

Study on the Effect of Permeation Grouting With Cement and Lime in Silty Sand

D. Janaki Ramudu¹, Dr. T. Kiran Kumar²,Post Graduate Student, Dept. of Civil Engineering, KSRM College (autonomous), Kadapa, India¹Associate Professor, Dept. of Civil Engineering, KSRM College (autonomous), Kadapa, India²

ABSTRACT: One of the effective ways to improve the engineering properties of the silty sand is permeation grouting. In this technique the grout is injected into the ground without disturbing the soil structure. In this investigation an attempt is made to study the comparison of permeation grouting with cement & lime grouting. The cement grout and lime grout are injected into the soil specimen by changing weight of cement and lime will be at 2%, 4%, 6%, 8%, & 10% by the soil weight. Grouting is conducted in a tank of 30x30x30cm, separately. The grouted samples are subjected to triaxial test will conducting the grouted samples after 1, 7, & 14 days of curing period. The permeability test will be conducting the grouted sample.

I. INTRODUCTION

Soil improvement is an important project in construction works, especially in those for buildings, bridges, and roads, etc. In practice, 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, vibroflotation and wick-drains. However, these methods are generally expensive and hardly make necessary costly accumulating of huge machinery and equipment. Requiring much lower accumulating cost, easy on application and cost effectiveness permeation grouting has wider application areas in small-scale projects than many other soil improvement techniques. The presence of voids, soft ground, settlement and water inflow are just a few barrier encountered where grouting can be employed to check their effects during construction.

A. OBJECTIVES OF THE PRESENT STUDY:

1. To studying the properties of the silty sand by grouting with lime and cement.
2. To studying the changes in strength properties of silty sand by Triaxial test.
3. To studying the changes in permeability of the silty sand by the constant head method.
4. To studying the changes in strength properties at 1, 7, 14 days of curing.
5. To studying the changes in strength properties at different percentages of lime and cement.

II. LITERATURE REVIEW

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". Purbi Sen. et al. (2011) reasoned that, it is attractive to utilize a blend of lime and bond or pretreatment of soil with lime before utilization of concrete or utilization of lime just if conceivable. Costas.A.Anagnostopoulos, (2005) has inferred that the mix of such material with bond in grouting reason concerning water concrete proportion contributes fundamentally to the change of grouted soil.

Requiring much lower preparation cost, simple on application and cost adequacy (Warner, 2004), penetration grouting has more extensive application zones in little scale ventures than numerous other soil change procedures. The nearness of voids, delicate ground, settlement and water inflow are only a couple of obstructions experienced where grouting can be utilized to relieve their belongings amid development. Low-weight penetration grouting is a proficient

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 11, November 2016

technique for lessening penetrability and for expanding solidness and quality of coarse-to-medium grained soils with low starting properties (Dano et al., 2004). The adequacy of this method, be that as it may, gives off an impression of being affected by different components and depends significantly upon on location experience and designing judgments. Consequences of related studies on infusion instrument were by and large not convincing and the change of grouting on building properties of soils couldn't be for all intents and purposes evaluated (Chang et al., 2005).

III. MATERIALS AND METHODOLOGY

A. MATERIALS

In this process the materials are locally available soil sample, cement and lime. The soil will be brought from near to satilitecity, rudhrabharathi peta, kadapa. Index and engineering properties of collecting soil will be conducting. The cement used for the study is 53grade Ordinary Portland Cement. The basic properties of the cement used are determined as per Indian Standards.

B. METHODOLOGY

Grouting is conducted in a tank of 30x30x30cm, separately. The grouted samples are subjected to triaxial test will conducting the grouted samples after 1, 7, & 14 days of curing period. The results of this study conclusively proved that the strength of the soil specimens grouted with cement grout is higher than that of lime grouted soil specimen.

The permeability of the soil will be conducted at different grouting materials of soil. In this cement and lime will be used for grouting materials in a soil. The percentage of lime and cement grouting will be increasing in the soil then permeability will be reduced. The void space in the soil will be filled with grouting then the permeability will be decreased.



