International Journal of Engineering Technology Science and Research
IJETSR
www.ijetsr.com
ISSN 2394 – 3386
Volume 5, Issue 1
January 2018

Stabilization of Subgrade Black Cotton Soil using Cement and M- Sand

Likhitha.H, Raghavendra.H.N, Rakesh.K.P., Uday Shrihari.P
Global Academy of Technology

ABSTRACT

Highways are viewed as supply routes of a nation which are vital for feasible monetary development. Quick populace development and industrialization created the utilization of transportation office to convey business heavier vehicle loads and redundant uses of it subsequently delivering heavier focuses particularly on roads running in clayey soil zones are known for bed condition and unusual conduct for which the way of the clayey soil add to some degree. The disappointments of asphalt in from of hurl dejection splitting and unevenness are brought about by the occasional dampness variety in subgrade soil. Instead of cutting out and replacing the unstable soil, soil adjustment is the only alternative as it saves lot of time and of money too.

Hence this paper investigates the improvements in the properties of expansive soils, as road subgrade stabilized with cement, and M-sand in varying percentages. Laboratory tests were undertaken to study the strength characteristics of expansive soils stabilized with cement and M-sand keeping cement percentage as constant.

KEYWORDS : Stabilization, Black cotton soil, M-Sand, Cement, Sub grade

INTRODUCTION

Expansive soils are those clay soils which exhibited significant volume changes as results of soil moisture variation. This type of soil, upon wetting and drying, causes severe damages to pavement constructed on such soil. Generally pavements on expansive subgrade soils show early distresses causing the premature failures of the pavement structure. Expansive soils usually have undesirable engineering properties, such as low bearing capacity, coupled with low stability and excessive swelling. The nature of these soils creating serious problems to the civil engineering structures particularly road pavements constructed on them. Many researchers are doing extensive studies on this problem and its remedial measures. Among various methods for the solutions to the problems posed by expansive soils, the stabilization of such soils is the best practical option. In general soil stabilization seems to be an effective alternative for improving soil properties.

Stabilization is a technique introduced many years ago with the main purpose to render the soils capable of meeting the requirements of the specific engineering projects. Stabilized materials may be used as improved sub grades or capping layers or sub-bases for road or airfield pavements. It is the alteration of one or more soil properties, by mechanical or chemical means, to create an improved soil material possessing the desired engineering properties. Soils may be stabilized to increase strength and durability or to prevent erosion and dust generation.

Purpose of the stabilization of flexible pavement resting on weak and troublesome soil is to acquire desirable properties of sub grade which are high compressive and shear strength, permanency of strength under all weather and loading conditions, ease and permanency of compaction, ease of, drainage and low susceptibility to volume changes and frost action. Since sub grade soils vary considerably, the interrelationship of texture, density, moisture content and strength of sub grade materials is complex.

LITERATURE RVIEW

1. Sujeet Kumar & Rakesh Kumar Dutta, (2014) : The laboratory test was conducted on effect of Sisal fibers on Bentonite-Lime-Phosphogypsum mixture. They conducted Unconfined Compressive Strength test with

curing. The conclusions say that with addition of 8% lime and 8% Phosphogypsum to Bentonite (reference mix) increased the Unconfined Compressive Strength than Bentonite alone. With addition of 1% sisal fibers to reference mix still increases the Unconfined Compressive Strength. The strength has also increased with curing days.

2. Mrs.Neetu B.Ramteke (2014) : Here the laboratory test were conducted on BC soil where the stablizers used where cement,sand as cement ,sand contain good binding property. Here the preliminary tests like sieve analysis, plastic limit , liquid limit were conducted.here they came to a conclusion that the engineering properties of soil can be increased by making use of stablizers.

3. Jayaprakash Babu (2013) : Here the laboratory test were conducted on BC soil where the stablizers used where cement,sand and flyash as cement ,sand contain good binding property. Here the preliminary tests like sieve analysis, plastic limit , liquid limit were conducted.here they came to a conclusion that the engineering properties of soil can be increased by making use flyash as one of the addition for stabilizer.

4. Gyanen Takhelmayum, Savitha. A (2013) : The study was done on effect of GGBS on the Compaction and Unconfined Compressive Strength properties of black cotton soil. The compaction was conducted with different percentage of coarse and fine grained GGBS. The conclusion shows that as the percentage of GGBS goes on increasing the Maximum Dry Density increases and Optimum Moisture Content decreases up to 30% of GGBS above which Maximum Dry Density decreases. This is due to formation of C-S-H (Calcium Silica Hydrate) due to hydration of GGBS.

