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EFFECTS OF STONE DUST AND FERRIC CHLORIDE (FeCl3) ON THE STRENGTH AND PROPERTIES OF SUBGRADE COHESIVE SOIL

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ABSTRACT

One of the most difficult issues in engineering practice in many areas of the globe is the construction of roads, homes, and factories on soft soil.

This study looked at how applying stone dust and FeCl3 on cohesive soil can change its behavior. Atterberg's limits, maximum dry density, optimal water content, specific gravity, and clay fraction were among the physical parameters of clayey soils that were measured and compared using IS requirements and American Standard for Testing and Materials (ASTM) standard specification. To make the first batch (i.e., the unstabilized soil), we combined a known quantity of clean water with an established quantity of clay particles, then compacted the resulting material to a known water content and dry density. In contrast, stone dust is combined with clay solids of a comparable weight in the second set (i.e. stabilized soil). Each soil type (unstabilized soil) or Stone dust content (stabilized soil) has had four distinct starting dry densities employed. Soil specimens (both unstabilized and stabilized) are prepared at their ideal dry density and water content for the direct shear test. The results showed that incorporating cutting stone dust into the cohesive soil raised the maximum dry density and lowered the optimal water content and UCS. The addition of stone slurry waste to the cohesive soil greatly increased its unconfined and direct shear strength and stiffness. Here, we add FeCl3 as an admixture to various percentages of stone dust at 0, 5, 10, and 20 percent. To sum up, it was determined that stone dust is most effective on highly plastic soil..

INTRODUCTION

Soil stabilization is a tried-and-true method for enhancing the durability and steadiness of expanding soils. Expansive clays that include waste elements including fiber materials, waste plastics, tire chips, tile waste, stone dust, etc. have been the subject of several investigations. The vast majority of the compaction, C.B.R., direct shear, and unconfined compression tests included in the thesis were performed on very tiny sample sizes. The soil is a crucial component in the design of any structure that will be erected on it, since all buildings must rest on the ground at some point. Without soils, it would be impossible to construct roads, buildings, skyscrapers, bridges, and many other constructions in our day of ever advancing technology. Understanding the soil's reaction under varying situations is crucial for ensuring its stability, which is in turn essential for constructing strong buildings.

Stone dust and ferric chloride were used to stabilize the expanding soil in this project. Aggregate crushing operations produce stone dust. Because of the negative effects on people's health and the environment, stone dust is often cited as a major annoyance. There are a lot of rubble quarries and aggregate crushers since these materials are in high demand for building projects.

Stone dust is one kind of solid waste that is generated in large quantities.
It accounts for around 25% of the total output of each crusher. Stone dust is made up mostly of the fines that are discarded during quarrying processes including crushing, washing, and screening. These hazardous materials are often dumped in large piles near the quarry. The great shear strength that stone dust has makes it an excellent geotechnical material. Its permeability is high, and changes in moisture content do not significantly alter its useful qualities. Given this context, any strategy for reusing this byproduct of biological processes is worth considering. Stone dust is used in several geotechnical contexts, including embankments, backfills, and sub-base. Highway building over clayey sub grade may be made much easier if Stone dust is included into the mix.

OBJECTIVES OF THE STUDY

The following are the goals of this experimental investigation.

The purpose of this work is to conduct experimental analysis of the effect of Stone dust and FeCl3 on the characteristics of expansive soil.

Through a careful analysis of the available literature, we want to determine the best approach for dealing with expanding clays.

The purpose of this study is to assess the efficacy of suggested additives and admixtures in stabilizing expansive clay.

I. LITERATURE REVIEW

Atterberg's limit, compaction (modified proctor), shear strength characteristics, and longevity of a loose soil stabilized with the optimal amount of quarry dust (40%) were all studied by Sabat (2012). Two to seven chapters were added to 1 Chronicles during this period of time. Shear strength characteristics were examined in both the 7-day and 28-day solidification conditions.

In order to anticipate the Ps of expansive soil (Bentonite) stabilized by Stone dust and lime, Sabat (2012) established statistical models linking the proportion of stabilizers, MDD, OMC, curing duration, and activity. As an added bonus, models were constructed to predict the Ps of stabilized expansive soil after 7 and 28 days of curing from the Ps of expansive soil after 0 days of curing, and the Ps of expansive soil after 28 days of curing from the Ps of expansive soil after 7 days of curing. The generated models were shown to be very accurate in predicting the pressure increase.