Fig 3.1: lime grouted tank



Fig 3.2: Taking the samples from the tank

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 11, November 2016

Table no 3.1: Properties of soil

PROPERTIES	VALUES
Specific Gravity	2.37
Sand, %	72
Silt + Clay, %	28
Liquid Limit, %	34
Plastic Limit, %	16
Plasticity Index, %	18
IS Classification of Soil	SW-SM (well graded silty sand)
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)	3.4×10^{-3}
Shear parameters	Cohesion = 0.47 kg/cm^2 Angle of internal friction = $17^\circ 90'$ $\tau = c + \sigma \tan \phi$ shear strength = 1.036 kg/cm^2

IV. RESULTS AND DISCUSSIONS

A. TRIAXIAL TEST FOR LIME GROUTED SOIL

Table 4.1.1 Shear parameters for lime grouted soil with 1 day of curing

Shear parameters	2% of lime	4% of lime	6% of lime	8% of lime	10% of lime
Cohesion (kg/cm^2)	0.63	0.78	0.91	1.03	1.15
Angle of internal friction	$16^\circ 10'$	$13^\circ 56'$	$12^\circ 21'$	$10^\circ 72'$	$9^\circ 86'$
Shear strength (kg/cm^2)	1.212	1.317	1.428	1.537	1.666

Table 4.1.2 Shear parameters for lime grouted soil with 7 days of curing

Shear parameters	2% of lime	4% of lime	6% of lime	8% of lime	10% of lime
Cohesion (kg/cm^2)	0.71	0.86	0.98	1.1	1.21
Angle of internal friction	$15^\circ 82'$	$13^\circ 34'$	$11^\circ 90'$	$10^\circ 56'$	$9^\circ 72'$
Shear strength (kg/cm^2)	1.654	1.679	1.774	1.831	1.93

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 11, November 2016

Table 4.1.3 Shear parameters for lime grouted soil with 14 days of curing

Shear parameters	2% of lime	4% of lime	6% of lime	8% of lime	10% of lime
Cohesion (kg/cm ²)	0.79	0.94	1.05	1.18	1.27
Angle of internal friction	15°56'	13°12'	11°69'	10°23'	9°58'
Shear strength (kg/cm ²)	1.98	1.968	2.03	2.045	2.126