MATERIALS AND METHODOLOGY

1. Soil: The black cotton soil is collected from, Holalkere in Chitradurga district, Karnataka State, India. The sample was collected from a depth of about 1.5m below the ground level by open excavation. The obtained soil is air dried and pulverized manually. The soil passing through 425μ IS sieve is used for the study. All the tests are conducted as per IS-2720 standards.

Table No.1: Properties of soil

Specific gravity		2.17
Water content		40%
Grain Size Distribution	Sand	10.65%
	Silt	89.35%
Liquid limit		50%
Plastic limit		21%
Optimum moisture content		24%
Maximum dry density		1.9 kg/cm^3

2 M-Sand: Manufactured sand is a substitute of river for construction purposes sand produced from hard granite stone crushing. The crushed sand is cubical shape with grounded edges, was grated to as a construction material. The size of manufactured sand (M-sand) is less than 4.75.Sand used for the work is clean and coarse sand passing through 4.75 mm sieve was oven dried for 24 hrs to eliminate sand's moisture before the conduction of tests.

Fig 2.1 M-sand

2. **Cement:**Portland pozzolana cement is a kind of blended cement which is produced by either intergrading of OPC clinker along with gypsum and pozzolanic materials in certain proportions or grinding OPC clinker , gypsum and pozzolanic material separately and thoroughly blending them in certain portions.The cement used is Portland pozzolanic Cement (PPC) used for the study was purchased from the market of known the specific gravity. 53 grade

Fig 2.2 PPC

4.Experimental Procedure

Initially the properties of natural black cotton soil are determined. The soil is then stabilized with sand and cement. The amount of sand for stabilization is taken in the proportion of 10%, 20% by dry weight of soil and the amount of cement was taken as 2% by dry weight of soil. Using these proportions, mix samples were prepared as given below and a set of laboratory tests were performed to determine the index properties and CBR values of both natural soil and mixed proportion samples.

1. Natural soil (3kg)
2. Soil +10% Sand +2% Cement.
3. Soil +20% Sand +2% Cement.

4.1 Proctor Compaction Test:

3kgs of air dried soil sample passing 4.75mm IS Sieve is taken thoroughly with a quantity of water and is filled in three layers into the standard mould which is fixed a collar. Each layer is compacted by the hammer giving 25 blows. Each compacted layer is racked with a spatula before placing the next layer. After compaction the collar is detached and the top of mould is trimmed off to remove extra soil. The total weight of wet soil with the mould is taken. A representative sample of soil in the mould is taken for moisture content determination. The test is repeated by adding more water each times say about 2% until the weight of mould with wet soil reduces.

4.2 California Bearing Ratio Test:

Dynamic compaction: Take about 4.5 to 5.5 kg of soil and mix it thoroughly with the desired (optimum moisture content, determined from standard compaction test) water. Fix the extension collar to the top of the mould and the base plate to its bottom. Insert the spacer disc over the base, (With the central hole of the disc at the lower side). Put a filter paper on the top of the spacer disc. Compact the mixed soil in the mould using either the light compaction or heavy compaction. For light compaction, compact the soil in three equal layers, each layer being given 56 blows, uniformly distributed, by the 2.6kg rammer. For heavy compaction, compact the soil in 5 layers, by giving 56 blows to each layer by 4.89kg rammer. Remove the collar and trim off excess soil. Turn the mould upside down and remove the base plate and the displacer disc. Weigh the mould with the compacted soil, so that is its bulk density and dry density may be determined. Put the filter paper on top of the compacted soil (collar side) and clam the perforated base plate on to it.

International Journal of Engineering Technology Science and Research
IJETSR
www.ijetsr.com
ISSN 2394 – 3386
Volume 5, Issue 1
January 2018

Penetration test:

- Place the surcharge weights back on the top of the soil specimen, and place the mould assembly on the penetration test machine.
- Seat the penetration piston at the center of the specimen with the smallest possible load but in no case excess of 4kg.So that full contact is established between the surface of the specimen and the piston.
- Set the stress and strain dial gauge to zero. Apply the load on the penetration piston, so that, the penetration is approximately 1.25mm/min. Record the load readings at penetrations of 0,0.5,1.0,1.5,2.0,2.5,3.0,3.5,4.0,5.0,10.0,12.5mm
- Plot the load penetration curve. If the initial portion of the curve at the point of greatest slope. The corrected origin will be the point where the tangent meets the abscissa. Find and record the corrected load reading corresponding to each penetration

