

# International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: [www.ijirset.com](http://www.ijirset.com)

Vol. 6, Issue 12, December 2017

## Behaviour of Bentonite Soil with Lime and Stone Dust

Jat, Sitaram<sup>1</sup>, Purohit, D.G.M.<sup>2</sup>

P.G. Scholar, Department of Civil Engineering, M.B.M. Engineering College, Faculty of Engineering, Jai Narayan  
Vyas University, Jodhpur, Rajasthan, India<sup>1</sup>

Professor, Department of Civil Engineering, M.B.M. Engineering College, Faculty of Engineering, Jai Narayan Vyas  
University, Jodhpur, Rajasthan, India<sup>2</sup>

**ABSTRACT:** Bentonite soil has the tendency to swell or shrink depending on its water content variations. Due to such expansive characteristics of these soils, the structures constructed over this may develop some cracks in due course of time. It is there for essential to stabilize such soils, prior to any construction work carried out on this to improve its engineering properties. At present waste materials like stone dust from crushers, lime from industry and plastic waste are in abundance at various parts of our country. These wastes not only create health problems but also its disposal is a great problem for our society. This paper deals with a feasibility study carried out to find the suitability of using waste material i.e. stone dust and lime as stabilizing material for improving the engineering properties of bentonite soil. Various tests like CBR, Standard Proctor Test were performed on the soil samples prepared by using stone dust (5%, 10%, 15% 20% and 25%) and lime (3%, 6% and 9%) mixed with bentonite soil at different percentages. On the basis of the results obtained from these tests, it may be concluded that the strength of bentonite soil can be substantially improved by mixing with stone dust and lime as stabilized materials.

**KEYWORDS:** Bentonite Soil, Soil Stabilization, Stone Dust, Lime, Atterberg's limits, CBR, OMC and MDD.

### I. INTRODUCTION

Expansive soils have the tendency to swell when their moisture content is increased and shrink when their moisture content is decreased. The moisture may come from rain flooding, leaking water or sewer lines or from reduction in surface evapo-transpiration when an area is covered by a building or pavement. The large amount of bentonite soils are available in Jaisalmer district (Ramgarh, Pokhren, etc), Barmer district, Pali district (Jetpur), Nagaur district, Jodhpur district (Bhopalgarh) in Rajasthan State and Gujarat etc. Swelling soil is present which leads us to a major investment over construction projects or a maintenance which gives an option to avoid the use of such land. Since long, improvement in characteristics of expansive soil by using different materials has been a challenging job for engineers. Swelling of soil leads to reduction in the serviceability, emergence of hairline cracks and sometimes even severe cracks which lead to collapse of the structure. Bentonite soil has proved itself as a source of damage to the property and economical losses. To achieve the economy and for proper performance of structures it is necessary to improve the geotechnical properties of expansive soil before construction in the areas having bentonite soil. To achieve the economy and proper performance of structures, it is necessary to improve the geotechnical properties of expansive soil before construction in the areas having bentonite soil. Swelling properties of bentonite soil may be reduced by alter the properties with some additives like cement, lime, stone dust, brick dust, sand, quarry dust, fly ash, polypropylene fibers, expanded polystyrene (EPS) geofoam, rice husk ash, silica fume etc.

# International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: [www.ijirset.com](http://www.ijirset.com)

Vol. 6, Issue 12, December 2017

## II. LITERATURE REVIEW

Soil stabilization is a procedure where we improve engineering properties of soil with the use of natural or synthesized admixtures. In the past many researchers have carried out their research work for improving the strength of expansive soil using different types of admixture at different percentages. The present paper deals with the stabilization of bentonite soil using stone dust and lime. Detailed literatures have been reviewed on this topic i.e. related to bentonite soil stabilization and some of the reviewed literatures are presented in proceeding paragraphs.

David, Robert and Rogers, (1998), stated that Expansive soils in many parts of the United State pose a significant hazard to foundations for light buildings. Swelling clays derived from residual soils can exert uplift pressures of as much as 5,500 PSF, which can do considerable damage to lightly-loaded wood-frame structures. Insurance companies pay out millions of dollars yearly to repair homes distressed by expansive soils. Expansive soils owe their characteristics to the presence of swelling clay minerals. As they get wet, the clay minerals absorb water molecules and expand; conversely, as they dry they shrink, leaving large voids in the soil. Swelling clays can control the behavior of virtually any type of soil if the percentage of clay is more than about 5 percent by weight. Soils with smectite clay minerals, such as montmorillonite, exhibit the most profound swelling properties.