The effects of ash-quarry dirt mixes with fly ash: quarry dirt as 1:2 on the engineering features of an expansive soil were investigated by Sabat and Satyendra N.Bose (2013). The most effective ratio of fly ash to stone dust was shown to be 45 percent. Several studies have looked at the effectiveness of using industrial scraps to fortify shaky ground.

The influence of stone dirt and ash on fly ash properties was credited to Ali and Koranne (2011). They determined that a mixture of equal parts stone dust and fly ash significantly improved the qualities of expansive soil. The swelling behavior of the expanding clay may be significantly manipulated.

Fly ash was investigated by Cokca (2001) for its impact on soil expansion. The plasticity index, activity, and swelling potential of the samples all dropped as the percent stabilizer and curing time increased, and he discovered that 2% fly ash was the optimal content for minimizing the swelling potential. The use of both high Ca and low Ca category C fly ashes has been advocated widely as an efficient method of stabilizing and bettering expansive soils.

Kumar and **Prasanna** (2012) studied the effect of silica and calcium extracted from rice husk ash on geo technical properties of expansive soils. They concluded that the characteristics`1of such soils are improved remarkably.

III MATERIALS

In the current study, the following materials areused

- Soil
- Stone dust
- Ferric Chloride ($FeCl_3$)

B.C Soil

The type of soil used in this investigation is of having high clay content, Expansive soil . The soil was brought from near to the Kadapa. The soil was air dried pulverized and passing through IS: 425- micron sieve is taken for study of properties. Different Engineering properties are soil initially can be find by conducting corresponding the experiments according to IS code specification.

Properties of Expansive soil

S. No	Property	Units	Value
1	**Grain size distribution**		
	Sand (%)	**%**	**6**
	Silt (%)	**%**	**27.5**
	Clay (%)	**%**	**66.5**
2	**Atterberg limits**		
	Liquid limit	**%**	**86**
	Plastic limit	**%**	**45**
	Plasticity index	**%**	**41**
3	**Compaction properties**		
	Optimum Moisture Content,	**%**	**22.1**
	Maximum Dry Density,	kN/m^3	**15.8**
4	**Specific Gravity (G)**		2.48
5	**IS Classification**		CH
6	**C.B. R**	%	3
7	**Differential free swell**	%	140
8	**Permeability**	cm/sec	1.325×10^{-6}
9	**Un confined compression strength**	kN/m^2	27.00
10	**Tri-axial shear strength**		
	Cohesion(C)	kN/m^2	78
	Angle of Internal Friction (ø)	degrees	53^0

Properties of Stone dust

S.NO	Property	Value
1	Atterberg's limits Plastic limit (%) Liquid limit (%)	 NIL 17.60
2	Specific gravity	2.42
3	Compaction properties Optimum moisture content (%) Maximum dry density (kN/m³)	 12.4 15.35
4	California bearing ratio (un soaked) (%)	7

Fig.: Properties of Ferric Chloride

S.NO	Molecular formula	$FeCl_3$
1	Molar mass	162.2 g/mol
2	Appearance	green-black by reflected light; purple-red by transmitted light hexahydrate: yellow solid aq. solutions:brown
3	Odor	slight HCl
4	Density	2.898g/cm³ (anhydrous) 1.82 g/cm³ (hexahydrate)
5	Melting point	306 °C(583 °F;579 K)(anhydrous) 37 °C (99 °F; 310 K) (hexahydrate)
6	Boiling point	315 °C (599 °F; 588 K) (anhydrous, decomposes) 280 °C (536 °F; 553 K) (hexahydrate, decomposes) partial decomposition to $FeCl_2$ + Cl_2

Experimental Work:

The present work follows study on expansivesoil Atterberg's limits Differential free swell (DFS)Modified proctor's Test Tri-axial Shear Test Cyclic plate load Test

IV RESULTS

Effect of Stone dust on Atterberg's of ExpansiveSoil.

Mix Proportions	Liquid limit (%)	Plastic limit (%)
Expansive soil	86	45
Expansive soil+5%Stone dust	72	43
Expansive soil+10%Stone dust	64	41
Expansive soil+15%Stone dust	59	38
Expansive soil+20%Stone dust	52	34

