically stuck during stormy season. If there should be an occurrence of trenches in dikes, incomplete cuts or in cutting, bed hurling joined by breaking of the bed cement is watched. Overwhelming sliding joined by dynamic disappointments is seen on the sides. Holding structure show tilting and trouble street get rutted

Details of the lab experimentation did with various blends of materials have been talked about in the past section including the research facility static plate burden tests on untreated and treated sweeping mud establishment beds.In this section a point by point exchange on the outcomes acquired from different research facility tests are exhibited including the consequences of lab static plate burden tests on untreated and treated far reaching mud sub grade establishment beds.

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II.VARIABLES TAKEN FOR THE STUDY

The study carried out on Expansive soil; Expansive soil treated vitrified polish waste and optimum of ES treated with Ferric chloride in the following percentages. Vitrified polish waste varied in percentages of 5%, 10%, 15% and 20% by weight of Expansive soil throughout the experiments. To increase the Index Properties of Expansive soil, Vitrified polish waste is added in various percentages with addition of Ferric chloride(0.5%,1%, 1.5% and 2%).

III.EXPERIMENTAL STUDY

Following tests are conducted for an Expensive soil and Expensive soil treated with Vitrified polish waste and Expensive soil with optimum moisture content of Vitrified Polish waste treated with ferric chloride.

Atterberg's Limits
Compaction
California Bearing Ratio Test (CBR)
Unconfined Compression Test(UCS)

ATTERBERG'S LIMITS: The Atterberg's limits are a basic measure of the critical water contents of a fine- grained soil, such as its shrinkage limit, plastic limit, and liquid limit. As a dry, clayey soil takes on increasing amounts of water, it undergoes dramatic and distinct changes in behavior and consistency. Depending on the water content of the soil, it may appear in four states: solid, semi-solid, plastic and liquid. In each state, the consistency and behavior of a soil is different and consequently so are its engineering properties. Thus these tests are used widely in the preliminary stages of designing any structure to ensure that the soil will have the correct amount of shear strength and not too much change in volume as it expands and shrinks with different moisture contents.

LIQUID LIMIT VALUES OF UNTREATED EXPANSIVE SOIL AND EXPANSIVE SOILTREATED WITH VITRIFIED POLISH WASTE (VPW)

The liquid limit test of Atterberg'sinvolved mixing a pat of Expansive soil sample passing through 425 microns IS Sieve in a round-bottomed porcelain bowl of 10–12 cm diameter. A groove was cut through the pat of clay with a spatula, and the bowl was then struck many times against the palm of one hand. Casagrande subsequently standardized the apparatus and the procedures to make the measurement more repeatable. Soil is placed into the metal cup portion of the device and a groove is made down its center with a standardized tool of 13.5 millimeters (0.53 in) width. The cup is repeatedly dropped 10 mm onto a hard rubber base at a rate of 120 blows per minute, during which the groove closes up gradually as a result of the impact. The number of blows for the groove to close is recorded. The moisture content at which it takes 25 drops of the cup to cause the groove to close over a distance of 13.5 millimeters (0.53 in) is defined as the liquid limit. The test is normally run at several moisture contents, and the moisture content which requires 25 blows to close the groove is interpolated from the test results. The liquid limit test was conducted on treated and untreated expansive soil using Casagrande liquid limit apparatus as per the procedures laid down in IS: 2720 part 4 (1970).

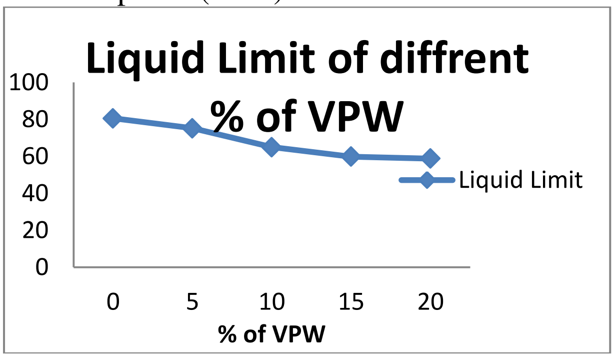

Figure 1 represents the Liquid limit values of untreated expansive soil and expansive soil treated with VPW

From the above figure shows that the laboratory investigations that the liquid limit of the expansive soil has been decreased by 6.06% on addition of 10% Vitrified Polish Waste.

