RESEARCHERID
THOMSON REUTERS

[I-CONCEPTS-18]

ISSN 2348 – 8034
Impact Factor- 5.070

GLOBAL JOURNAL OF ENGINEERING SCIENCE AND RESEARCHES

A STUDY ON THE EFFECT OF PERMEATION GROUTING WITH LIME IN SANDY SOIL

K. Suresh[1*], P.Suresh Praveen[2] &K.S.V.Praveena[3]

[1]Professor and Head, Dept. Civil Engg, CMRCET, Hyderabad
[2]Assoc. Professor , Dept Civil Engg, KSRM CET, Kadapa
[3]Assoc. Prof, Dept. of Civil Engg, CMR CET, Hyderabad

ABSTRACT

In this paper the strength properties of soil were studied with different percentages of cement and lime grout at same water: cement / lime ratio i.e. 2:1. In the present work dry density of the soil is kept constant 1.77 gm/cc throughout. To study the changes in strength properties of sandy soil with Triaxial test, changes in permeability of the sandy soil by constant head method, changes in strength properties at 1, 7, 14 days of curing and changes in strength properties at 2%, 4%, 6%, 8%, 10% of lime and cement.

Keywords*: 2-6 Keywords are required.*

I. INTRODUCTION

Soil improvement is an important project in construction works, especially in those for buildings, bridges, and roads, etc. In usual procedure, many methods are used to improve in-situ properties of deep soil layers, such as dynamic compaction, stone columns, jet grouting, compaction grouting, permeation grouting, vibro flotation and wick-drains. In the low-pressure permeation grouting is an efficient method for reducing permeability, increasing strength and stiffness of coarse-to-medium grained soils with low initial properties. The influence of this technique, however, appears to be affected by various factors and calculate substantially upon on-site experience and engineering experience. Results of related studies on injection mechanism were generally not conclusive and the improvement of grouting on engineering properties of soils could not be practically measure.

Permeation grouting is a low-pressure form of cement grouting that involves grout injection into voids, cavities and fissures in soil or rock formations in order to improve their properties, specifically to increase their strength and durability and reduce their permeability or to increase their bearing capacity.

The basic limits that are influencing the grouting methods are: (i) grain-size distribution of the soil, (ii) the size of a cement particles in the suspension grout, (iii) fineness content of the soil passing through the sieve of 0.6 mm, (iv) grouting pressure (P), and (v) water/cement ratio by weight (w/c) ratio of the grout. The scope and objectives of this study is to investigate the limits that affect the strength of cement grouted granular soils through laboratory testing. It is to be noted that the literature many researchers have studied the grout ability characteristics of soils and proposed different set preparation for granular soils. However, the number of experiments in these studies has usually been very limited.

II. LITERATURE REVIEW

Polyurethane chemical grout is composed of two components of water activated material called hydro-phobic and hydrophilic resin (Vinson, 1970). The soil profile in seaside territory often consists of free sandy soils reaching out to a profundity of 3 to 4 m starting from the earliest stage underlain by clayey soils of medium firmness (Nonveiller 1989), the silicate chloride amide system is one of the widely use silicate grout system containing sodium silicate as a gel forming material (US Army Corps of Engineers, 1995)

