

Improvement in Characteristics of Expansive Soil by Using Quarry Waste and Its Comparison with Other Materials like Cement And Lime Being Used For Soil Improvement- A Comparative Study

Ravi Shankar Mishra 1 Brajesh Mishra 2,

Asst. Professor and Head, Department of Civil Engineering, AIMT, Lucknow, U.P., India 1

M. Tech. P.T. Student, Department of Civil Engineering, KNIT, Sultanpur, U.P., India 1

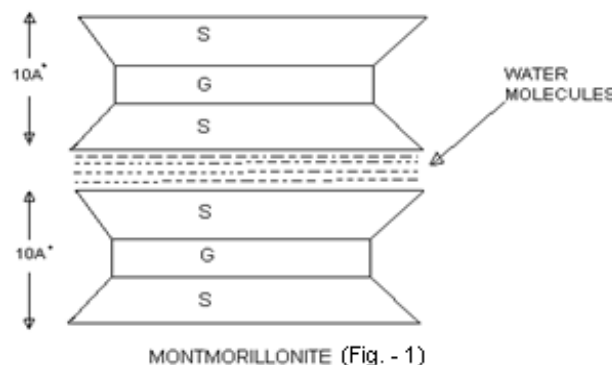
ABSTRACT: Since long, improvement in characteristics of expansive soil by using different materials has been a challenging job for engineers. In modern days of industrialization it becomes imperative to use waste materials from various industries to use for expansive soil stabilization so as to reduce the polluting effect of waste materials from various industries and to achieve worthwhile results. The objective of present study is to explore whether a waste from quarries i.e. stone dust can be used as a stabilizing materials for expansive soil or not without any admixtures or binding materials and comparing it with stabilization using conventional binding materials like cement and lime. Fruitful results in this direction can not only be very cost effective but also environmental friendly.

KEYWORDS: Expansive Soil, Quarry dust, Swelling Index, Unconfined compressive strength

I. INTRODUCTION

The complete study is based upon a simple hypothesis that improvement in swelling characteristics of expansive soil may result in improvement of other important properties of such soil such as Atterberg's Limits, Unconfined compressive strength, optimum moisture content and maximum dry density. It appears that if soil swells more its other properties are poorer.

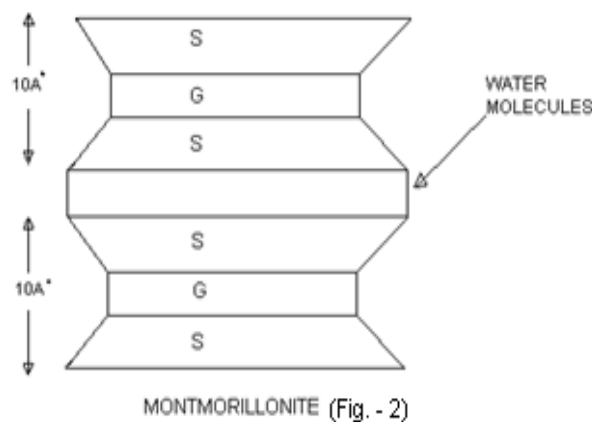
Besides swelling also imparts shrinkage cracks when soil gets dried as swelling is the property of wet expansive soil



that is expansive soil swells almost to the double of original volume when it is submerged and tries to regain its original volume when gets dried causing a lot of shrinkage cracks. Since all the expansive soils encountered in the field are clay

.Clay minerals chiefly contain silicates. One of the most important clay minerals found in expansive soil is Montmorillonite, besides Bentonite and Elite, Smecite. The basic structural unit of montmorliionite is as follws i.e water entrapped between to structural units which is main cause of expansion of soil.

Once quarry waste is mixed and sufficient time is given for chemical reaction leading to stabilization of soil Gibbsite sheet is possibly introduced between two successive structural units expelling water or reacting with water. The possible structure after stablization is as follows.



(After stabilization)

The whole of the following study is based upon above premise/hypothesis.

II. RESEARCH METHODOLOGY

(1)Sample collection:

Samples of virgin expansive soil were collected from Jhansi a district of state Uttar Pradesh in India. . Samples of quarry waste were collected from a quarry near Haldwani in Uttarkhand State of India.

(2) Tests:

Test on virgin soil sample were carried out. Again, test on quarry waste were carried out and finally soil sample was mixed with quarry waste, sufficient time was given for stablisation and tests were carried out for stabilized soil.

The tests which were carried out are for (1) Free swelling index (2) Atterberg's Limits (3) Unconfined strength. Only these tests were carried out as they give clear cut indication for possible improvement in soil characteristics.