PLASTIC LIMIT VALUES OF UNTREATED EXPANSIVE SOIL AND EXPANSIVE SOILTREATED WITH VITRIFIED POLISH WASTE (VPW)

The plastic limit (PL) is determined by rolling out a thread of the fine portion of a soil on a flat, non-porous surface. The procedure is defined in ASTM Standard D 4318. If the soil is at moisture content where its behavior is plastic, this thread will retain its shape down to a very narrow diameter. The sample can then be remolded and the test repeated. As the moisture content falls due to evaporation, the thread will begin to break apart at larger diameters. The plastic limit is defined as the moisture content where the thread breaks apart at a diameter of 3.2 mm (about 1/8 inch). A soil is considered non-plastic if a thread cannot be rolled out down to 3.2 mm at any moisture.

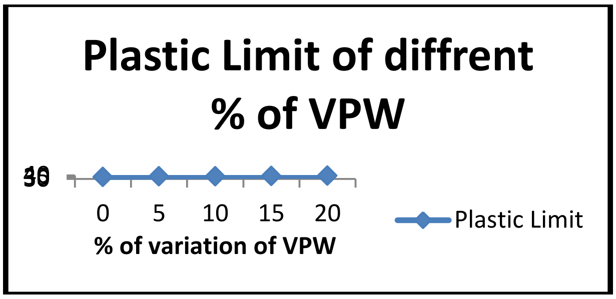

Figure 2 represents the Plastic limit values of untreated expansive soil and expansive soil treated with VPW

From the above figure the laboratory investigations that the plastic limit of the expansive soil has been improved by 2.75% on addition of 10% Vitrified Polish Waste

PLASTIC LIMIT VALUES OF UNTREATED EXPANSIVE SOIL AND EXPANSIVE SOILTREATED WITH VITRIFIED POLISH WASTE (VPW)

The plasticity index (PI) is a measure of the plasticity of a soil. The plasticity index is the size of the range of water contents where the soil exhibits plastic properties. The PI is the difference between the liquid limit and the plastic limit (PI = LL-PL). It is observed that the Plasticity Index of the Expansive soil used in this study is >30 so it is highly plastic in nature.

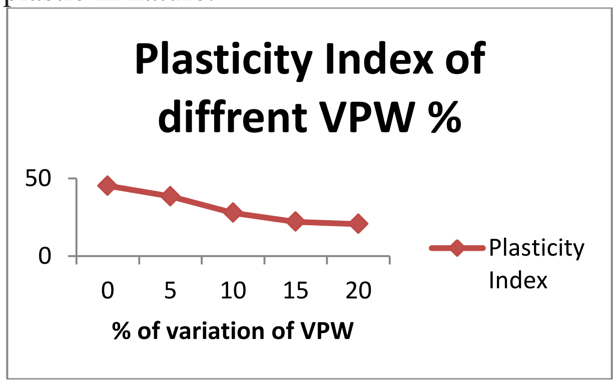

Figure 3 represents the Plasticity Index values of untreated expansive soil and expansive soil treated with VPW

From the above figure the laboratory investigations that the plasticity index of the expansive soil has been improved by 9.75 % on addition of 10% Vitrified Polish Waste.