The previous uses the dry powdered folio though the last uses the water-fastener slurry. Normally, there are a few contrasts in the execution machines amongst dry and wet strategies (Bromes et al., 1999). The profound blending technique is regularly characterized into two strategies: dry and wet strategy, based on the kind of fastener, the system of seeping in revolving or fly helped, and the vertical degree over which mixing is refined (Bruce, 2000). Permeation grouting method is by and large used to decrease ground penetrability and control ground water stream, however it can likewise be utilized to fortify and harden the ground (CIRIA, 2000). Suat Akbulut et al. (2002) presumed that the dirt molecule size and the bond most extreme molecule size effect sly affect the fruitful grouting". Grouting for the most part is utilized to fill voids in the ground (gaps and permeable structures) with the intend to build resistance against twisting, to supply attachment, shear-quality, compressive quality lastly to diminish pressure driven conductivity or interconnected porosity in an aquifer (Moseley and Kirsch, 2004). Penetration grouting strategy is all things considered used to abatement ground vulnerability and control ground water stream, in any case it can similarly be used to brace and solidify the ground (CIRIA, 2000). Costas.A.Anagnostopoulos, (2005) has gathered that the blend of such material with security in grouting reason concerning water solid extent contributes in a general sense to the change of grouted soil.The polyurethane is toxic in nature, so, it is mostly applicable in forming to block water inflow (water reactive resins). Epoxy resins are liquid pre-polymers with hardening agent, they usually exhibit very high tensile, compressive and bond strength. Generally epoxy resins will have either good chemical resistance or good heat resistance (Magill and Berry, 2006). The low viscosity has a better penetrability but greater shrinkage and less strength due to the weak bonding lead to more subsidence, whereas the high viscosity may better if adequate pressure is maintained long enough to permit the grout filling into small void. However, epoxy is one of the resins types which are toxic in nature and requires special care during handling. Through the turning development, the dirt is blended with the folio and a quick response begins. The enhanced soil gets the offer of a segment (Kazemian, 2009). Grouting is the procedure of ground change achieved by infusion of a liquid like material that is fit for shaping a gel and restricting the dirt particles. P. Thirumalini et al 2011 (12) in their study they have reasoned that the compressive quality Treating lime mortar with 5% home grown juice gives more prominent flexural, elastic and compressive qualities. This requires the need to do inquire about in discovering substitute ecofriendly materials for ground change. It appears that numerous characteristic polymers (Biopolymers) can be utilized as substitute for routine parts of grouting materials. Thus in this study an endeavor is made to utilize the biopolymer (Hydroxy Propyl Methyl Cellulose-HPMC) as an added substance with the bond grout to ponder the change of the dirt property. Hamid Reza Khatami et al (2012) have inferred that, biopolymers can adequately enhance the quality attributes of sand without bringing about ecological lethality. Laetitia Patural et al. have presumed that, cellulose are thickener, great folio, film previous and utilized as added substances to enhance the bond based material furthermore enhance the properties of mortar, for example, water maintenance, workability, and consistency of material.

III. MATERIALS AND METHODOLOGY

3.1 Materials

3.1.1 Soil

Grouting is normally undertaken to reduce the permeability and to improving the bearing capacity of the soil. The materials are used in this study are sandy soil shown in the figure The soil will be brought from near to satilitecity, rudhrabharathi peta, kadapa. The Latitude and Longitude of soil collecting area is 14.5667 and 78.8 respectively. Index and engineering properties of collecting soil will be conducting.

The properties of the soil sample after determining with various tests on the soil samples which is used in the study. The tests are done to determine the basic properties of the soil sample.

The basic soil properties are shown in the table 3.1.

PROPERTIES	VALUES
Specific Gravity	2.37
Sand %	64.7
Silt %	12.2

Clay %	23.1
Liquid Limit, %	34
Plastic Limit, %	16
Plasticity Index, %	18
IS Classification of Soil	SC
Free Swell Index, %	10
Degree of expansion	LOW
Optimum Moisture Content, %	14.8
Maximum Dry Density (gm/cc)	1.77
Coefficient of Permeability (cm/sec)	$3.4X10^{-3}$
Shear parameters	Cohesion C = 0.47 kg/cm^2 Angle of internal friction □ = 18˚ shear strength τ = 1.036 kg/cm^2

3.1.2 Cement

The cement used for the study is 53grade Ordinary Portland Cement as shown in figure 3.2. The basic properties of the cement used are determined as per Indian Standards as shown in the table 3.2. This cement grout is used for Permeation grouting into the soil specimen and the test results are used for the comparison. The cement grout will be preparing to the water and cement ratios are 2:1 in the weight of cement. The cement grout will be used 2%, 4%, 6%, 8%, and 10% of the weight of cement in the soil.

Cement

3.1.3 Lime

Calcium Oxide (lime) was purchased in local market, Hanmakonda, which is having 95% purity of CaO and remaining 5% impurities and the fig 3.3 shows calcium oxide (lime).

The lime grout will be preparing to the water and lime ratios are 2:1 in the weight of lime. The lime grout will be used 2%, 4%, 6%, 8% and 10% of the weight of lime in the soil. This lime grout is used for permeation grouting into the soil specimen and the test results are used for the comparison. The parameters are in the lime will be shown in the table 3.3

Table No. 3.2: Properties of Lime

Parameter	Percentage
Calcium oxide (Cao)	38-42 (%)
Silica (SiO_2)	20-25 (%)
Alumina (AL_2O_3)	2-4 (%)
Other oxides (Na, Mg)	1.5-2.5 (%)
Loss on ignition	30-32 (%)

ISSN 2348 – 8034
Impact Factor- 5.070

3.2 Methodology

3.2.1. Sample preparation

Figure No. 3.1: Tank setup for grouting

Permeation grouting of sandy soil is done with cement grout and lime grout each separately in different tanks. The container is an acrylic tank of size 30cm x 30cm x 30cm. The tank is made with completely dry before filling the soil. One-third of the tank is filled with soil. Then the grout pipe is placed in the tank in such a manner to spread the grout uniformly for the entire tank. Four PVC Pipes of 20 mm diameter are used for the grouting. The bottom of the pvc pipe is plugged so as to disperse the grout circumferentially and make the grouting more effective. The grout which is prepared at cement with the water cement ratios are 2:1, and disturbed well to get uniform grout solution is poured into the four pvc pipes uniformly. The Viscosity of the cement grout is determined with Marsh funnel viscosity test.