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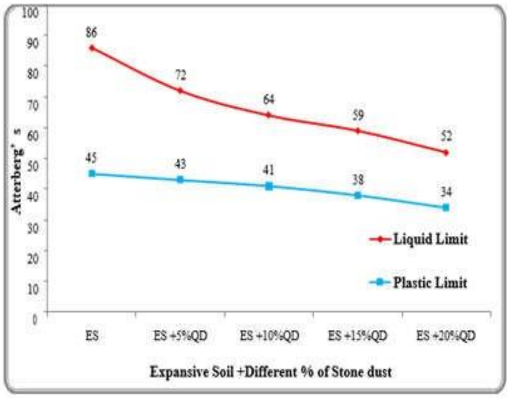
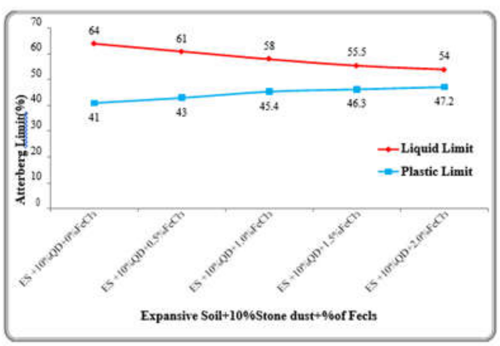


Effect Of Stone dust & $Fecl_3$ in Atterberg's Limits

Mix Proportions	Liquid limit (%)	Plastic limit(%)
Expansive soil+10%Stone dust	64	41
Expansive soil + 10% Stone dust + 0.5% FeC13	61	43
Expansive soil + 10% Stone dust + 1.0 % FeC13	58	45.4
Expansive soil + 10% Stone dust + 1.5% FeC13	55.5	46.3
Expansive soil + 10%Stone dust + 2.0% FeC13	54	47.2



Effect Of Stone dust On Compaction Parameters Of Soils.

Mix Proportions	Dry density γd (kN/m³)	OMC (%)
Expansive soil	15.8	22.1
Expansive soil+5%Stone dust	16.18	18.3
Expansive soil+10%Stone dust	16.83	17.1
Expansive soil+15%Stone dust	16.51	18.2
Expansive soil+20%Stone dust	16.4	19.3

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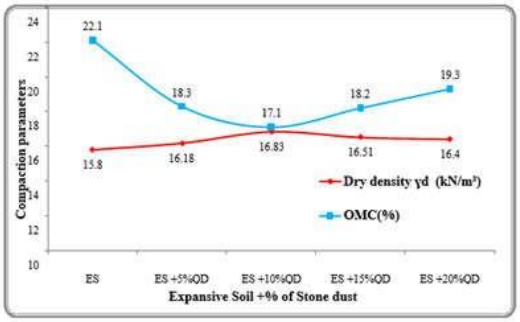
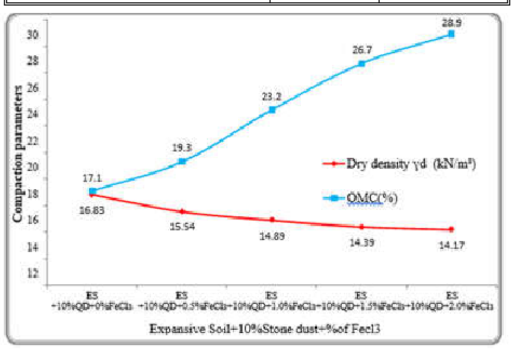


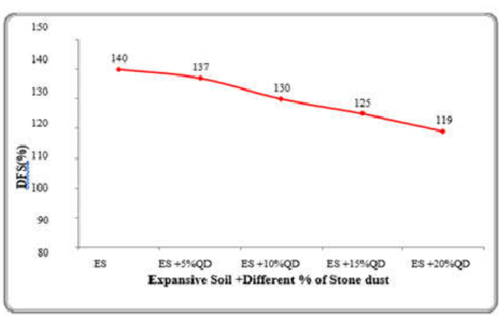
Effect of Stone dust And FeCl3 on CompactionParameters of Soils.

Mix Proportions	Dry density γd (kN/m3)	OMC (%)
Expansive soil+10%Stone dust	16.83	17.1
Expansive soil+10%Stone dust+0.5%FeCl3	15.54	19.3
Expansive soil+10%Stone dust+1.%FeCl	14.89	23.2
Expansive soil+10%Stone dust+1.5%FeCl3	14.39	26.7
Expansive soil+10%Stone dust+2.0%FeCl3	14.17	28.9



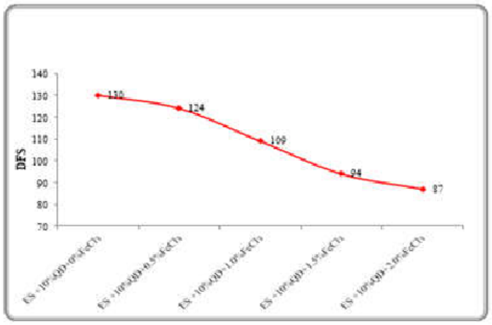
Effect Of Stone dust On DFS Values Of Soils

