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Study on Permeation Grouting with Cement and Chebolic Myrobalan Grout in Sandy Soils

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ABSTRACT: Grouting is quite a familiar term in foundation engineering, the primary purpose of which is to fill the voids in the material by replacing them with the grout and thereby improving the engineering properties of the medium. In this investigation it is observed that the effect of chebolic myrobalan solution with cement grout as an ground improving technique and improve the shear strength of loose and medium state of sandy soil. The cement grout solution is of 10:1, 8:1, 6:1 and 4:1, by replacing water to chebolic myrobalan solution. Plate load test are to be conducted on these grouted samples in a tank of size of 21cm x 24cm. The main objective is to arrive at a correlation between the load and the displacement of the grouted medium. The results of the various investigations have proved that as the grout ratio decreases the load bearing capacity of the soil increases gradually. The effectiveness of grouting in reducing permeability of the granular medium was also observed that after the curing period of 14 days and 28 days the hydraulic conductivity of the grouted soil sample shows a decrement in soil as the voids are filled with the grout solution.

I. INTRODUCTION

Grouting is technique to improve the bearing capacity of the soil and properties of the material by reducing the void present in the soil and binding the soil particles with grout, usually its strength, and or to reduce its permeability. Grouting is the process of ground improvement attained by injection of a fluid like material that is capable of forming a gel and binding the soil particles. P. Thirumalini et al 2011 (2) in their study they have concluded that the compressive strength Treating lime mortar with 5% herbal juice provides greater flexural, tensile and compressive strengths. The transverse, tensile and compressive strengths are increased by 1.6 times, 3 times and 2.5 times respectively in comparison with plain lime mortar. Hence, addition of herbs can greatly enhance the compression and tensile stress of lime mortar that can be used in repair of ancient monuments and also in building eco-friendly structures.

Tariq Ahmad Lone et al. 2014 (15) that the Terminalia chebula contains the various chemical compositions such as Flavonoids after treating with 5% Sodium hydroxide and diluted hydrochloride acid thus indicated the presence of flavonoids. The Terpenoid was present in the plant extract as there was reddish brown colour formation in the test tubes after treating with chloroform and concentrated Sulphuric acid. Alkaloid There was a reddish brown colour formation in the test tubes after treating with Potassium Bismuth iodide solution thus indicates the presence of alkaloid in the plant extract.

II. MATERIALS

Grouting is normally undertaken to reduce the permeability of soil formation and this process is used extensively in construction of hydraulic structure. The results for the testes done on the soil sample which is collected from the field and the results of the cement used in grouting with chebolic myrobalan solution. The results of experimental investigation carried out in this direction are presented in below table

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Table 1. Elaborates 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

PROPERTIES	VALUES
Specific Gravity	2.63
Coarse Sand,%	25
Medium Sand, %	70
Fine Sand, %	5
D ₆₀ , mm	0.9
D ₃₀ , mm	0.6
D ₁₀ , mm	0.47
C _c	0.85
C _u	1.91
e _{max}	0.82
e _{min}	0.68
e _{Avg}	0.75
Classification	SP

The results for the testes done on the cement which is used in this study and their properties are been enlisted, this cement is been used in grouting with chebulic myrobalan solution. The cement bag used in this study is opened at once and utilized within 10 days.

Table 2. Properties of the cement which is used and their basic amenities determined with the tests such as the specific gravity and other tests done according to the Indian standard

PROPERTIES	VALUES
Grade	53
Specific Gravity	3.15
Fineness, %	95
Consistency, %	35
Initial Setting Time, min	32

Permeation grouting of sandy soil with cement with chebulic myrobalan grout solution is done in an acrylic tank (21cm x 24cm) in room temperature of 28°C. The tank should be completely dry before filling the sand (i.e.) water content should be there. One-third of the tank is filled with sand. Then the grout pipe is placed in the tank in manner of dividing it four parts and place it in the centre of each parts. Thin film fails should place inside the pipe such that the sand should not enter the grout pipe's holes. Then the soil is filled in the tank without disturbing all the four grout pipes.

III. METHODOLOGY

The soil is filled in the tank without disturbing all the four grout pipes. Fig 2 Shows the Inflow of the cement with cement chebulic myrobalan grout into tank of 21cm x 24cm The slurry of cement chebulic myrobalan grout solution is

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mixed with correct proportion of ratio of water is poured inside all four grout pipes equally. The slurry solution should be stirred continuously and thoroughly the will not be any kind of pressure induced flow of the grout in to the pipes which is having perforation.