The soil is filled in the tank without disturbing the four grout pipes as shown in the figure 3.1. The cement grout poured inside the mixing tank. Agitator is placed inside the funnel for continuous mixing of grout solution. By controlling the valves grout solution is distributed to all four grout pipes equally. The grout solution will flow through the soil particles by permeation. After filling the grout solution into the silty sand, the grout pipes are removed from the tank softly without disturbing the soil after 24 hours and replacing the gap of the grout pipes with soil. The same procedure is followed for the cement grout and lime grout separately in different tanks.

ISSN 2348 – 8034
Impact Factor- 5.070

Figure No. 3.2: Tank of grouted sample

Figure No. 3.10: Collection of sample from the tank

After one day of curing the samples are collected from the tank. The sampler will be at the diameter is 3.8 cm, and the length of the sampler is 7.5 cm. Grease is applying inner side of the sampler. These samplers are inserted in to the soil as shown in figure 3.10. Then these samplers are removed from the tank filling with soil. Then after we are removing the soil specimen from the sampler. For the curing this soil specimen are placed in the desiccators. After 1 day, 7 days, 14 days of curing the soil specimen we are tested to triaxial test.

IV. RESULTS AND DISCUSSIONS

4.1. General

The triaxial tests are conducting the grouted soil for different percentages of cement and lime in the grout. In this triaxial test determining the shear parameters, they are cohesion and angle of internal friction. The cohesion and angle of internal friction are varying with percentages of cement and lime in the grouting. These variations are shown in the following tables and figures. Maximum strength achieved in the cement grout to comparing the lime grouting.

ISSN 2348 – 8034
Impact Factor- 5.070

4.2. Shear Parameters

The shear strength of soils is an important aspect in many foundation engineering problems such as the bearing capacity of shallow foundations and piles, the stability of slopes of the dams and embankments, and lateral earth pressure on retaining walls. In this chapter we have study the shear strength characteristics of granular and cohesive soils and the factors that control them will be discussed (Das, 1983).

In 1910, Mohr gave a method for fracture in materials. According to this method failure along a plane in a material develops by a critical combination of normal and shear stresses and not by normal or shear stress alone. The practical relationship between normal and shear stress on the failure plane can be given by

$$\tau_f = c + \sigma_f \tan\emptyset$$

Where, C = cohesion and

Φ = angle of internal friction on the soil

a) Cohesion

The variations of cohesion with percentages of cement and lime grouting is shown in the below tables and figures. The cohesion found to improving constantly with increase in percentages of cement and lime grout. The cohesion will maximum in cement grouting to comparing with lime grouting.

b) Angle of internal friction

The variations of angle of internal friction with percentages of cement and lime grouting is shown in the below tables and figures. The angle of internal friction found to decreasing constantly with increase in percentages of cement and lime grout. The cohesion will minimum in cement grouting to comparing with lime grouting.

4.3 Triaxial test for lime grouted soil

The variations of the cohesion and angle of internal friction of the soil with different percentages of lime grout is shown in the below figures. The improving percentage of lime in the grout the cohesion is increasing and angle of internal friction is reducing.

The results of shear parameters for lime grouted soil in one day of curing are shown in the figure 4.1. In this increasing the percentage of lime grouting in soil shear strength will considerably improving. The cohesion is increasing by improving the percentage of lime grouting and angle of internal friction is decreasing by improving the percentage of lime grouting. The results of shear parameters for lime grouted soil in 7 days of curing are shown in the figure 4.2. In this increasing the percentage of lime grouting in soil shear strength will considerably improving. The cohesion is increasing by improving the percentage of lime grouting and angle of internal friction is decreasing by improving the percentage of lime grouting. The results of shear parameters for lime grouted soil in 14 days of curing are shown in the figure 4.3. In this increasing the percentage of lime grouting in soil shear strength will considerably improving. The cohesion is increasing by improving the percentage of lime grouting and angle of internal friction is decreasing by improving the percentage of lime grouting.