Mix Proportions	DFS (%)
Expansive soil	140
Expansive soil+5%Stone dust	137
Expansive soil+10%Stone dust	130
Expansive soil+15%Stone dust	125
Expansive soil+20%Stone dust	119



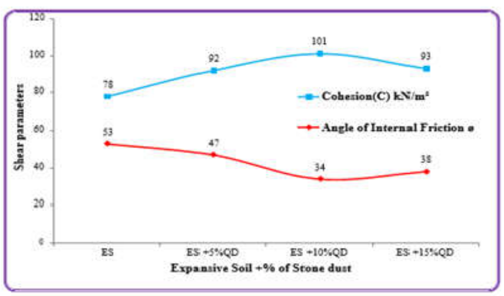
Effect of Stone dust And FeCl3 on DFS Valuesof Soils.

Mix Proportions	DFS (%)
Expansive soil+10%Stone dust	130
Expansive soil+10%Stone dust+0.5%FeCl3	124
Expansive soil+10%Stone dust+1.%FeCl3	109
Expansive soil+10%Stone dust+1.5%FeCl3	94
Expansive soil+10%Stone dust+2.0%FeCl3	87



Effect Stone dust in Cohesion and Angle ofinternal friction values

Mix Proportions	Cohesion(C) kN/m²	Angle of Internal Friction (Ø) °
Expansive soil	78	53
Expansive soil+5%Stone dust	92	47
Expansive soil+10%Stone dust	101	34
Expansive soil+15%Stone dust	93	38



Effect Stone dust and FeCl3 in Cohesion andAngle of internal friction values

Mix Proportions	Cohesion(C) kN/m²	Angle of Internal Friction (ø) °
Expansive soil+10%Stone dust	101	34
Expansivesoil+10%Stonedust+0.5%FeCl3	108	30
Expansive soil+10%Stone dust+1.0%FeCl3	119	26
Expansive soil+10%Stone dust+1.5%FeCl3	128	18
Expansive soil+10%Stone dust+2.0%FeCl3	124	20

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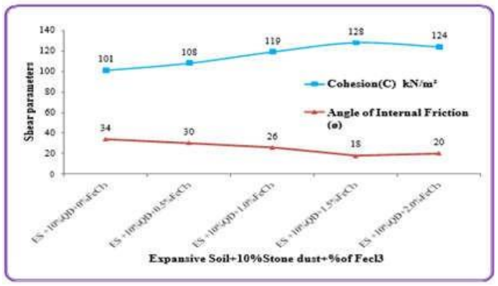
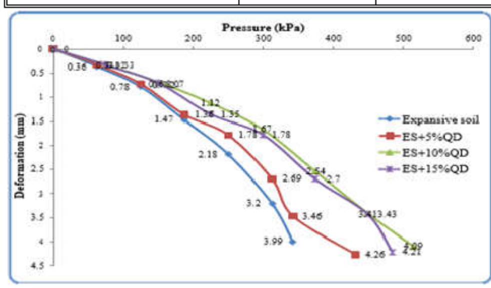


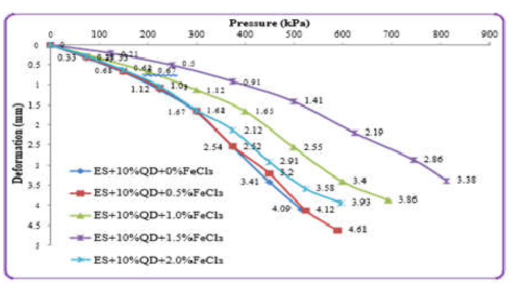
Effect Stone dust in cyclic plate load test onflexible Model tank.

Mix Proportions	Pressure (kPa)	Deformation (mm)
Expansive soil	342.23	3.99
Expansive soil+5%Stone dust	432.17	4.26
Expansive soil+10%Stone dust	514.6	4.09
Expansive soil+15%Stone dust	484.63	4.21



Effect Stone dust and FeCl3 in cyclic plate loadtest on flexible Model tank

Mix Proportions	Pressure (kPa)	Deformation (mm)
Expansive soil+10%Stone dust	514.6	4.09
Expansive soil+10%Stone dust+0.5%FeCl3	589.55	4.61
Expansive soil+10%Stone dust+1.%FeCl3	693.47	3.86
Expansive soil+10%Stone dust+1.5%FeCl3	812.77	3.38
Expansive soil+10%Stone dust+2.0%FeCl3	597.04	3.93



V. CONCLUSIONS

On the whole, this investigation is an attempted to provide insight into the compaction properties, shear parameters and cyclic load behavior of Expansive soil stabilized with different proportions of Stone dust and Ferric chloride. Reduce the environmental problems by utilizing some portion of the industrial waste like Stone dust. The following conclusions are made based onthe laboratory experiments carried out in this investigation study.

