Effect of Lime on Engineering Characteristics of Sand

Pooja Khurana, R.K.Yadav, A.K.Singhai

Abstract- The main aim of the study is to analyze the change in engineering properties of sand with the addition of lime. Permeability, Compaction and Shear strength are the properties which are analyzed in this study. Falling head permeameter test was conducted to assess the permeability characteristics of sand mixed with 6%, 10%, 15% and 20% of lime by weight of sand. Test results indicate that the permeability of sand has reduced after the addition of lime from 10-3cm/sec to 10-5cm/sec. Change in compaction characteristics has also been observed; there is slight increment in values of OMC from 8.3% to 12.82%. Direct shear tests were also conducted to assess the shear strength parameters. For the mixtures with lime content varying from 0 to 20%, the corresponding angle of internal friction reduces from 38° to 35° degrees and increase in cohesion intercept from 0.01 kg/cm2 to 0.03 kg/cm2.

Keywords- Sand/lime mixtures, permeability, compaction, shear strength parameters.

1. INTRODUCTION

Soil is used as a construction material. If the natural soil does not meet the requirements of the structure to be built, solutions like changing the place of the construction or removing the unsuitable soil layer are mostly not economical. For this reason, improvement of the soil properties with various admixtures is widely used in the engineering applications today as an appropriate and economical solution. The main use of soil stabilization is to improve the natural soils for the intended construction

Lime stabilization can be applied in field by (i) mixing the in situ material with lime at the site and then compacted after the addition of moisture (ii) mixing soil and amount of lime with water at a plant and then hauled back to the site for compaction (iii) pouring lime slurry through small drill holes. This study will lead us to examine the engineering characteristics of sand with the addition of lime in it in different percentages.

1. RESEARCH SIGNIFICANCE

In the research reported in this study, sand is mixed with lime in different percentages in order to study the changes in permeability of sand. And also, analyzing the change in shear parameters (φ,c). The focus of the study is to ascertain the performance of sand containing lime mixes.

- *Pooja Khurana, is currently pursuing masters in geotechnical engineering in Jabalpur Engineering College, India. E-mail: pooja.khurana063@gmail.com*
- *R.K.Yadav, Associate Professor in Civil Deapartment in Jabalpur Engineering College, India. E-mail: rkyadav07@yahoo.com*
- *A.K.Singhai Head of Department in Civil Engineering Department in Jabalpur Engineering College, India.*

The objectives of the study are:

1. To provide an option of the stabilizing agent for sand.
2. To study the change in permeability characteristics on addition of lime.
3. The check on shear parameters of sand after the addition of lime.

2. MATERIAL CHRACTERISTICS AND TEST METHOD

Sand:

Sand used in this study is local sand which is typically used as a construction material. The grain size distribution curve of the sand is shown in Fig. 1. The corresponding coefficient of uniformity (Cu) and coefficient of curvature (Cc) are 5 and 0.61, respectively. Fine soil fraction passing through 0.075mm size sieve is 0.67%.

Table 1
Properties Sand

S.No.	Property	Values
1	Specific Gravity	2.63
2	Permeability	$3.75*10^{-3}$ cm/sec
3	Angle of Friction	38°

4	Co-efficient of Uniformity, C_u	5
5	Co-efficient of Curvature, C_c	0.61
6	Effective Size (mm)	0.28
7	Fine Soil Fraction (75μ)	0.67%

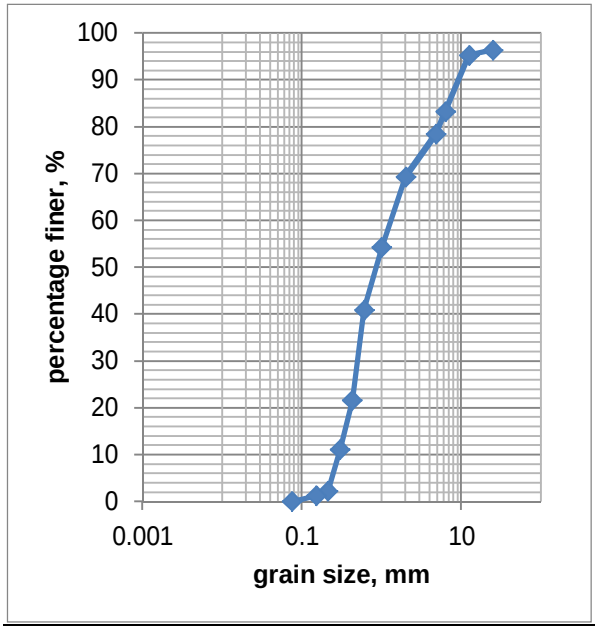

Fig 1. Grain Size Distribution Curve

3. EXPERIMENTAL PROGRAMME FOR THE STUDY ON SAND/ LIME MIXTURES

Following are the mix specification of the sand/lime mixtures used for the study:

Table 2
Mix Specification

S.No.	Narmada Sand/lime mixtures	% Sand	% Lime
1	SL0	100	0
2	SL6	94	6
3	SL10	90	10
4	SL15	85	15
5	SL10	80	20

Proctor Compaction Test

Sand lime mixtures was prepared by mixing oven-dry sand with air-dry lime in dry state and initial water content of about 6% was added and kept in air tight containers for 24 hrs. The standard Proctor compaction test was carried out as per IS: 2720 (part VII). For each sand-lime mixture, the optimum water content and the maximum dry unit weight were determined.

Falling Head Permeability Test

For determining co-efficient of permeability, conventional falling head permeability test was conducted by using standard permeameter as per IS:2720 (Part XVII). Soil samples for these tests were prepared in compaction moulds by compacting the soils at maximum dry density and optimum moisture content. Samples were left for one week saturation and then connected to water column.

Sample connected to Water column

Fig 2. Permeability Test Setup

Direct Shear Test

Shear strength parameters (i.e., cohesion and friction angle) of the compacted sand-lime mixtures which are significant parameters in stability analysis, were determined by conducting a series of direct shear tests.

Sample under testing

Fig 3. Direct Shear Test

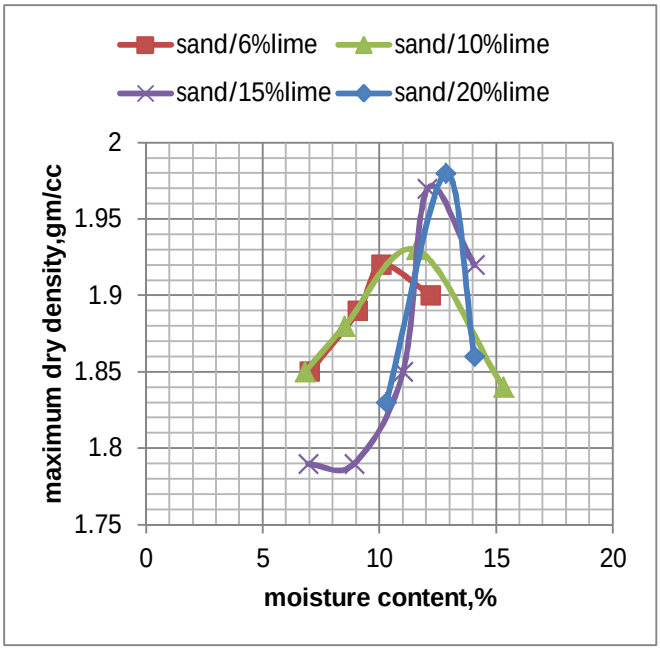

Fig 4. Compaction Curves

4. TEST TRESULTS

Following are the test results for the series of test conducted on samples:

Compaction results

Compaction test results of sand-lime mixtures are shown tabulated in table 4 and shown in fig 4. It is seen that with the increase in lime content, the optimum moisture content increases from 8.3% to 12.83% and the maximum dry density increases from 1.89gm/cc to 1.97gm/cc as the bentonite content is increase from 0% to 20%.

Table 4
Compaction results of Sand/lime

S.No.	% Mixes	Maximum dry density (gm/cc)	Optimum Moisture Content (%)
1	SL0	1.89	8.3
2	SL6	1.92	10.1
3	SL10	1.93	11.58
4	SL15	1.97	11.85
5	SL10	1.97	12.82

Permeability Results:

After getting compaction results, the samples which were kept for over one week were tested for permeability. For all sets of mixtures the results found are summarized in table 5 and shown in fig 5. It can be clearly seen that with the addition of lime there is reduction in co-efficient of permeability of sand reported from 3.75*10-3 cm/sec at 0% lime to 6.99*10-5 cm/sec at 20% lime.