MODIFIED PROCTOR COMPACTION TEST RESULTS OF UNTREATED EXPANSIVE SOIL AND EXPANSIVE SOILTREATED WITH VPW

The Proctorcompaction test is a laboratory method of experimentally determining the optimal moisture content at which a given soil type will become densest and achieve its maximum dry density. These laboratory tests generally consist of compacting soil at known moisture content into a cylindrical mold of standard dimensions using a compactive effort of controlled magnitude. The soil is usually compacted into the mold to a certain amount of equal layers, each receiving a number of blows from a standard weighted hammer at a specified height. This process is then repeated for various moisture contents and the dry densities are determined for each. The graphical relationship of the dry density to moisture content is then plotted to establish the compaction curve. The maximum dry density is finally obtained from the peak point of the compaction curve and its corresponding moisture content, also known as the optimal moisture content. For this study, a compaction test is carried out for expansive soil treated with different percentage of Quarry dust and Ferric Chloride (Fecl3) by dry weight of the soil for determining the optimal percentage of Quarry Dust and Ferric Chloride.

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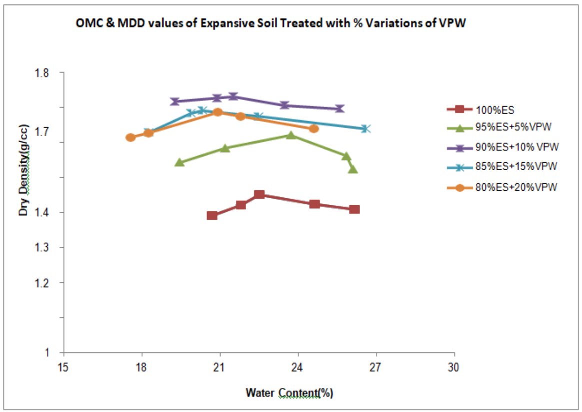

Figure 4 represents the OMC & MDD values of untreated expansive soil and expansive soil treated with VPW

From the above figure the laboratory investigations shows that the optimum moisture content of the expansive soil has been decreased by 4.65% on addition of 10% Vitrified Polish Waste and the maximum dry density of the expansive soil has been improved by 18.9% on addition of 10% Vitrified Polish Waste

MODIFIED PROCTOR CBR TEST RESULTS OF UNTREATED EXPANSIVE SOIL AND EXPANSIVE SOILTREATED WITH VPW

CBR test is carried out by Compacting a mix soil of about 5kg with required optimal water content using heavy compaction. For determining the penetration test the mould assembly with the surcharge weights is placed on penetration test machine and the penetration load is applied at a rate of1.25mm/min. The load readings at penetrations of 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 4.0, 5.0, 7.5, 10 and 12.5 mm are recorded and the maximum load and corresponding penetration if it occurs for a penetration less than12.5 mm is noted down. Finally, a representative sample is taken from the top 3cm layer and the moisture content is determined. Similarly, CBR is carried out for expansive soil treated with different percentage of Quarry Dust and Fecl3 for finding optimal value.

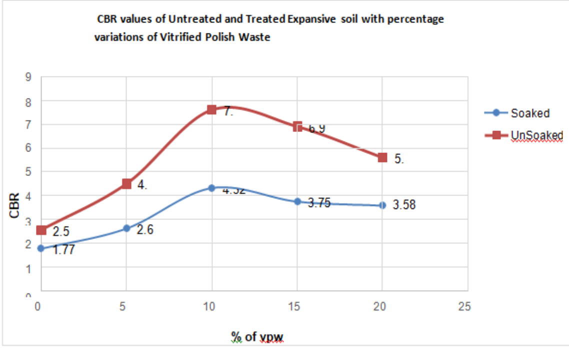

Figure 5 represents the CBR & Soaked CBR values of untreated expansive soil and expansive soil treated with VPW

From the above figure the laboratory investigation shows that the C.B.R. value of the expansive soil has been improved by 111.86% on addition of 10% Vitrified Polish Waste