Chemical composition was also assessed for virgin soil and quarry waste to interpret the test results.

The same methodology was adopted for soil sample and its possible improvement with its stabilization with cement and lime.

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 8, August 2015

(3) Interpretation of results:

Finally the results were interpreted for improvement in soil characteristics with its stabilization by mixing quarry waste cement and lime separately and then they were compared. If there was improvement in characteristics of soil its possible reasons were found out

Properties of Expansive soil,:

Chemical Composition:

It is as follows

S. No.	Description	Formula	Range
1.	Silica	SiO ₂	48-58(%)
2.	Alumina	Al ₂ O ₃	13—22(%)
3.	Lime	CaO	1-8(%)
4.	Magnesium Oxide	MgO	1.8-5.0(%)
5.	Ferric Oxide	Fe ₂ O ₃	7.5-1.5(%)
6.	Sulphates	SO ₄	0.9-2.0(%)
7.	Carbonates	CO ₃	0.5-6.6(%)
8.	Organic Matter	-	0.4-3.6(%)
9.	Loss on Ignition	-	4.8-16.5(%)
10.	PH	-	6.7-8.9

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 8, August 2015

Other properties of expansive Soil:

S.No	Description of Property	Value
1	Liquid limit (%)	47
2	Plastic limit (%)	20
3	Plasticity Index (%)	27
4	Specific Gravity	2.51
5	I.S.Classifiaction	CH
6	Optimum Moisture Content (%)	23%
7	Maximum Dry Density (t/cu.m)	1.83
8	Unconfined Compressive strength	18.0 kg/cm ²
9	Free swell Index	87

Properties of Quarry waste, Chemical composition

S. No.	Description	Formula	Range
1.	Silica	SiO ₂	75%
2.	Alumina	Al ₂ O ₃	14%
3.	Lime	CaO	1.28%
4.	Magnesium Oxide	MgO	0.33%
5.	Ferric Oxide	Fe ₂ O ₃	1.22%
6.	Sulphates	SO ₄	0.9-2.0(%)
7.	Carbonates	CO ₃	0.5-6.6(%)
8.	Organic Matter	-	0%
9.	Loss on Ignition	-	Not assessed
10.	PH	-	Not assessed

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 8, August 2015

Other properties of quarry waste

S.No	Description of Property	Value
1	Specific Gravity	2.58
2	Liquid limit	Non Plastic
3	Plastic limit	Non Plastic
4	Maximum Dry density (t/cu.m)	1.93
5	Optimum Moisture Content	7.2%
6	Colour	Grey

Properties of soil mixed with quarry waste

Variation of O.M.C with Varying Percentage of Stone Dust is added to Soil

S.No	Percentage of Stone Dust added	Optimum moisture content (%)
1	20	23
2	30	24.2
3	40	25.1

III. SOIL INDEX PROPERTIES

The soil used in our experimental study is brought from Jhansi district. The index properties of Black cotton/clayey soils are presented in table below

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 8, August 2015

Index Properties of Black Cotton Soil/clayey

S.No	Description of Property	Value
1	Liquid limit (%)	47
2	Plastic limit (%)	20
3	Plasticity Index (%)	27
4	Specific Gravity	2.51
5	I.S.Classifiaction	CH
6	Optimum Moisture Content (%)	23%
7	Maximum Dry Density (t/cu.m)	1.83
8	Unconfined Compressive strength	18.0 kg/cm ²
9	Free swell Index	87

The maximum dry density of soil at different optimum moisture content values are listed below in table
O.M.C and M.D.D Curve for Soil Sample

S.No	Optimum Moisture Content (%)	Maximum Dry Density (t/cu.m)
1	15.34	1.658
2	17.12	1.759
3	23.00	1.83
4	26.00	1.724