ISSN 2348 – 8034
Impact Factor- 5.070

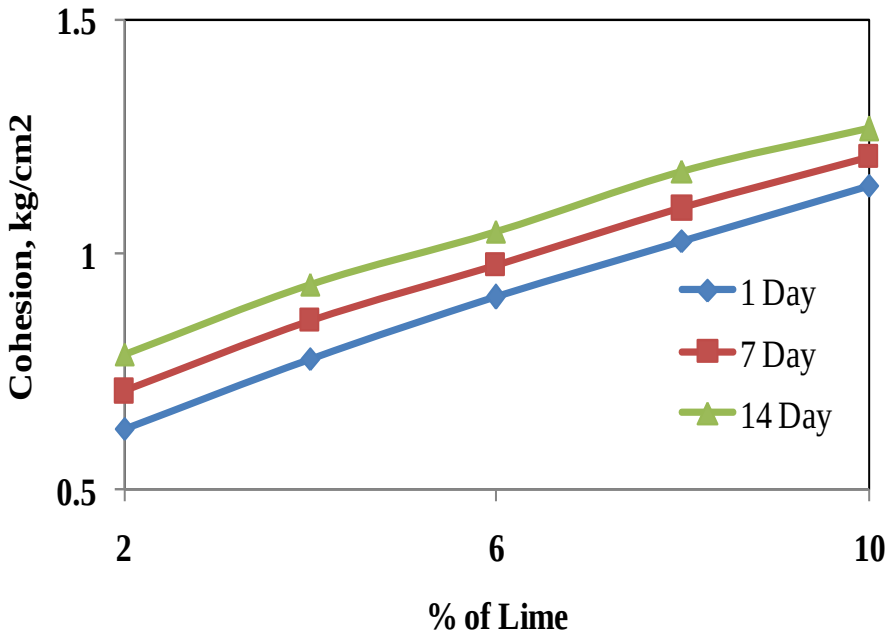

Figure:4.1 % of Lime Vs Cohesion with different days

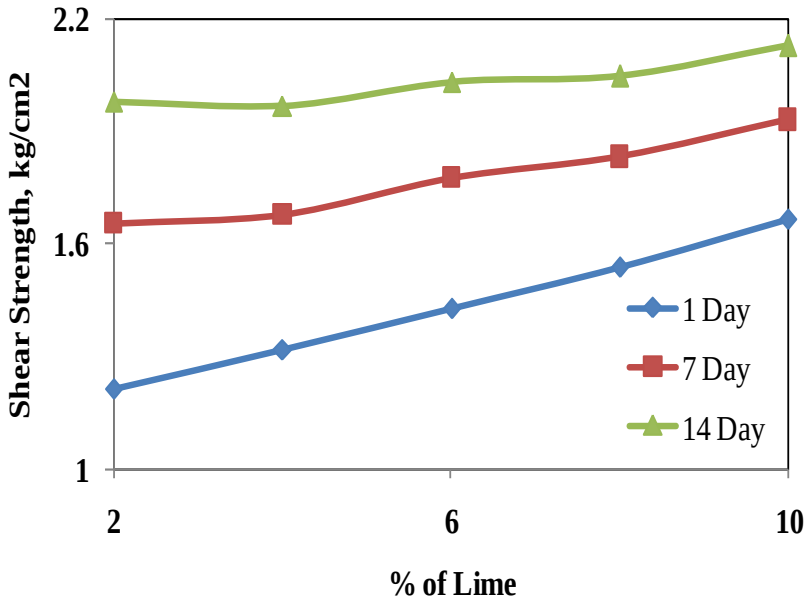

Figure:4.2 % of Lime Vs Shear Strength with different days

ISSN 2348 – 8034
Impact Factor- 5.070

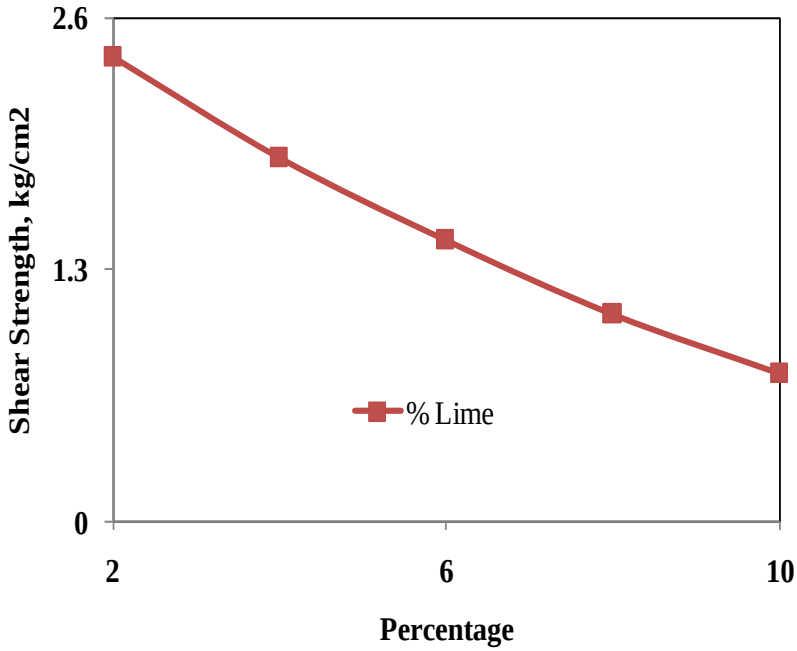

Figure:4.3 Percentage Vs Shear Strength

V. CONCLUSION

The present work we have examination of shear quality and porousness of the silty sand for cement and lime grouting. In this grouting the rates of lime and cement will increment by weight of the silty sand with 2% interim. The tests are led on the readied soil tests according to IS codes. The fallowing conclusions are drawn from the effect of test results.

1 day of curing with increasing percentage of lime the cohesion increased, from 2% lime the cohesion is 0.63 kg/cm2 to 10% lime the cohesion is 1.15 kg/cm2, percentage increase is 144%. 7 days of curing with increasing percentage of lime the cohesion increased, from 2% lime the cohesion is 0.71 kg/cm2 to 10% lime the cohesion is 1.21 kg/cm2, percentage increase is 157%. 14 days of curing with increasing percentage of lime the cohesion increased, from 2% lime the cohesion is 0.79 kg/cm2 to 10% lime the cohesion is 1.27 kg/cm2, percentage increase is 170%. With increasing percentage of lime the permeability decreased, from 2% lime the permeability is 2.5x10-3 cm/sec to 10% lime the permeability is 0.93x10-3, percentage increase is 73%.

REFERENCES

1. *Annamaria Cividini, An Experimental and Numerical Study of the Low-Pressure Grouting of Granular Soils by Diluted Chemical Solutions, The International Journal of Geomechanics, Volume 1, Number 4, pp 415–439 (2001)*