Purohit, Ameta and Wayal, (2007), stated that the expansive soils, which are spread over extensive areas of India in states, like Rajasthan, Madhya Pradesh, Gujarat, Andhra Pradesh, Karnataka and Tamil-Nadu posed serious problems for buildings and roads. In our country the typical example of expansive soils are black cotton soil, bentonite soil, mar and kabar. Bentonite is a highly expansive soil. It exhibits a tendency of swelling on coming in contact with water and shrinks on removal of water which may result in structural damage to engineering construction.

## III. EXPERIMENTAL INVESTIGATIONS

Various tests such as Atterberg's limits (liquid limit and plastic limit) , CBR, OMC & MDD, etc., have been performed to find out the engineering properties of bentonite soil as well as the soil mixed with stone dust (5%, 10%, 15% 20% and 25%) and lime (3%, 6% and 9%) as stabilized material.

### 3.1 Material Used

Bentonite soil - About 100kg of soil sample for the present work was collected from the Jaismer (Rajasthan)

Stone Dust - Stone dust for the present work was obtained from stone crusher located at BORANADA, INDUSTRIAL AREA JODHPUR.

Lime – Lime were purchased from local market, Jodhpur,Rjasthan.

### 3.2 Atterberg's limits

Tests were carried out on the virgin soil sample to find out Atterberg's limit as per the procedure mentioned in IS 2720 (Part5) 1985. From the test results, plasticity index of the virgin bentonite soil was found to be 179% and hence the soil sample can be categorized as clay with high plasticity. Virgin bentonite soil were mixed in varying percentages of stone dust (5%, 10%, 15% 20% and 25%) and lime (3%, 6% and 9%) by the weight of soil sample & the details are given in Table 3.1

# International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: [www.ijirset.com](http://www.ijirset.com)

Vol. 6, Issue 12, December 2017

**Table 3.1:** Atterbergs Limits of bentonite soil mixed with Stone dust and lime

Lime (%)	Stone dust (%)	Virgin Soil (%)	Liquid Limit (%)	Plastic limit (%)	Plasticity Index (%)
-		100	215	36	179
3	5	92	80	24	56
	10	87	52	22	30
6	5	89	66	21	45
	10	84	49	20.5	28.5
	15	79	42	18.5	23.5
	20	74	39	NP	NP
	25	69	36	NP	NP
9	5	86	68	16	52
	10	81	51	NP	NP
	15	76	46	NP	NP
	20	71	42	NP	NP
	25	66	40	NP	NP

### 3.3 Standard Proctor Test

Proctor tests were conducted to find out the OMC & MDD of the virgin soil samples and also the soil samples mixed with various percentages of stone dust (5%, 10%, 15% 20% and 25%) and lime (3%, 6% and 9%) as given in Table 3.2. For these tests procedure is given in IS 2720 (Part7) 1980. OMC and MDD of virgin soil were found to be 32.3% and 1.58 g/cm<sup>3</sup> respectively. The test results are given in table 3.2. The minimum value of OMC (24%) and maximum value of MDD (1.74 g/cc) were found for the mix of bentonite soil with stone dust (20%) and lime (6%).

**Table 3.2:** OMC and MDD of bentonite soil mixed with lime and stone dust

Lime (%)	Stone dust (%)	Virgin Soil (%)	Optimum Water Content (%)	Max. Dry Density (g/cm <sup>3</sup> )
-	-	100	32.3	1.58
3	5	92	31	1.63
	10	87	30	1.64
6	5	89	31.5	1.62
	10	84	29.5	1.70
	15	79	28	1.72
	20	74	24	1.74
	25	69	26	1.66
9	5	86	30.4	1.67
	10	81	28	1.69
	15	76	27	1.70
	20	71	26.3	1.71
	25	66	26	1.65

# International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: [www.ijirset.com](http://www.ijirset.com)

Vol. 6, Issue 12, December 2017

### 3.4 California Bearing Ratio

CBR tests were conducted on the virgin soil samples and also samples mixed with various percentages of stone dust (5%, 10%, 15% 20% and 25%) and lime (3% and 6%) as given in table 3.3. For these tests, the procedure given in IS 2720 (Part16) 1987 were follow. The test results are given in table 3.3. Un-soaked CBR of virgin soil was found to be 1.83.