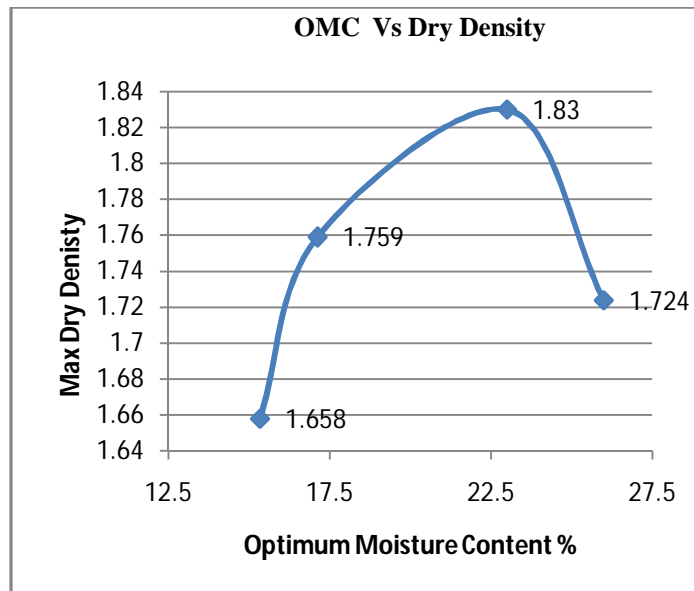


Figure 4.1 Optimum moisture content vs. Dry density

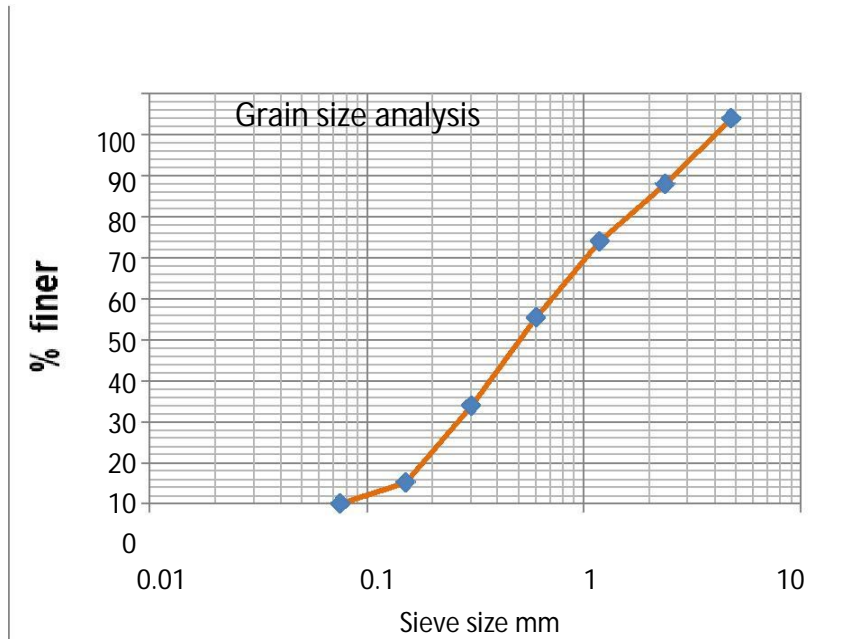
2. STONE DUST PROPERTIES

The Stone Dust used in our experimental study is collected from a quarry nearby Haldwani in Nainital District. The physical values of Stone dust are represented in table below

Physical Properties of Stone Dust

S.No	Description of Property	Value
1	Specific Gravity	2.57
2	Liquid limit	Non Plastic
3	Plastic limit	Non Plastic
4	Maximum Dry density (t/cu.m)	1.9
5	Optimum Moisture Content	7.3%
6	Colour	Grey

Grain Size Distribution of Stone Dust (Quarry Dust)



Grain size analysis of stone dust

Variation of O.M.C with Varying Percentage of Stone Dust is added to Soil

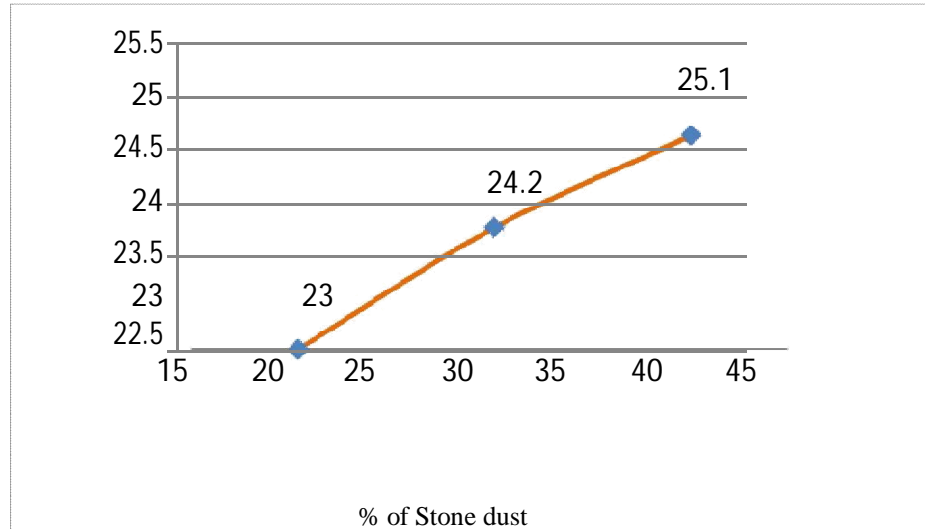
S.No	Percentage of Stone Dust added	Optimum moisture content (%)
1	20	23
2	30	24.2
3	40	25.1