PROPERTIES OF EXPANSIVE SOIL TREATED WITH AN OPTIMUM OF 10% VPW

S.No	Property	Symbol	Expansive Soil	ES+10%VPW
1	Liquid Limit (%)	WL	70	64.9
2	Plastic Limit (%)	WP	35.78	37.1
3	Plasticity Index (%)	IP	34.22	27.8
4	Soil Classification	---	CH	CH
5	Specific Gravity	G	2.65	2.46
6	Free Swell (%)	F.S	130	80
7	Optimum Moisture Content (%)	O.M.C	22.5	21.5
8	Maximum Dry Density(g/cc)	M.D.D	1.455	1.73
9	CBR (%)	---	1.77	4.32

OPTIMUM MOISTURE CONTENT AND MAXIMUM DRY DENSITY OF 10% VITRIFIED POLISH WASTE TREATED EXPANSIVE SOIL WITH PERCENTAGE VARIATION OF FERRIC CHLORIDE

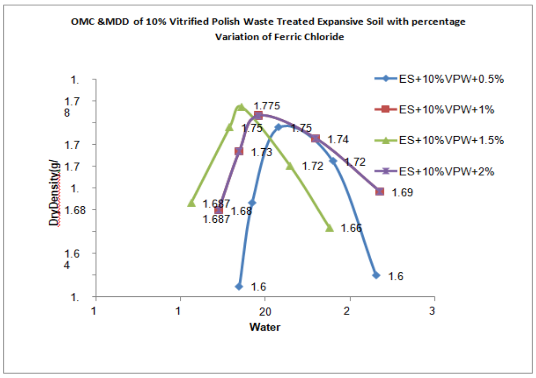

Figure 6 Optimum moisture Content and Maximum Dry Density of 10% Vitrified Polish Waste Treated

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Expansive Soil with percentage Variation of Ferric Chloride

From the above figure shows that the maximum dry density of the expansive soil has been improved by 18.9% on addition of 10% Vitrified Polish Waste and further the maximum dry density of ferric chloride treated expansive soil has been improved by 21.99% with the addition of 1.5% ferric chloride as an optimum when compared with untreated expansive soil.

CBR VALUES OF TREATED EXPANSIVE SOIL WITH 10% VITRIFIED POLISH WASTE WITH VARIOUS PERCENTAGES OF FERRIC CHLORIDE

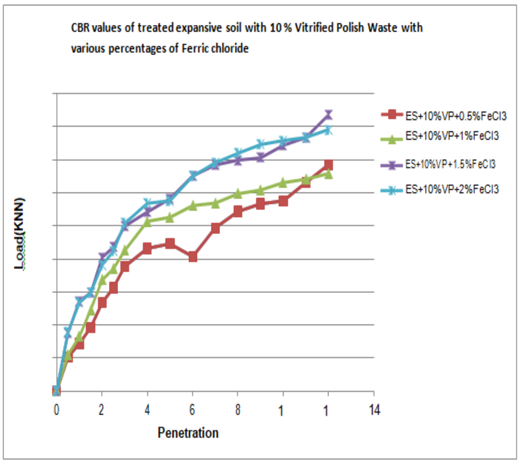

Figure 7 represents the CBR values of 10% Vitrified Polish Waste Treated Expansive Soil with percentage Variation of Ferric Chloride

From the above figure shows that an optimum and further the C.B.R value of ferric chloride treated with expansive soil has been improved by 258.75% with the addition of 1.5% ferric chloride as an optimum when compared with untreated expansive soil.