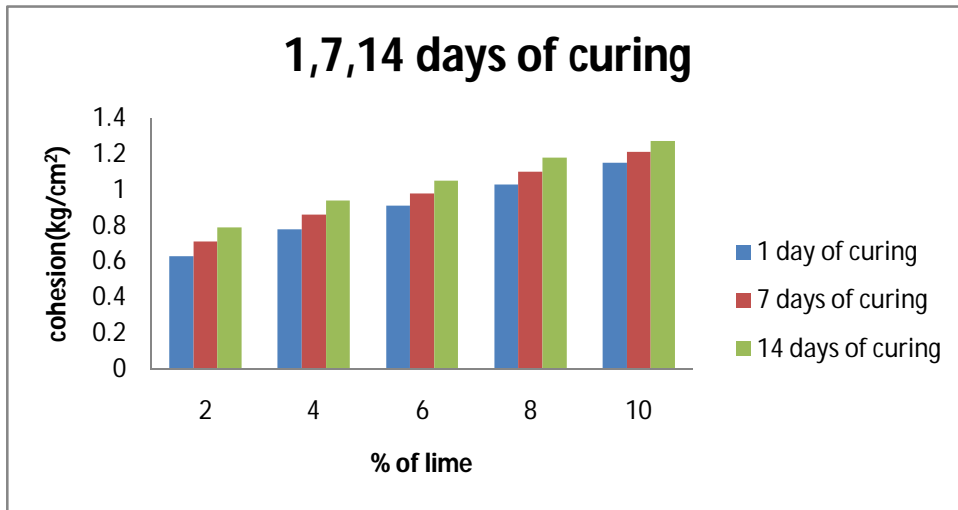


Fig 4.1: Variation of cohesion with % of lime for different curing period

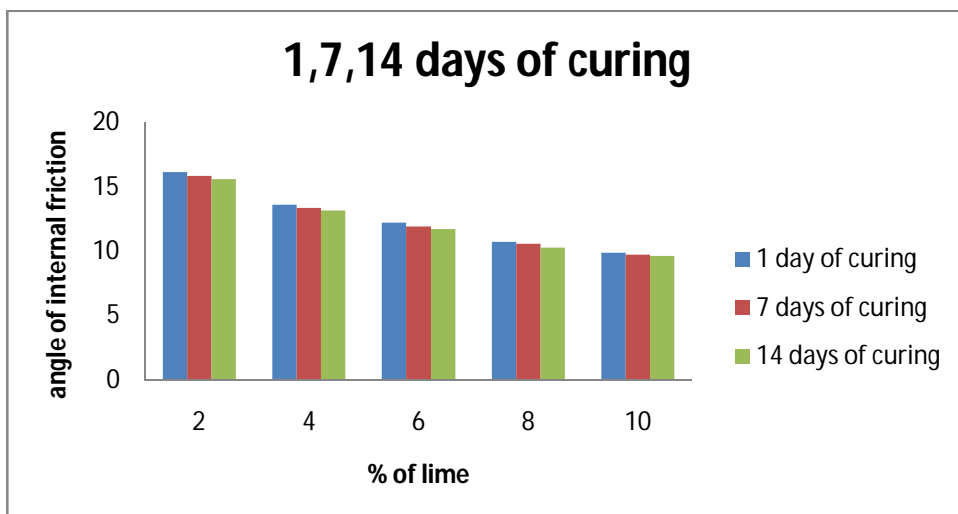


Fig 4.2 variation of angle of internal friction with % of lime for different curing period

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 11, November 2016

B. TRIAXIAL TEST FOR CEMENT GROUTED SOIL

Table 4.2.1 Shear parameters for cement grouted soil with 1 day of curing

Shear parameters	2% of cement	4% of cement	6% of cement	8% of cement	10% of cement
Cohesion (kg/cm ²)	0.66	0.84	1.02	1.19	1.35
Angle of internal friction	15°20'	12°23'	11°15'	9°86'	8°93'
Shear strength (kg/cm ²)	1.453	1.538	1.678	1.834	1.96

Table 4.2.2 Shear parameters for cement grouted soil with 7 days of curing

Shear parameters	2% of cement	4% of cement	6% of cement	8% of cement	10% of cement
Cohesion (kg/cm ²)	0.76	0.94	1.11	1.27	1.43
Angle of internal friction	14°95'	11°96'	10°86'	9°55'	8°68'
Shear strength (kg/cm ²)	1.89	1.895	2.016	2.09	2.218

4.2.3 Shear parameters for cement grouted soil with 14 days of curing

Shear parameters	2% of cement	4% of cement	6% of cement	8% of cement	10% of cement
Cohesion (kg/cm ²)	0.8	1.04	1.16	1.35	1.5
Angle of internal friction	14°62'	11°58'	10°45'	9°23'	8°35'
Shear strength (kg/cm ²)	2.15	2.17	2.205	2.294	2.393

