Research Article

DUNE SAND STABILIZATION USING BENTONITE AND LIME

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ABSTRACT

This paper presents experimental results on the use of bentonite and lime in stabilizing dune sands for possible uses in geotechnical engineering. The addition of lime help in the immediate amelioration effects caused by base exchange and flocculation. The tangible effect of lime soil stabilization in increasing the strength of mixture begins to be felt as lime content further increased due to pozzolanic reactions resulting in the production of cementious compounds. The bentonite added to the mix was helping in making cohesive bond in the mix. The various mix prepared for the tests were addition of 5%, 10% and 15% bentonite with lime 1%, 2% and 3%. Laboratory tests such as compaction and unconfined compression test were performed to measure the engineering characteristics of stabilized materials. The results showed substantial improvements in unconfined compression strength with addition of 15% bentonite and 3% lime. Thus bentonite and lime can be used to improve the strength characteristics of dune sand.

KEYWORDS Dune sand, bentonite, lime, stabilization, unconfined compression strength.

INTRODUCTION

Dune sand is abundantly available in western Rajasthan. It is loose and cohesion less in its natural form. Due to its low bearing capacity and shifting nature easy movement of vehicles is impossible. To make use of dune sand as sub base and base course for roads it is must to be stabilized with some suitable admixtures. The construction as well as protection of pavement for the purpose of approach roads, temporary roads and landing strips in desert region has been a problem of great concern, which necessitates stabilization of dune sand with some admixtures to improve its strength property and reduce settlements. The main aim of the present study was to develop a mix proportion that can be economically used for stabilization of dune sand using cheap and locally available materials like bentonite and lime. The standard proctor and unconfined compression strength were conducted for assessing the suitability of different proportions of mixtures of bentonite and lime added to dune sand.

Many researchers worked in the area of stabilization of soil and control on desertification like Ingles and Metcalf (1972),Bell (1998), Kar (1994), Venkateswarlu. (1993), Venkateswarlu and Kar (1996), Watson (1990).

LABORATORY INVESTIGATIONS

Materials:

Dune sand used for the present study was collected from Osion 60 km North west of Jodhpur. The lime used for the study was hydrated lime passed through 425 micron sieve and the bentonite used to admix for stabilization was obtained from Ramgarh, Jaisalmer.

Dune sand:

The grain size distribution by performing dry sieve analysis according to IS 2720 (Part IV)- 1965. The specific gravity of dune sand was determined by pycnometer under standard procedure as per IS 2720 (Part II) –1980. The standard proctor test and insitu density test were also conducted. The index properties of dune sand are as listed below in Table No.1.

Bentonite:

The grain size distribution, Atterberg's limits, standard proctor and specific gravity tests were conducted and the results are listed in Table No.1.

Table 1. Geotechnical Properties of Dune sand and Bentonite

Property	Dune sand	Bentonite
Specific Gravity	2.67	2.40
Atterberg's limits		
Liquid limit %	-	86 to 89
Plastic limit %	-	39 to 41
Shrinkage limit	-	8.2 to 14.5
Grain size distribution		
Fine sand %(0.075 to 0.2 mm)	98	4.5 to 8
Silt % (0.075 to 0.002 mm)	2	12 to 16
Clay % (Less than 0.002 mm)	-	12 to 16
Insitu density		-
Maximum dry density	1.60 g/cc	-
	1.65 g/cc	1.4 to 1.44
Optimum moisture content		g/cc
IS classification of soil	11.0 %	
		20.5 to 26 %
		CH

Lime:

The chemical characteristics of lime used for the study are shown in the following Table No.2.

Table No.2. Chemical characteristics of lime

1.	SiO_2	30.54
2.	Al_2O_3	0.59
3.	Fe_2O_3	1.30
4.	CaO	33.62
5.	MgO	0.89
6.	TiO_2	0.09
7.	K_2O	0.28
8.	Na_2O	0.046
9.	SO_3	0.118
10.	Cl	0.01
11.	Cr_20_3	0.00
12.	LOI	27.40
13.	SUM	91.48

Curtsy: J. K. White Cement Factory, Gotan.