RESULTS & DISCUSSIONS

5.1 Standard Proctor Compaction Test:

1. Natural soil

% Water Added	12%	14%	16%	18%	20%	22%	24%	26%
Wt of empty mould	5.61	5.61	5.61	5.61	5.61	5.61	5.61	5.61
Wt of mould + compacted soil	7.54	7.69	8.2	7.54	7.52	7.51	7.49	7.47
Wt of compacted soil	1.89	1.91	1.93	1.95	2.02	1.91	1.89	1.87
Bulk Density	1.88	1.92	1.94	1.96	1.98	1.94	1.92	1.90
Dry Density	1.76	1.8	1.93	1.98	2.02	2	1.98	1.97

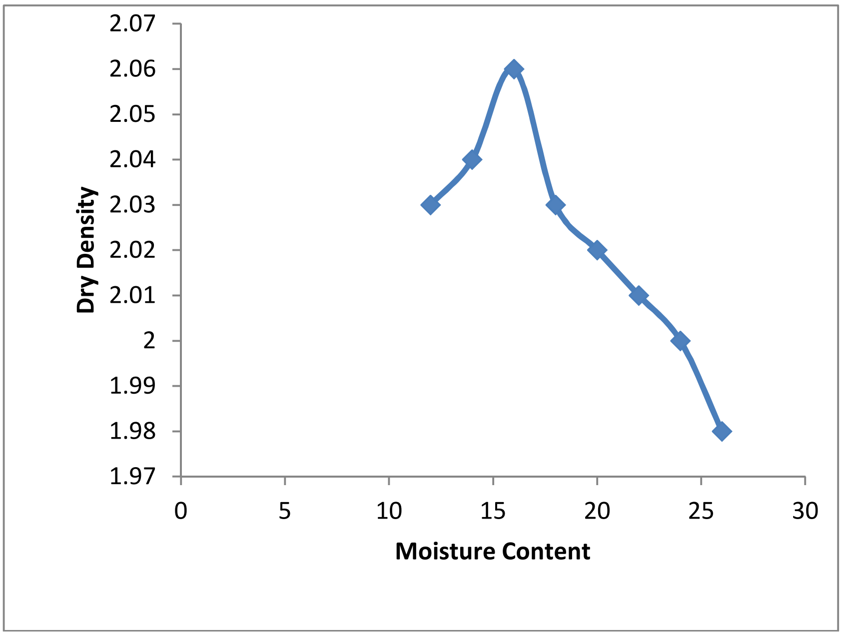

Fig. a Dry density – moisture content graph of natural black cotton soil

2. Soil+ 10%sand+2%cement

% Water Added	12%	14%	16%	18%	20%	22%	24%	26%	28%	30%
Wt of empty mould	5.57	5.57	5.57	5.57	5.77	5.57	5.57	5.57	5.57	5.57
Wt of Mould + compacted soil	7.54	7.55	7.57	7.64	7.63	7.58	7.54	7.5	7.48	7.44
Wt of compacted soil	1.97	1.98	2	2.06	2.04	2.01	1.97	1.93	1.91	1.87
Bulk Density	2	2.01	2.03	2.09	2.05	2.04	2	1.96	1.94	1.9
Dry Density	1.97	1.98	2.01	2.04	2.03	2.02	2.01	1.99	1.98	1.96

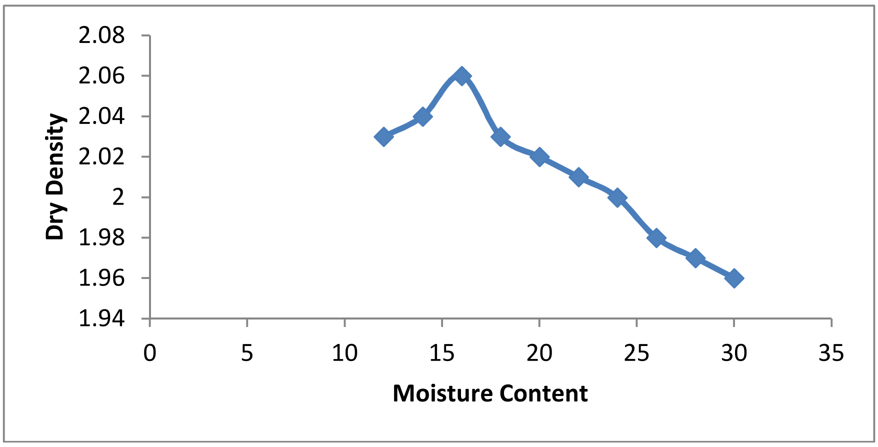

Fig. b Dry density – moisture content graph of soil stabilized with 10% sand & 2% cement