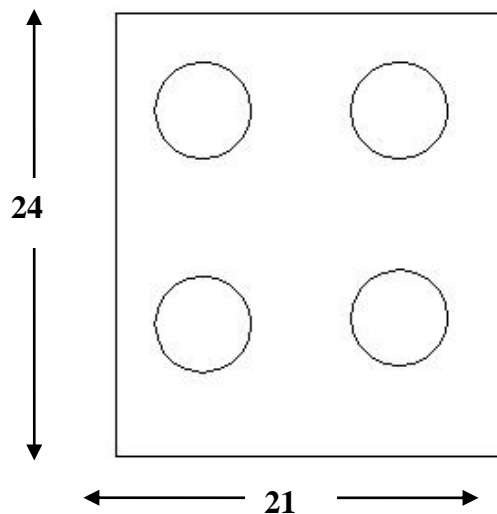


Fig 1 Perforated pipes fixed in the tank of 21cm x 24cm for grouting with the grout of cement chebulic myrobalan grout solution in the tank using permeation type of grouting

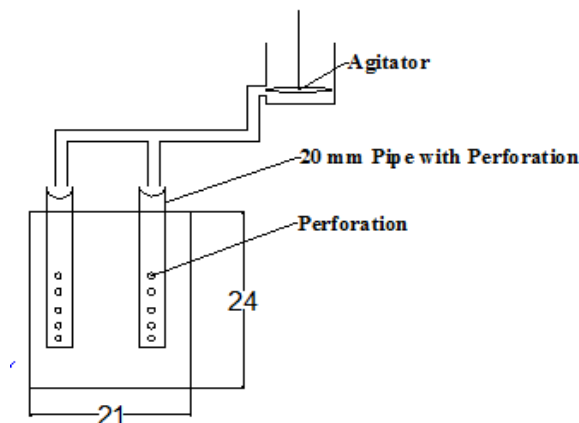


Fig 2 Inflow of the cement chebulic myrobalan solution into tank of 24cm x 21cm connected with the agitator which is used to mix the solution and the it is conveyed with the pipe which is of 20 mm dia with perforation in them which is used to flow the solution in the tank

For preparing permeation grouted samples, a tank of size 21cm x 24cm is fabricated with poly-carbide sheet. The sand to be grouted is filled in the tank. Four PVC Pipes of 20 mm diameter are used for the grouting, with perforations in surface of the pipe with 3mm diameter for each pipe. 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 chebulic myrobalan solution: cement ratio of 10:1, 8:1, 6:1 and 4:1, and agitated well to get uniform grout solution is poured into the four pvc pipes uniformly. The Viscosity of the chebulic myrobalan cement grout is determined with Marsh funnel viscosity test .The grouted sample was kept under moist condition for a curing period of 14 days and 28 days. The sample is placed in between the triaxial loading frame, and a steel plate (7x7cm) is placed at the top centre. A steel spherical ball is placed

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over the centre of the loading test plate in which the load cell is induced on them. For the ultimate load using L.V.D.T set up the displacement is noted and for the corresponding load the displacement is noted. All the above function is displayed in the data logger.

IV. RESULTS AND DISCUSSION

The grout able ratio was determined for the different ratio of the grout solution and their viscosity was tested using marsh funnel viscosity and compared with the cement grout with water and the cement grout with the chebulic myrobalan grout solution.

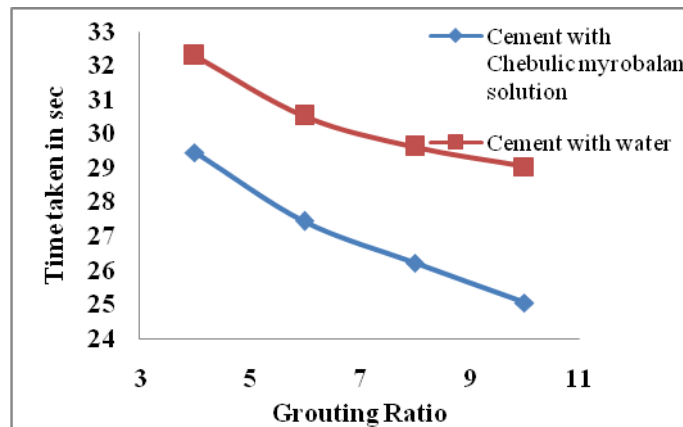


Fig.3 Graphical representation of comparison between the cement grout with water to the cement with chebulic myrobalan grout solution in the marsh funnel viscosity test with various ratio from 10:1 to 4:1 with the solution.

Plate load test on the soil sample without grouting in the loose state and medium dense state by using a plate of 7 x7cm in the tank of size 21x 24 cm. Fig.4 show the load settlement curve for varying grout solution from 10: 1 to 4:1 for 14 days curing of permeation grouted sand in the loose state. From the graph it can be determined that as the grout ratio decreases the ultimate load increases by 40% more than the sand without grouting for 14 days curing.