Table 5
Permeability Results

S.No.	Permeability Results of Sand/lime mixtures cm/sec	
	Mixes	Values
1	SL0	3.75*10-3
2	SL6	2.88*10-3
3	SL10	1.97*10-3
4	SL15	6.16*10-5
5	SL10	6.99*10-5

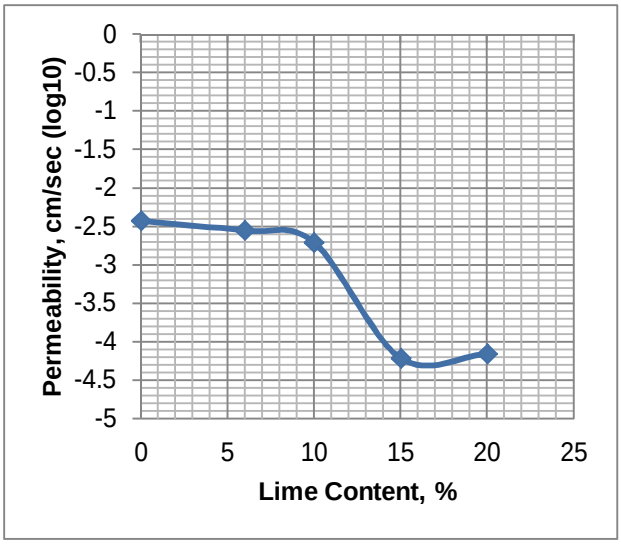

Fig 5. Permeability Curve

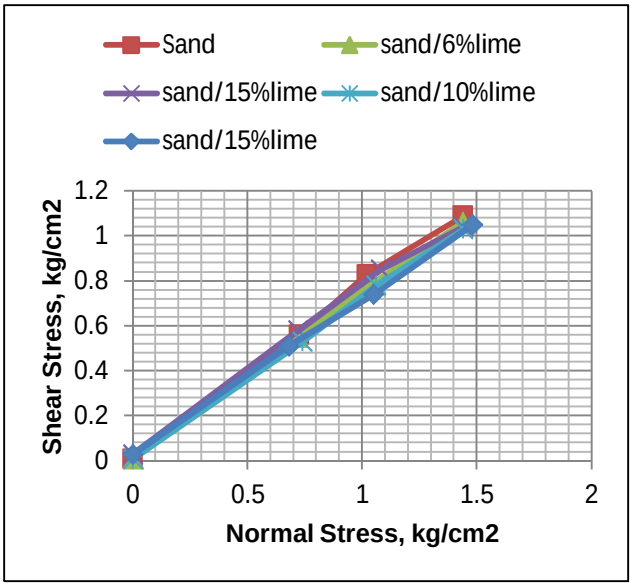

Fig 6. σ-τ Curve

Direct Shear Results:

The shear strength parameters of sand/lime mixtures obtained from direct shear tests are summarized in table 6 and shown in fig 6. The test results shows that with the increase in lime content from 6-20% the angle of shearing resistance decreased from 38° to 35°. It can be seen that there is no such improvement in cohesion property as well as in the angle of friction with the addition of lime to sand.

Table 6
Direct Shear Results

S.No.	Mixes	c Kg/cm2	Φ (°)
1	L1	0.01	38
2	L2	0.01	37
3	L3	0.01	36
4	L4	0.03	35
5	L5	0.03	35

5. CONCLUSIONS

Following conclusions can be drawn from the study:

- Co-efficient of permeability of sand has reduced at considerable rate with the addition of lime from 3.75*10-3 cm/sec at 0% lime content to 6.99*10-5 cm/sec at 20% lime.
- Compaction results show that there is increase in the optimum moisture content with the increase in lime content. There is increase of OMC from 8.3% at 0% lime to 12.82% at 20% lime.
- When varying lime content from 0 to 20%, the angle of shearing resistance of the sand-lime mixtures decreases from 38 to 35 degrees. At the same time, cohesion property does not show any significant change.

REFERENCES:

[1] Thian Siaw Yin1, Lee Choon Yong, "Shear strength behaviour of mining sand treated with clay and hydrated lime". INTERNATIONAL JOURNAL OF CIVIL AND STRUCTURAL ENGINEERING Volume 3, No 1, 2012.

[2] Jaspal Singh, Atul Kumar, Ritesh Jain, N.K.Khullar, "Effect of Lime on Properties of Soil". The 12th International Conference of International Association for Computer Methods and Advances in Geomechanics (IACMAG) 1-6 October, 2008.

[3] IS:2720 (Part XVII), Indian Standard code of practice for determination of co-efficient of permeability using Falling head permeameter, BIS New Delhi.

[4] IS: 2720 (part VII), Indian Standard code of practice for determination of water content dry density relation using Light Compaction, BIS New Delhi.

[5] IS:2720 (part XIII), Indian Standard code of practice for determination angle of shearing resistance and cohesion intercept using Direct Shear Test, BIS New Delhi.

".