3.Soil+ 20%sand+ 2%cement

% Water Added	12%	14%	16%	18%	20%	22%	24%	26%	28%	30%
Wt of empty mould	5.57	5.57	5.57	5.57	5.77	5.57	5.57	5.57	5.57	5.57
Wt of Mould + compacted soil	7.55	7.58	7.62	7.61	7.61	7.53	7.45	7.43	7.42	7.4
Wt of compacted soil	1.98	2.01	2.05	2.04	2.04	1.96	1.88	1.86	1.85	1.83
Bulk Density	2.01	2.04	2.08	2.07	2.07	1.99	1.91	1.89	1.88	1.86
Dry Density	2.03	2.04	2.06	2.03	2.02	2.01	2	1.98	1.97	1.96

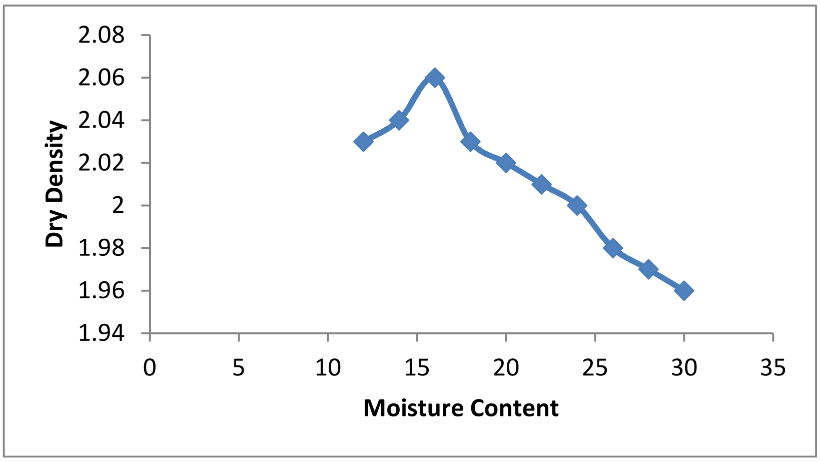

Fig. c Dry density – moisture content graph of soil stabilized with 20% sand & 2% cement

Type	**OMC**	**MDD** g/cm^{-3}
Natural Soil	20%	2.02
Soil + 10% sand + 2% cement	18%	2.04
Soil + 20% sand + 2% cement	16%	2.06

The above table shows the values obtained from compaction , for varying percentages of cement, & M-sand. We can see that the stability of the subgrade black cotton soil can be increased by using stabalizers like cement , m-sand , as there is OMC decreases and dry density increases when stablizers are used.

5.2 CBR test results

1. Natural BC soil

Dial Gauge Reading	**Proving Ring Reading**		**Load**
	Div.	**Div. * PRC**	**(kN)**
0	1	58.8	5.99
0.5	2.4	164.64	16.782
1.0	3	176.4	17.98
1.5	3.4	199.2	20.3
2.0	4	235.2	23.97
2.5	4.6	270.48	27.57
3.0	5.2	305.76	31.168
3.5	5.8	341.04	34.764
4.0	6.2	364.56	37.162
4.5	6.6	388.08	39.56
5.0	6.85	399.84	40.75

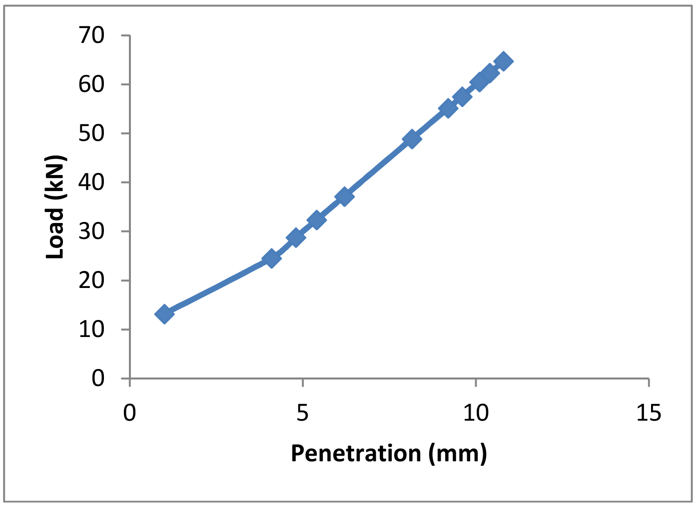

Fig. d CBR graph of natural black cotton soil

International Journal of Engineering Technology Science and Research
IJETSR
www.ijetsr.com
ISSN 2394 – 3386
Volume 5, Issue 1
January 2018