2. *Costas A. Anagnostopous (2005), "Laboratory study of an injected granular soil with polymer grouts", Tunneling and Underground Space Technology, 20, pp 525 – 533.*
3. *Dr. Abdel-Monem Moussa, Dr. Fatma El-Zaharaa Baligh, Dr. Tahia Abdel-Monem Awad, Asmaa El- Rokh (2007), "Sandy soil improvement using grouting", 12th ICSCE, Cairo, Egypt.*
4. *IS 14343 : 1996 Choice Of Grouting Materials For Alluvial Grouting - Guidelines. Bureau of Indian Standards.*

ISSN 2348 – 8034
Impact Factor- 5.070

5. *K. Venkat Raman, P. Dayakar, Dr. K.V.B. Raju, Study on Permeation Grouting with Cement and Chebulic Myrobalan Grout in Sandy Soils, International Journal of Innovative Research in Science, Engineering and Technology, Vol. 4, Issue 6, June 2015, pp. 4448 - 4456.*
6. *Kamal H., M., AbdulJaleel, A., Abdul Salam, S., Taha M, Development of Cement Grout mixes for treatment of underground cavities in Kuwait, International Journal of Civil and Structural Engineering, Volume 2, No 2, 2011.*
7. *P. Dayakar, K. Venkat Raman, Dr. K.V.B. Raju, 2012, Study on Permeation Grouting Using Cement Grout In Sandy Soils, IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE) ISSN: 2278-1684, Volume 4, Issue 4 (Nov-Dec. 2012), PP 05-10.*
8. *Suat Akbulut and Ahmet Saglamer (2002), " Estimating the grout ability of granular soils: a new approach", Tunneling and Underground Space Technology, 17, pp 371 – 380 Purbi Sen., Sina Kazemian, Bujang.B.K.Huat , (2011), "Assessment and Comparison of grouting and Injection Method in Geotechnical Engineering", European Journal of Scientific Research,vol 27 no.2(2011), pp 234-247.*
9. *T. G. Santhosh Kumar, Benny Mathews Abraham, A. Sridharan, Babu. T. Jose, 2011 Determination of Cement Content of Grouted Sandy Soils, Proceedings of International Conference on Advances in Civil Engineering, 9ACE-2011, 21-23 October 2011, pp. 169-172.*