Addition of Stone dust(i.e. 0to 20% by dry weight of soil) decreases the liquid limit values from 86% to 52% and plastic limit values are shows gradual decrease from 45% to 34% respectively.

The liquid limit of expansive soil treated with 10% of Stone dust(optimum value) and varying proportion of Fecl3 (i.e. 0 to 2.0%)by dry weight of soil were decreases from 64% to 55% and plasticlimit increases from 41% to 47.2%.

The compaction properties of Expansive soil are improved to a greater extends that is Max. dry density (MDD) increases up to a certain limit from 15.8kN/m^3 to 16.83kN/m^3 (Expansive soil+10% Stone dust) and then further Addition of Stone dust by 5% increment shoes decreasing from 16.83kN/m^3 to 16.4kN/m^3 .and the OMC goes on varying from 22.1 to 18.3, 17.1,18.2 and 19.3 at Expansive soil treated with 0 to 20% Stone dust respectively.

When Expansive soil treated with optimum 10% ofStone dust is mixed with different percentages of Fecl3 (i.e. 0 to 2.0%) the Max. dry density goes on decreasing from 16.83kN/m^3 to 14.17kN/m^3 and OMC increases from 17.1% to 28.9%.

The differential free swell of Expansive soil goes on decreases from 144 to 119 when treated with different percentages of Stone dust (i.e. 0%, 5%, 10%, 15% and 20%).

The Expansive soil treated with 10% Stone dust (optimum Value) and varying percentages of ferric chloride (i.e. 0%, 0.5%, 1.0, 1.5% and 2.0%) the DFS is decreases from 130 to 87.

In the addition of Stone dust to the expansive soil from 0 to 15% by its dry weight soils ,the shear parameters like Cohesion© increases from78kN/m^2 to 101N/m^2 and internal friction angle decreases from53^0 to 34$^{0.}$

When Expansive soil treated with optimum 10% ofStone dust is treated with different percentages of ferric chloride , the Cohesion C goes on increases from 101kN/m^2 to 128kN/m^2 and angle of internal friction increases decreases from 34^0 to 18^0.

From the cyclic load test results it was observed that the load carrying capacity of expansive soils goes on Addition of Stone dust(i.e. 0to 15%) by dryweight of soil. The load carrying capacity of expansive soils at optimum moisture content are goes on varying from 342.23 kPa, 432.17 kPa, 514.6 kPa and 484.63 kPa with respective deformations of 3.99mm to 4.26mm, 4.09mm and 3.62mm.

When Expansive soil treated with optimum 10% of Stone dust is mixed with different percentages of Fecl3 (i.e. 0 to 2.0%). it was observed that the load carrying capacity of expansive soils at optimum moisture content goes on varying from 514.6 kPa, 589.55 kPa, 693.47 kPa, 812.77 kPa and 597.04 kPa with respective deformations of 4.09mm to 4.61mm, 3.88mm, 3.86mm and 4.61mm.

REFERENCES

IS: 2720 (Part 3) (1980). Methods of Test for Soils: Determination of Unconfined Compression Strength, Bureau of Indian Standards, New Delhi, India.

Arun Kumar et al., (2013) were studied the effect of different percentages of Stone dust mixing in expansive soil. Atterberg limit and compaction test were carried out on both unmodified and modified soil.

Aditya Chansoria (2016), Effect of Stone dust on engineering properties of blackcotton soil IJIRST volume 2

Chandrasekhar, B.P., Prasada Raju, G.V.R.,Ramana Murthy, V. and Hari Krishna, P. (1999): “Relative Performance of Lime and Calcium Chloride on properties of Expansive soil for pavement subgrades”, Proc. of IGC-99, Calcutta, pp 279-282

Chaturvedi, A.C., “Expansive Soil in India with Special Reference to U.P.”, Proceedings of First

National Symposium on Expansive Soils, HBTI-Kanpur, India, 1977, pp. 2-1 to 2-5.

Chen, F.H., "Foundations on Expansive Soils", Elsevier Pub Co., 1988, Amsterdam.