CBR for 2.5mm Penetration = (Test Load/ Standard Load)*100 = (27.57/1370)*100 = 2.012%

CBR for 5mm Penetration = (Test Load/ Standard Load)*100 = (40.75/ 2055)*100 = 1.98%

Here 5kgs of black cotton soil is taken and the CBR test was conducted ,then the obtained penetration values for 2.5mm is 2.012% and for 5mm penetration 1.98%.

2. Soil +10%sand +2% cement

Dial Gauge Reading	Proving Ring Reading		Load (kN)
	Div.	Div. * PRC	
0	1	129.36	13.186
0.5	4.1	241.08	24.57
1.0	4.8	287.75	28.77
1.5	5.4	217.52	32.366
2.0	6.2	364.56	37.17
2.5	8.15	479.78	48.90
3.0	9.2	540.96	55.14
3.5	9.6	564.48	57.54
4.0	10.1	593.88	60.53
4.5	10.4	611.52	62.33
5.0	10.8	635.04	64.73

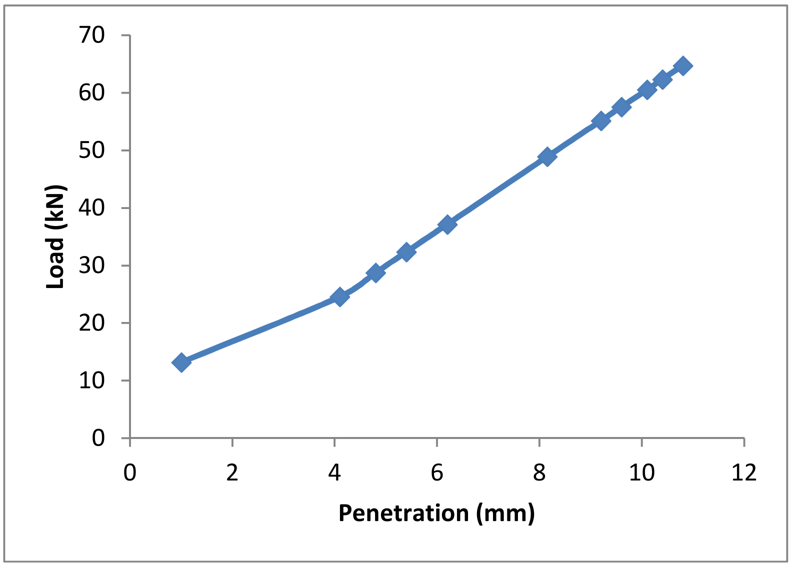

Fig. e CBR graph of soil stabilized with 10% sand & 2% cement

CBR for 2.5mm Penetration = (48.908/1370)*100 = 3.57%

CBR for 5mm Penetration = (64.733/ 2055)*100 = 3.15%

Here out of 5kgs , 10% m-sand ,2% cement were taken and the CBR test was conducted ,then the obtained penetration values for 2.5mm us 3.57% and for 5mm penetration 3.15%.

International Journal of Engineering Technology Science and Research
IJETSR
www.ijetsr.com
ISSN 2394 – 3386
Volume 5, Issue 1
January 2018

Dial Gauge Reading	Proving Ring Reading		Load (kN)
	Div.	Div. * PRC	
0	1.8	105.84	10.78
0.5	1.8	105.84	10.78
1.0	3.2	188.16	19.18
1.5	5.6	329.28	33.56
2.0	8.8	517.44	52.74
2.5	11.72	689.45	70.281
3.0	13	764.4	77.7
3.5	14.2	834.96	85.11
4.0	15.4	905.52	92.3
4.5	16.2	952.52	97
5.0	17.2	1011.36	103.09