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 8, August 2015

% of Stone dust vs O.M.C (%)

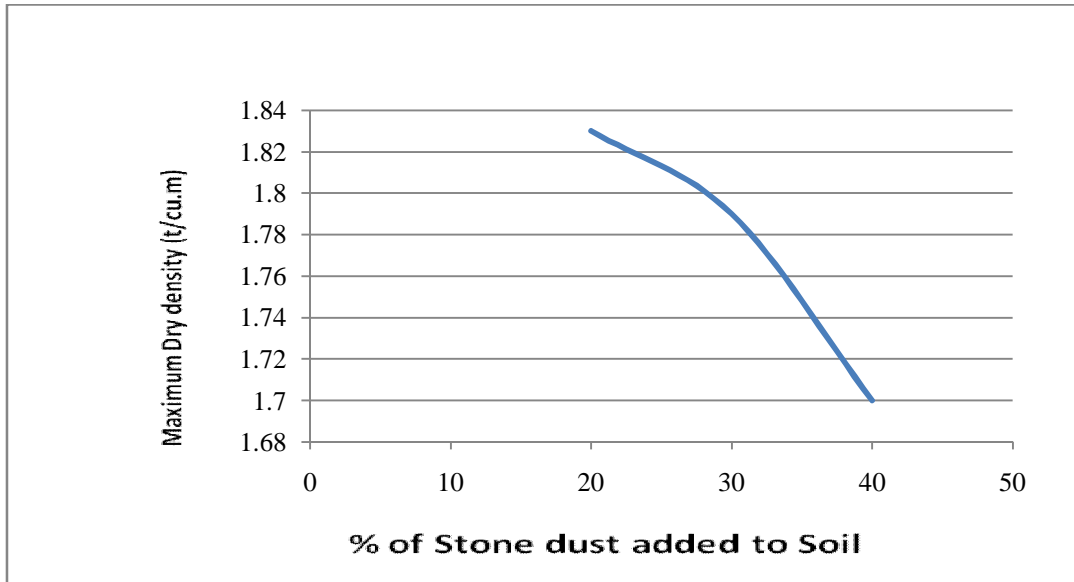


Variation of O.M.C with % of Stone dust added

From above graph it shows that as the percentage of Stone dust is increasing the optimum moisture content is also increasing

Variation of Maximum Dry Density with Varying Percentage of Stone Dust is added to Soil

S.No	% of Stone dust added to soil	Maximum Dry density (t/cu.m)
1	20	1.83
2	30	1.79
3	40	1.7

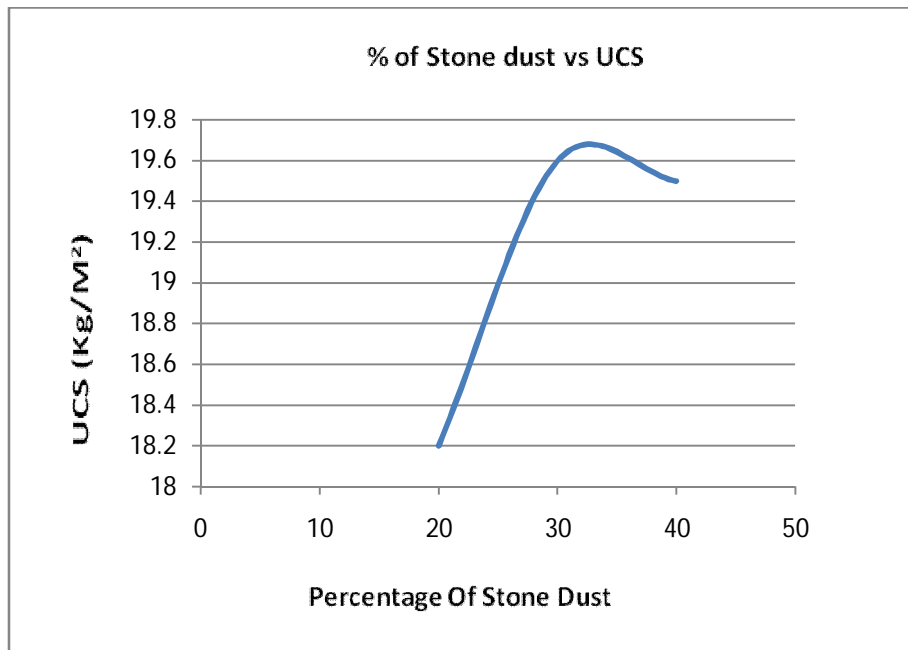


Variation of M.D.D with % of Stone dust added

From the above graph it shows that as the percentage of stone dust is increasing the maximum dry density is decreasing