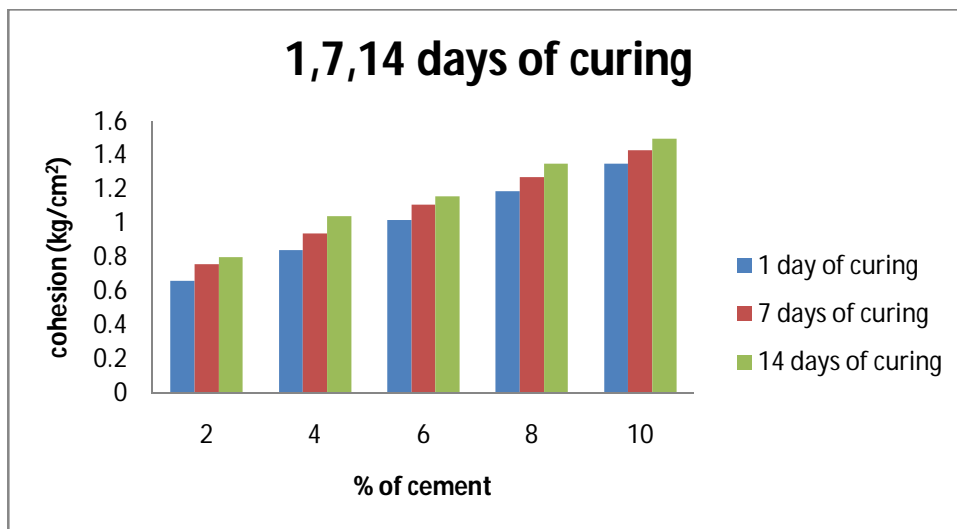


Fig 4.3 Variation of cohesion with % of cement for different curing period

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 11, November 2016

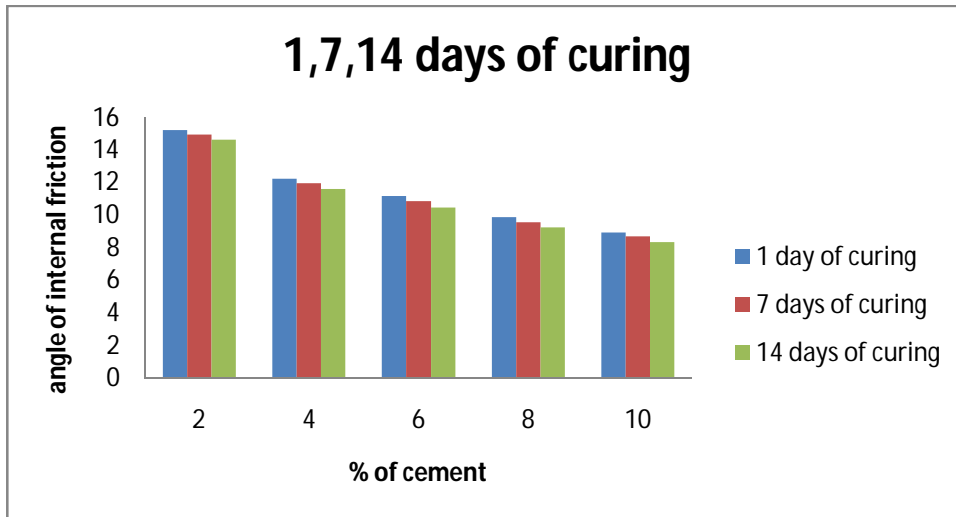


Fig 4.4 variation of angle of internal friction with % of cement for different curing period

C. PERMEABILITY OF THE LIME GROUTED SAMPLE

Table 4.3.1 Coefficient of permeability of the Lime grouted sample

SL.NO	% of Lime	Permeability(cm/sec)
1	2	2.5×10^{-3}
2	4	2.05×10^{-3}
3	6	1.64×10^{-3}
4	8	1.25×10^{-3}
5	10	0.93×10^{-3}