Table 3. Compaction data of present study

SR.No.	Dune Sand Bentonite and lime Mixtures	Dune sand%	Bentonite%	Lime %	Maximum Dry density (g/cc)	Optimum Moisture Content (%)
1.	M1	94	05	01	1.66	12.45
2.	M2	93	05	02	1.69	12.80
3.	M3	92	05	03	1.71	13.30
4.	M4	89	10	01	1.70	14.50
5.	M5	88	10	02	1.73	14.60
6.	M6	87	10	03	1.74	14.80
7.	M7	84	15	01	1.8	15.10
8.	M8	83	15	02	1.81	15.30
9.	M9	82	15	03	1.83	15.80

RESULTS AND DISCUSSIONS

Compaction characteristics of dune sand bentonite and lime mixtures:

The Various mixtures selected for the test programme are bentonite varied as 5%, 10% and 15% with lime 1%, 2% and 3% by weight with dune sand. The mixtures and its maximum dry density and optimum moisture content analyzed with the help of standard proctor test carried out according to IS 2720 (Part VII) are shown in the Table 3.

In the present study it was observed that the Maximum dry density of the mixture M1 to M9 varied from 1.66 g/cc to 1.83 g/cc. The optimum moisture content of the mixture varied from 12.45% to 15.80%.

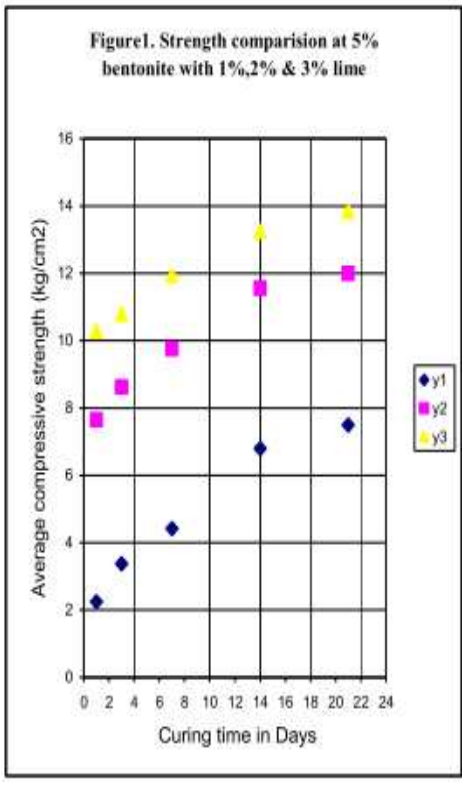
The compaction characteristics of dune sand, bentonite and lime mixtures are found to be in good agreement with the results reported in literature.

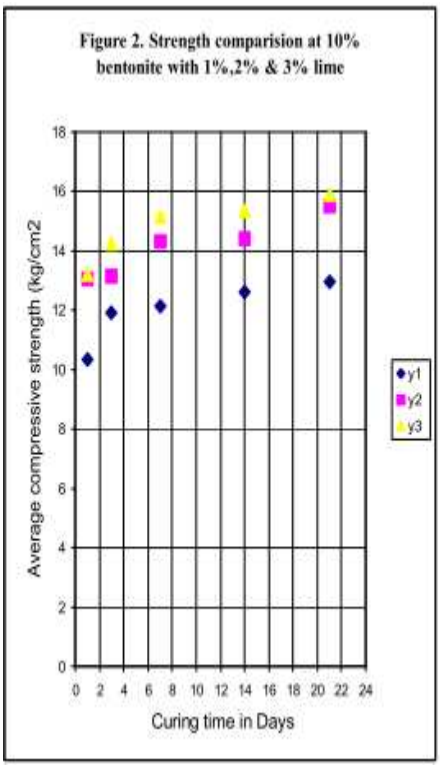
Effect of addition of bentonite and lime on unconfined compression strength of dune sand.