UCS TEST RESULTS OF UN TREATED ANDTREATED EXPANSIVE SOIL WITH VITRIFIED POLISH WASTE AND PERCENTAGE VARIATION OF FERRIC CHLORIDE

SAMPLE PREPARATION

Both treated and untreated samples were prepared by compacting different mixes to the maximum dry density of the soil. The initial moisture content for these samples was maintained at optimum moisture content of the untreated soil. The amount of chemical to be added to the amount of water was arrived at based on the optimum moisture content of the natural soil and the chemical solution was prepared. This solution was added to the dry soil and the mixture was thoroughly mixed.The various mixes of soil and additives in different proportions are fixed at water content corresponding to OMC values of each mix and the samples are prepared for conducting Unconfined Compressive Strength test for each proportion in the constant volume mould. These samples are cured for 1 day, 7 days,14 days and 28 days. After the period of curing, these samples are tested for unconfined compressive strength test as per IS code of practice(IS:2720,1664).

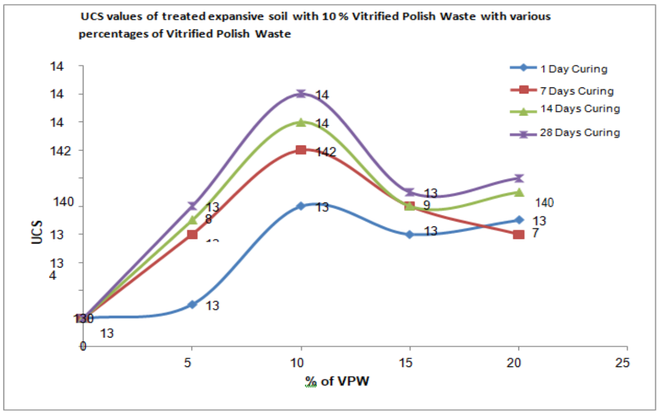

Fig 8 UCS Value of 10% VPW treated Expansive soil with various percentages of FeCl3

From the above figure shows that UCS values are increased due to increase the curing period

IV. CONCLUSIONS

The following conclusions were drawn based on the laboratory studies carried out on this study.Optimum percentage of chemical and quarry dust observed during the laboratory investigations are summarized.

- It is noticed from the laboratory investigations that the liquid limit of the expansive soil has been decreased by 6.06% on addition of 10% Vitrified Polish Waste and further the liquid limit of ferric chloride treated expansive soil has been decreased by 12.9% with the addition of 1.5 % ferric chloride as an optimum when compared with untreated expansive soil.

- It is observed from the laboratory investigations that the plastic limit of the expansive soil has been improved by 2.75% on addition of 10% Vitrified Polish Waste and further the plastic limit of ferric chloride treated with expansive soil has been improved by 13.29% with the addition of 1.5% ferric chloride as an optimum when compared with untreated expansive soil.
- It is observed from the laboratory investigations that the plasticity index of the expansive soil has been improved by 9.75 % on addition of 10% Vitrified Polish Waste and further the plasticity index of ferric chloride treated expansive soil has been improved by 12.49% with the addition of 1.5% ferric chloride as an optimum when compared with untreated expansive soil
- It is found from the laboratory investigations that the optimum moisture content of the expansive soil has been decreased by 4.65% on addition of 10% Vitrified Polish Waste and further the optimum moisture content of ferric chloride treated expansive soil has been decreased by 20.96% with the addition of 1.5% ferric chloride as an optimum when compared with untreated expansive soil
- It is found from the laboratory investigations that the maximum dry density of the expansive soil has been improved by 18.9% on addition of 10% Vitrified Polish Waste and further the maximum dry density of ferric chloride treated expansive soil has been improved by 21.99% with the addition of 1.5% ferric chloride as an optimum when compared with untreated expansive soil.
- It is observed from the laboratory investigations that the C.B.R. value of the expansive soil has been improved by 111.86% on addition of 10% Vitrified Polish Waste as an optimum and further the C.B.R value of ferric chloride treated with expansive soil has been improved by 258.75% with the addition of 1.5% ferric chloride as an optimum when compared with untreated expansive soil.
- The soaked CBR values of expansive soil on stabilizing treated with ferric chloride is found to be 4.58% and it is satisfying standard specifications. So finally it is concluded from the above results that the ferric chloride can potentially stabilize the expansive soil.

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