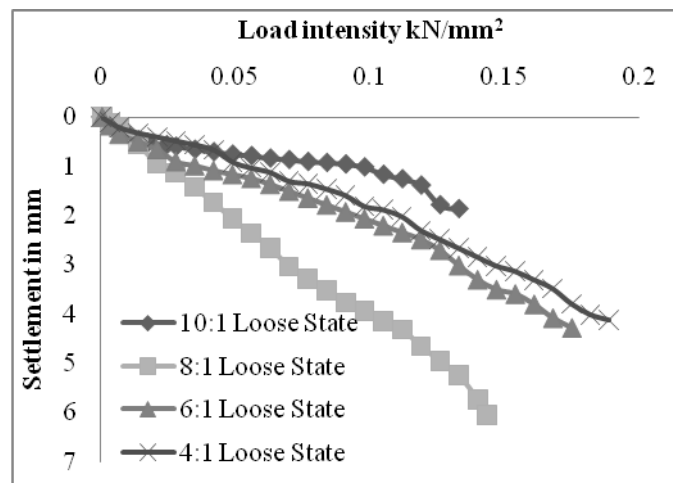


Fig.no.4 Load vs Settlement behavior of loose state of soil sample grouted with cement chebulic myrobalan grout solution in the tank of 21x 24 cm using the plate size of 7 cm after 14 days of curing.

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Fig.5 show the load settlement curve for varying grout solution from 10: 1 to 4:1 for 14 days curing of permeation grouted sand in the medium dense state. From the graph it can be determined that as the grout ratio decreases the ultimate load increases by 20% more than the sand without grouting for 14 days curing.

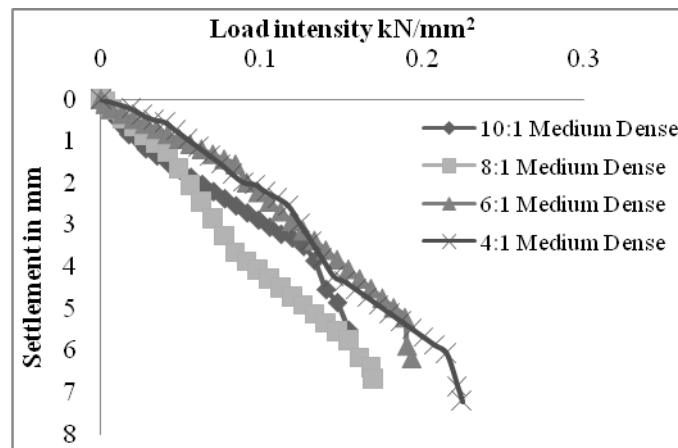


Fig.5 Load vs Settlement behavior of medium dense state of soil sample grouted with cement chebulic myrobalan grout solution in the tank of 21x 24 cm using the plate size of 7 cm after 14 days of curing

Fig.6 show the load settlement curve for varying grout solution from 10: 1 to 4:1 for 28 days curing of permeation grouted sand in the Loose state. From the graph it can be determined that as the grout ratio decreases the ultimate load increases by 58% more than the sand without grouting for 28 days curing

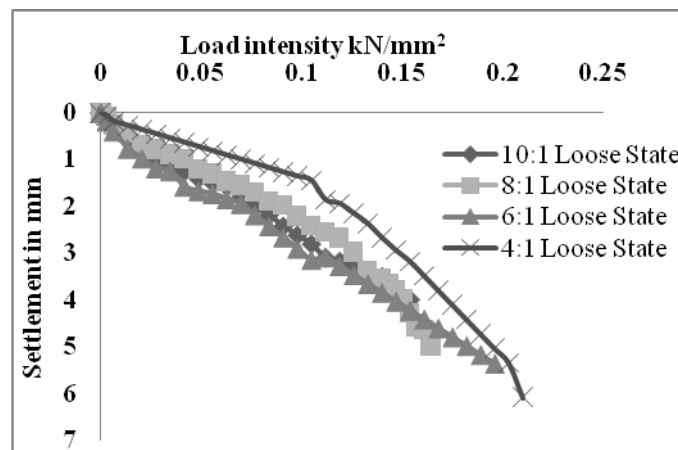


Fig.6 Load vs Settlement behavior of Loose state of soil sample grouted with cement chebulic myrobalan grout solution in the tank of 21x 24 cm using plate loads test with the plate size of 7 cm after 28 days of curing