Variation of UCS with Percentage of Stone Dust is added to Soil

S.No	Percentage Of Stone Dust	UCS (Kg/M ²)
1	20	18.2
2	30	19.60
3	40	19.5



Variation of UCS Strength with % of Stone dust added

From the above graph the unconfined compressive strength of soil is increased and later decreases in addition of Stone dust

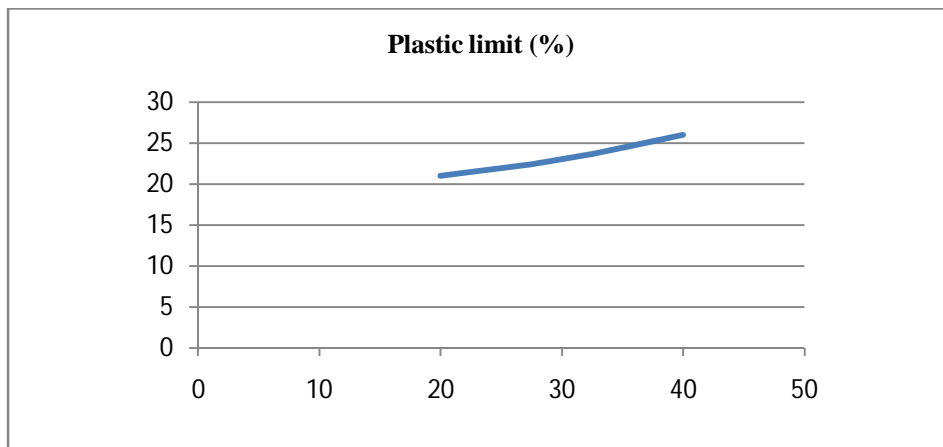
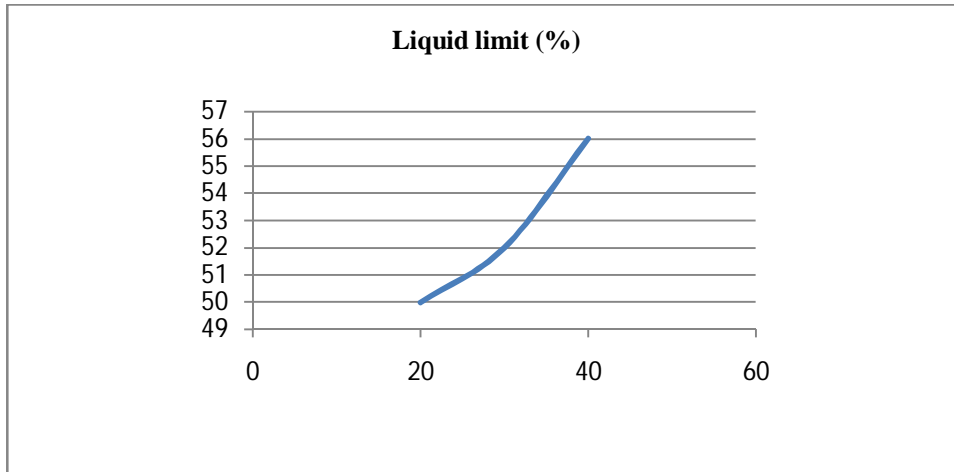
Variation of Liquid Limit and Plastic Limit with Percentage of Stone Dust is added to Soil

S.No	Percentage of Stone dust	Liquid limit (%)	Plastic limit (%)
1	20	50	21
2	30	52	23
3	40	56	26