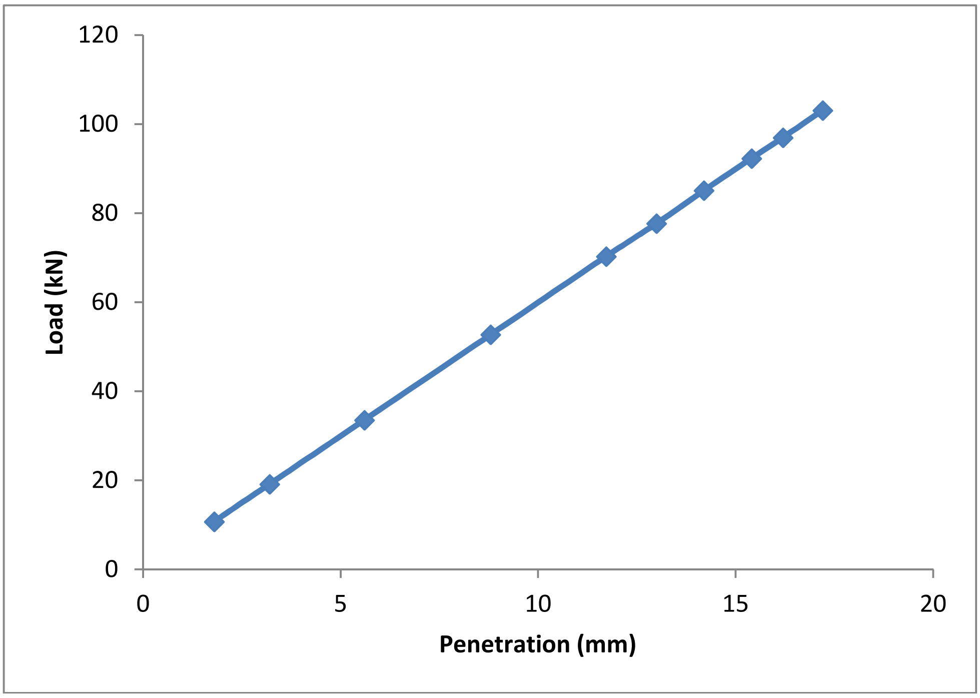

Fig. f CBR graph of soil stabilized with 20% sand & 2% cement

CBR for 2.5mm Penetration = (70.281/1370)*100 = 5.13%

CBR for 5mm Penetration = (103.09/ 2055)*100 = 5.01%

Here out of 5kgs , 20% m-sand ,2% cement were taken and the CBR test was conducted ,then the obtained penetration values for 2.5mm us 5.13% and for 5mm penetration 5.01%.

We consider the 2.5mm penetration values since it is greater than 5mm penetration values.

From CBR tests of black cotton soil with varying percentage of stabilizers like cement, M –sand. It can seen that from the graph the CBR values increases when stabilizers were used. Hence can conclude that the stability of the Black cotton soil can be increased by making use of the stabilizers such as cement, M - sand.

Type	2.5mm penetration	5mm penetration
Natural BC Soil	2.1	1.98
Soil +10%sand + 2% cement	3.57	3.15
Soil +20%sand + 2% cement	5.13	5.01

CONCLUSIONS

- From the above experiments conducted we conclude that the stability of the Black cotton soil can be increased by making use of the stabilizers such as cement, M-sand.
- If the density of the BC soil increases, it supports in increase in value of CBR and hence the area of BC soil will be useful for laying pavements.
- Economical method of stabilization.
- The concrete mixture generates a very low heat of hydration which prevents thermal cracking.

REFERENCES

1.Dr. S.M. Prasanna Kumar, "Cementitious compounds formation using Pozzolans and their effect on stabilization of soils of varying engineering properties." (2011),Vol.8, International conference on 2.Environment Science and Engineering.

2. Mukesh A. Patil, Dr. H.S.Patel, "A Review on effects of stabilizing agents for stabilization of weak soil." (2012) ,Vol. 2, No.6, IISTE.

3.Pankaj R. Modak, Prakash B.Nangare, "Stabilization of Black cotton soil using admixtures" (2012) Vol. 1, Issue 5, IJEIT.

4.Başer O., 2009, "Stabilization of expansive soils using waste marble dust", Master of Science thesis submitted to Civil Engineering Department, Middle East ,Technical University.

5.Khusbhu S. Gandhi 2013 Stabilization of Expansive soil of Surat region Using Rice Husk Ash and Marble Dust . ISSN 2277-4106 Vol 3 , 2013

6.Prasad Dahale and Vishali j . Rajurkar .International Journal of Applied Engineering Research ISSN 0973-4562 Volume 9, number 2.

7.Bose, B(2012), "Geo engineering properties of expansive soil stabilised with bagasse ash," Electronic journal of geotechnical engineering, Vol 17 bund. J, pp1339-1353.