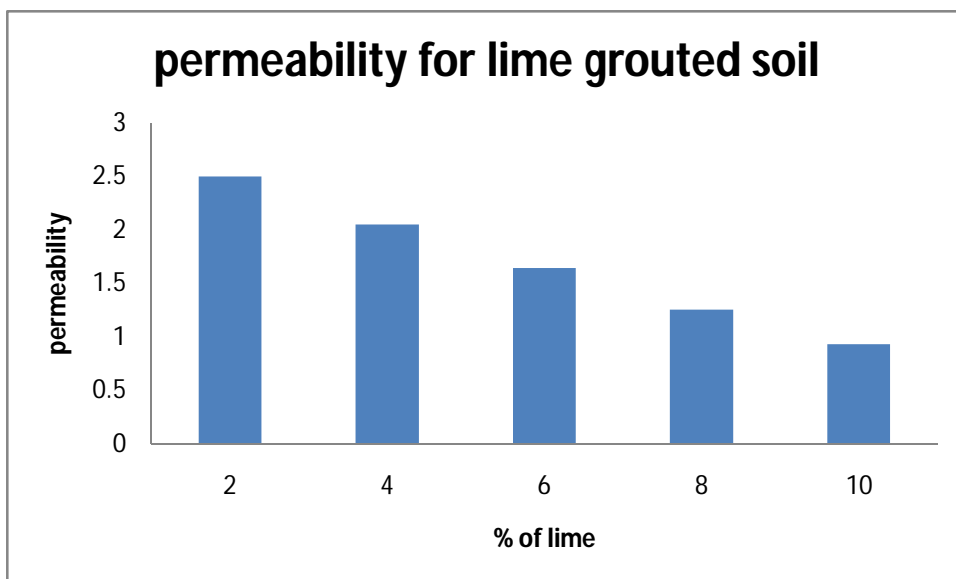


Fig 4.5 variation of permeability with % of lime

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 11, November 2016

D. PERMEABILITY OF THE CEMENT GROUTED SAMPLE

Table 4.4.1 Coefficient of permeability of the Cement grouted sample

SL.NO	% of Cement	Permeability
1	2	2.4×10^{-3}
2	4	1.88×10^{-3}
3	6	1.45×10^{-3}
4	8	1.07×10^{-3}
5	10	0.76×10^{-3}

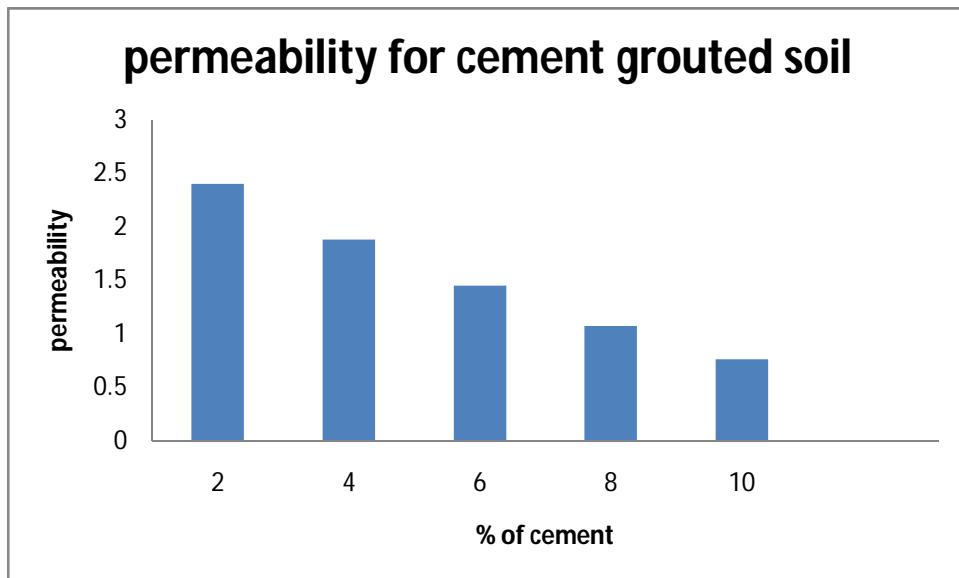


Fig4.6 variation of permeability with % of cement

VI. CONCLUDING REMARKS

- The triaxial test the strength will be improving with lime grouting soil sample is up to 105% of the strength of without grouted soil sample.
- The cohesion will be improving with lime grouted soil sample is up to 170% of the cohesion of without grouted soil sample.
- The angle of internal friction will be reducing with lime grouted soil sample is up to 47% of the strength of without grouted soil sample.
- The triaxial test the strength will be improving with cement grouted soil sample is up to 131% of the strength of without grouted soil sample.
- The cohesion will be improving with cement grouted soil sample is up to 219% of the cohesion of without grouted soil sample.
- The angle of internal friction will be reducing with cement grouted soil sample is up to 54% of the strength of without grouted soil sample.
- Permeability of lime grouted soil sample will be reducing the 73% of without grouted soil sample.
- Permeability of cement grouted soil sample will be reducing the 78% of without grouted soil sample.

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 11, November 2016

REFERENCES

- (1) 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
- (2) 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.
- (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 ICSCCE, Cairo, Egypt.
- (4) Costas A. Anagnostopoulos (2005), "Laboratory study of an injected granular soil with polymer grouts", Tunneling and Underground Space Technology, 20, pp 525 – 533.
- (5) 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, ACE-2011, 21-23 October 2011, pp. 169-172.
- (6) 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.
- (7) IS 14343 : 1996 Choice Of Grouting Materials For Alluvial Grouting - Guidelines. Bureau of Indian Standards.
- (8) 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)
- (9) 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.
- (10) 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.