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 8, August 2015

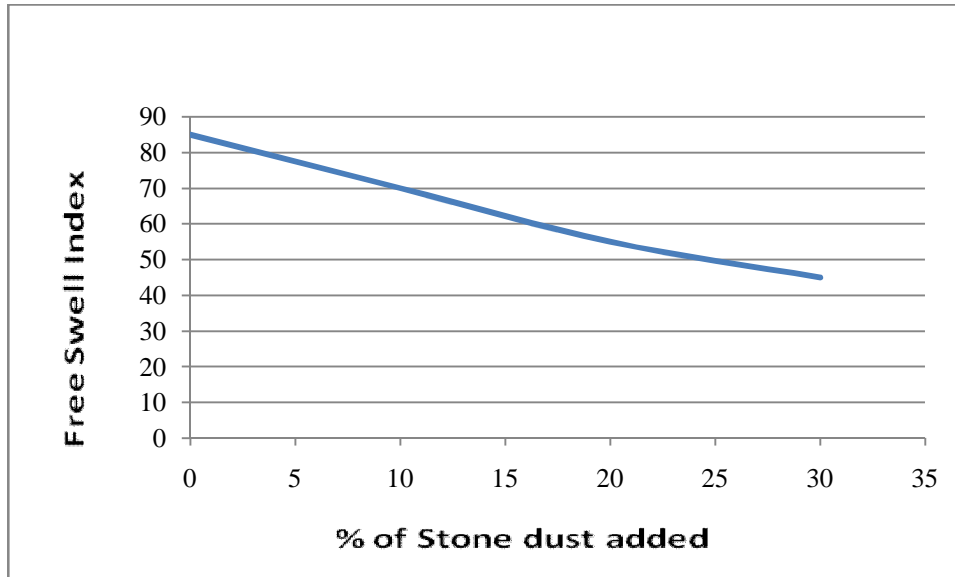


Variation of Liquid and Plastic limit with % of Stone dust added

From the above graphs as the Stone dust content increases the Liquid limit and plastic limit are also increasing

Variation of Free Swell Index with Varying Percentage of Stone Dust is added to Soil

S.No	% of Stone dust added	Free Swell Index
1	0	85
2	10	70
3	20	55
4	30	45



Variation of FSI with % of Stone dust added

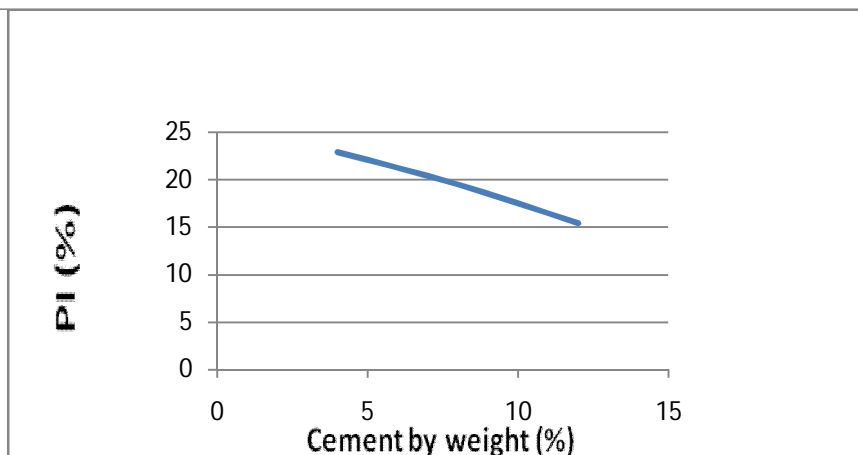
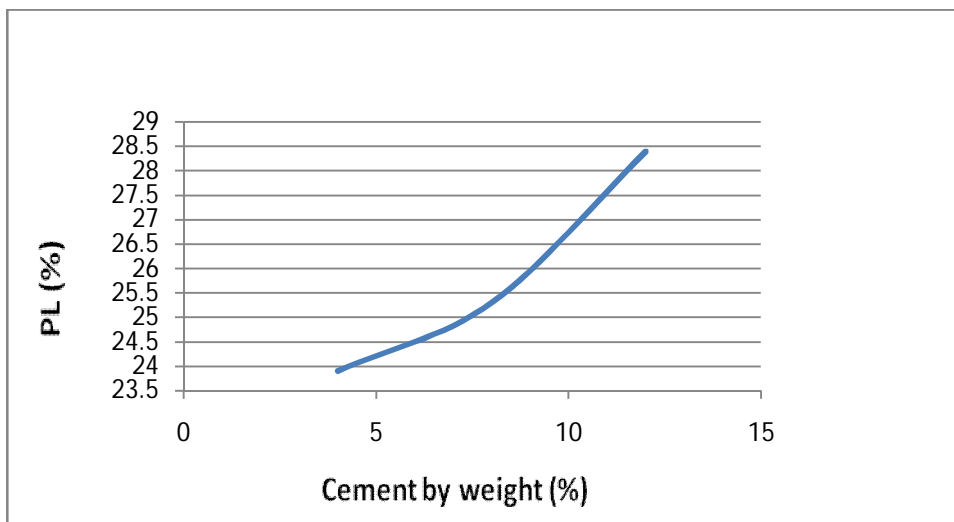
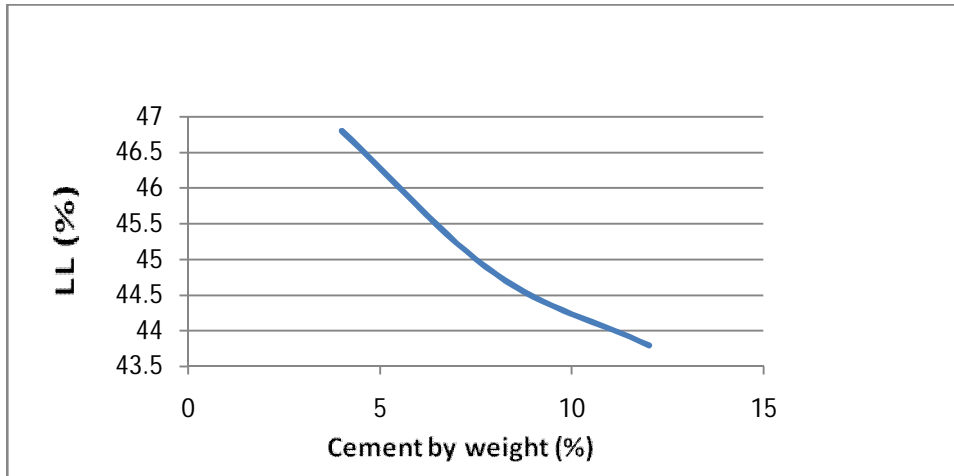
From above graph it shows that as the percentage of stone dust content is increasing sudden decrease in the free swell Index is observed.