**Table 3.3:** Un-soaked CBR value for bentonite soil mixed with stone dust and lime

Lime (%)	Stone dust (%)	Virgin Soil (%)	Water Content (%)	Un-soaked CBR value at 2.5mm Penetration
-		100	32.3	1.83
3	5	92	31	4.38
	10	87	30	5.47
6	5	89	31.5	4.74
	10	84	29.5	5.83
	15	79	28	6.56
	20	74	24	9.49
	25	69	26	7.30

## IV. DISCUSSIONS ON THE TEST RESULTS

### 4.1 Discussion on Atterberg's limits Test results

Liquid limit of bentonite soil was decreases by addition of lime and stone dust at different percentage. The liquid limit of virgin bentonite soil was found to be 215% and the minimum value of liquid limit was found to be 36% at 6% lime and 25% stone dust.

The Plastic limit was increases by addition of lime and decreases with addition of stone dust. Further addition of admixtures plastic limit 36% (for virgin soil) was gradually decreased up to 6% lime & 15% stone dust and further addition of admixtures soil was found non plastic.

### 4.2 Discussion on the Standard Proctor Test results

OMC & MDD of the virgin soil was found to be 32.3% and 1.58 g/cm<sup>3</sup> respectively. From the test results, it was found that the Optimum Moisture Content decreases and the maximum dry density increases with the addition of stone dust and lime and maximum value of MDD was found to be 1.74 g/cm<sup>3</sup> with 24% OMC at 20% stone dust and 6% lime and minimum value of MDD was found to be 1.62 g/cm<sup>3</sup> with 31.5% OMC at 5% stone dust and 6% lime.

### 4.3 Discussion on the California bearing ratio results

Un-soaked CBR value of virgin bentonite soil obtained as 1.83%. From the test results, it was found that the un-soaked CBR value of bentonit soil increases with the addition of stone dust and lime & maximum value of CBR was found to be 9.49% at 20% stone dust and 6% lime and minimum value of un-soaked CBR was found to be 4.38 at 5% stone dust and 6% lime.

# International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: [www.ijrset.com](http://www.ijrset.com)

Vol. 6, Issue 12, December 2017

## V. CONCLUSION

On the basis of experimental investigations & results obtained, following conclusion can be drawn –

1. Liquid limit decreases from 215% (for virgin soil) to 36% by addition of 6% lime & 25% stone dust with bentonite soil.
2. Plastic limit was increases by addition of lime and decreases with addition of stone dust. Further addition of admixtures plastic limit 36% (for virgin soil) was gradually decreased up to 6% lime & 15% stone dust and further addition of admixtures soil was found non plastic
3. The optimum value of maximum dry density was found 1.74 g/cc at 6% lime & 20% stone dust.
4. Optimum moisture content 32.3% (for virgin soil) was found gradually decreasing by adding admixtures and optimum OMC was found 24% at 6% lime & 20% stone dust.
5. The un-soaked CBR value of virgin bentonite soil obtained as 1.83. On the addition of Stone dust & Lime, the value of un-soaked CBR increased and the maximum value of un-soaked CBR was found to be 9.49% with 20% stone dust and 6% lime.

## REFERENCES

1. Bshara et al. (2014) Effect of Stone Dust on Geotechnical properties of Poor soil. Int. Journal of Civil Engineering and Technology (IJCIET), vol. 5, issue 4, 37-47.
2. Chansoria and Yadav (2016) "Effect of Quarry Dust on Engineering Properties of Black Cotton Soil", International Journal for Innovative Research in Science & Technology, Volume 2, Issue 11, April 2016.
3. Gulsah (2004), "Stabilization of expansive soils using aggregate waste, rock powder and lime", a Master of Science thesis, submitted to the graduate school of natural and applied sciences of the Middle East technical university.
4. David et al. (Sep. 1985) "Damage to foundations from expansive soils".
5. Gupta et al. (2002), "Stabilization of black cotton soil using crusher dust –A waste product of Bundelkhand region." Proceedings of Indian Geotechnical Conference, Allahabad, pp. 308-311.
6. Jones and Holtz (Aug. 1973) "Expansive Soils – The hidden Disaster", Civil Engineering, Vol.43, Nov. 8
7. Wayal et al., (2007), Characteristics, Problems and Remedies of Expansive Soils of Rajasthan, India, EJGE.
8. Kamon and Nontananandh, (1991), "Industrial Wastes with Lime for Soil Stabilization" Research gate.
9. Kate (2008) "A Case Study on Rectification of Damaged Structures on Expansive Soil Deposits" International Conference on Case Histories in Geotechnical Engineering-I
10. Katti (1979) "Search for Solutions to Problems in Black Cotton Soils". Indian Geotechnical Journal, LG.S. Vol. 9, No. 1.
11. Purohit et al. (2007), "Economics of Stabilizing of Bentonite Soil with Lime-Gypsum" India. EJGE.