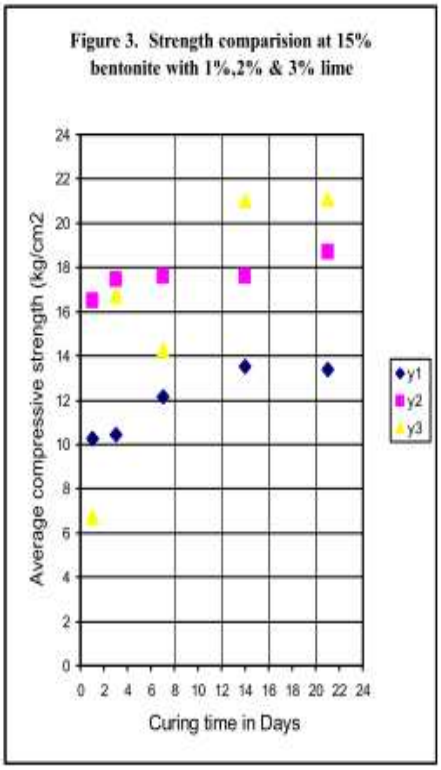
The unconfined compression tests were conducted for the samples M1 to M9 as per IS 2720 (Part X) 1973.The specimen for the test was of the size diameter 38mm and length 76mm. Two different loading rates 1.25mm/min and 2.5mm/min were used for testing. The samples prepared were of maximum dry density and optimum moisture content.

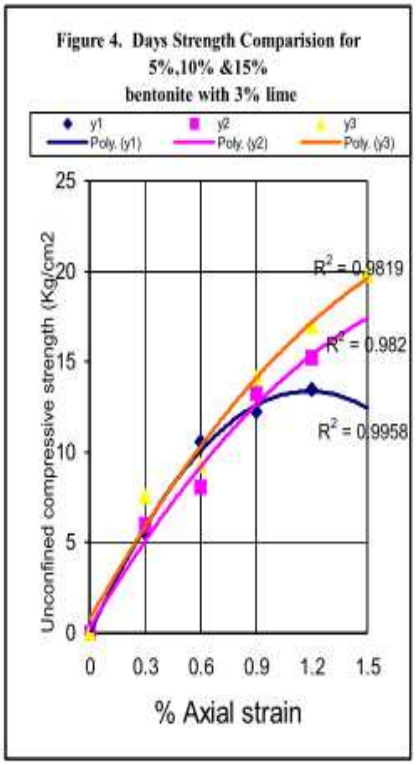
The water was added 2% more than the optimum moisture content to counter balance the evaporation losses. The sample tested were air dry and oven dry with curing period varied from 1,3,7,14 and 21 days.

The axial strain and the corresponding unconfined compressive loads were recorded at regular intervals. The maximum load at which the specimen failed was taken as unconfined compressive strength. The graphical representation of %axial strain Vs unconfined compressive stress was done. The unconfined compressive strength values of various mixtures are as represented in the Figures.(Figure No.1 to Figure No.4).









CONCLUSIONS

The unconfined compressive strength increases with the increase of bentonite and lime up to 15% and 3% respectively. Further addition of bentonite and lime in dune sand causes compaction difficulties as the mix becomes sticky.

The maximum unconfined compressive strength has been found in soil samples of mixture 15% bentonite and 3% lime. The minimum values of unconfined compressive strength were found in the mixture 5% bentonite and 1% lime.

The percentage axial strain at failure increases with increase in strain rate for specimens tested under similar conditions of curing and mix composition. The development of the strength in dune sand stabilized with bentonite & lime depends upon the mix composition, curing environment and curing time. In this it is seen that curing environment appears to have been the greatest influence on the strength development

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