Variation in Properties of soil with addition of LIME:

The basic property which was checked before the variation in other properties was checked was free swell Index which is an indicative of swelling. The other properties were checked after that. It was found even with the addition of lime up to 50% no improvement in swelling potential was there hence other properties were not checked

Variation in Properties of soil with addition of Cement:

Atterberg's limit values cement stabilized soil samples				
S. No.	Cement by weight (%)	LL (%)	PL (%)	PI (%)
1	4	46.80	23.90	22.90
2	8	44.80	25.30	19.50
3	12	43.80	28.40	15.40



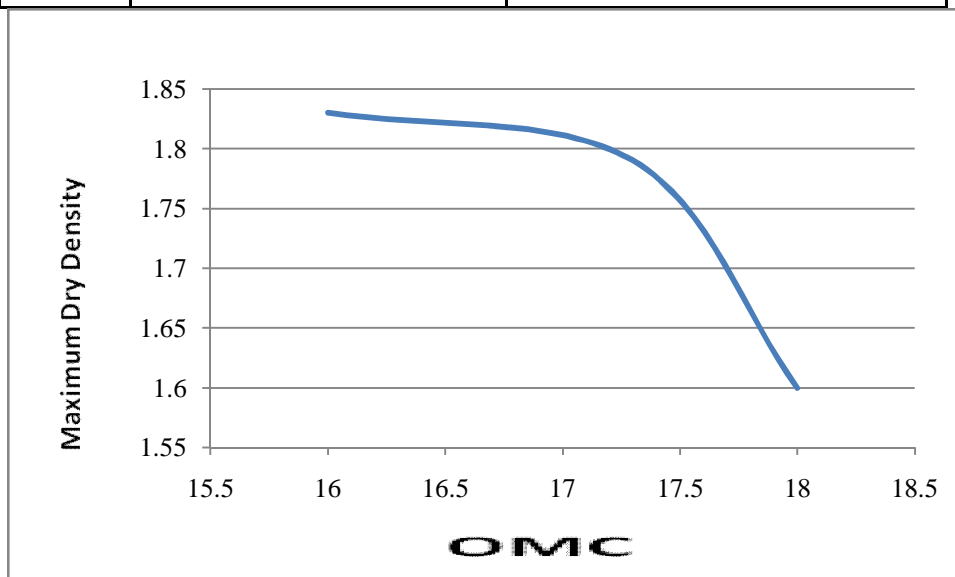
International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 8, August 2015

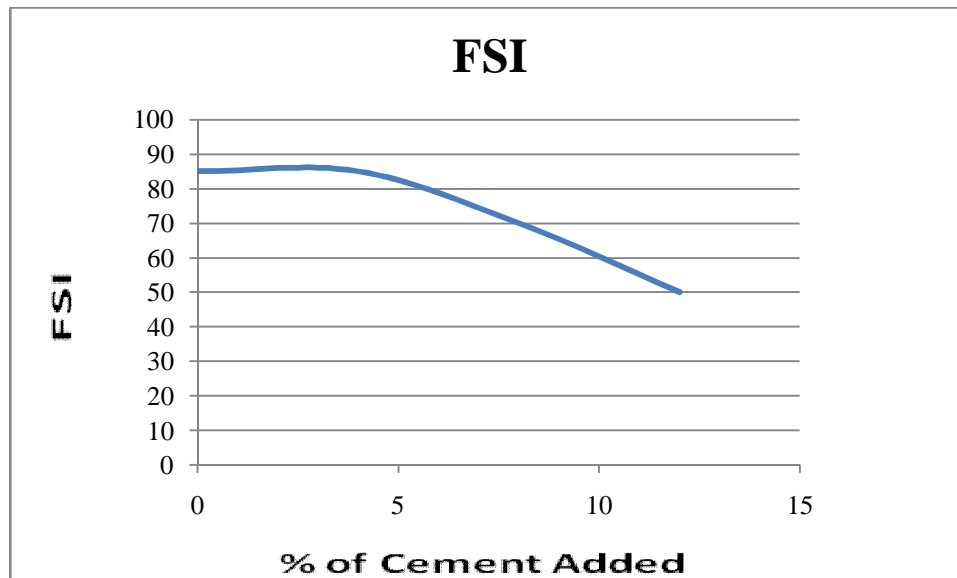
OMC vs MDD

S.No	Optimum Moisture Content (%)	Maximum Dry Density (t/cu.m)
1	16	1.83
2	17.3	1.79
3	18	1.6



Free Swell Index

S.No	% of Cement Added	FSI
1	0	85
2	4	85
3	8	70
4	12	50



IV. ANALYSIS AND RESULTS

From the above study it is clear that basically it is alumina which is responsible for improvement in soil characteristics of expansive soil which replaces the water sheet sand witted between two Structural units of Montmorillonite and which imparts expansive properties to the soil. Since most of the study has been done for improvement in soil characteristic by composite materials like lime pozzolona or cement sand or cement pozzolona in which alumina content is already there. With only lime there was no improvement probably because it didn't has alumina. The researches show that improvement is there with lime columns which are a long term effect and its mechanism shall have to be studied while any short term effect has not been observed in the studies probably because there is no alumina. In case of cement alumina is already there in cement and slight improvement is there while in case of sand dust considerable improvement is there which contains a lot of alumina (up to 14%) . Effect of silica was not inferred as soil mineral already contains most of it so any further addition of silica is not likely to be fruitful

REFERENCES

1. A Study on Some Geotechnical Properties of Lime Stabilized Expansive Soil – Quarry Dust Mixes by Dr. Akshaya Kumar Sabat (SSN 2249-6149 Issue 2, Vol.1 (January -2012 Pg. No 42-49)
2. Effect of Marble Dust on Strength and Durability of Rice Husk Ash Stabilized Expansive Soil by Akshaya Kumar Sabat, Radhikesh P. Nanda (ISSN 0976 – 4399 Pg. No: 939-948)
3. Experimental Studies On Utilization Of Murrum As Hard Shoulder Material by pradeep Muley, Dr. P.K. Jain, Rajeev Jain (International Journal of Engineering Science and Technology Vol. 2(9), 2010, 4896-4901)
4. Performance Analysis of Expansive Soil Treated With Stone Dust And Fly Ash by Mir Sohail Ali, Shubhada Sunil Koranne.
5. Potentials Of Rice Husk Ash For Soil Stabilization By Musa Alhassan (AUJ.T. 11(4):246-250) Apr. 2008
6. R.K.KATTI (1979) —Search for Solutions to Problems in Black Cotton Soils| IGC Annual Lecture, —Indian Geotechnical Journal| Vol.9.
7. Soil Mechanics And Foundation Engineering by Dr.K.Arora
8. Soil Mechanics and Foundation Engineering By B.C.Punmina
9. Stabilization of BLACK COTTON SOIL with Lime and Stone Dust by Ankur Mudgal.
10. Strength Of Stabilized Soils A Laboratory Study On Clays And Organic Soils Stabilized With Different Types Of Binder Doctoral Thesis By Helen Ahnberg.
11. Stabilization of Expansive Soils Using Waste Marble Dust by Onur Baser.