Fig.7 show the load settlement curve for varying grout solution from 10: 1 to 4:1 for 28 days curing of permeation grouted sand in the medium dense state. From the graph it can be determined that as the grout ratio decreases the ultimate load increases by 72% more than the sand without grouting for 28 days curing

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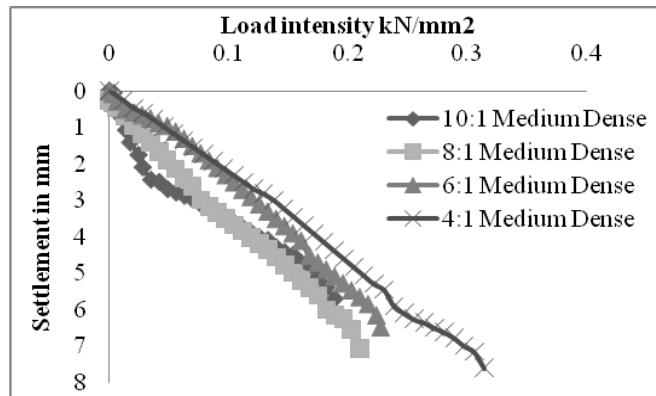


Fig.7 Load vs Settlement behavior of medium dense state of soil sample grouted with cement chebulic myrobalan grout solution in the tank of 21x 24 cm using plate load test with the plate size of 7 cm after 28 days of curing

Fig.8 shows the Comparative chart of Load intensity with the curing period for grouted sample with cement chebulic myrobalan grout solution after 14 and 28 days of curing in loose state. From the graph it can be compared that as the curing period increases the load intensity also increases.

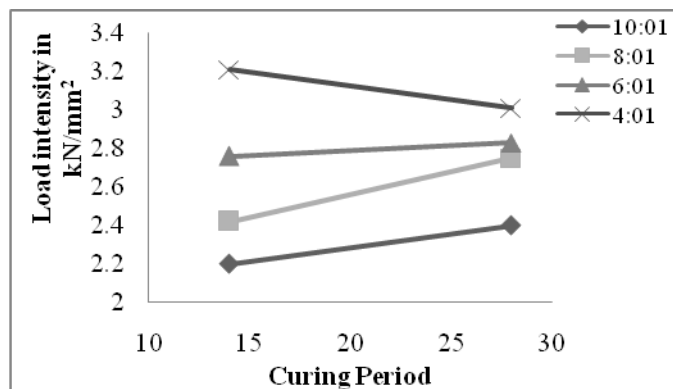


Fig.8 Comparative chart of Load intensity with the curing period for grouted sample with cement chebulic myrobalan grout solution after testing the sample using plate load test for a curing period of 14 and 28 days in loose state.

Fig.9 shows the Comparative chart of Load intensity with the curing period for grouted sample with cement chebulic myrobalan grout solution after 14 and 28 days of curing in medium dense state. From the graph it can be compared that as the curing period increases the load intensity also increases.

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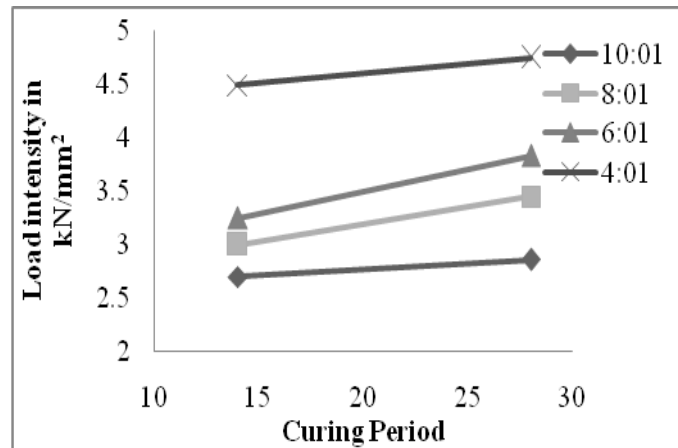


Fig.9 Comparative chart of Load intensity with the curing period for grouted sample with cement chebulic myrobalan grout solution after testing the sample using plate load test for a curing period of 14 and 28 days of curing in medium dense state

Even though the application of this grouting technique to reduce the permeability of the soil collected from the field. Table 6.3 indicates the permeability value of grouted sample after performing plate load test on the soil sample for a curing period of 14 and 28 days.

Table 4. Coefficient of permeability of the grouted sample after determining the hydraulic conductivity of the soil sample after testing the sample using plate load test for a curing period of curing period of 14 days and 28 days

Sl .NO	STATE OF SOIL	Water Cement Ratio	K	
			14 days	28 days
1	Loose State	10:01	0.133	0.154
2	Loose State	8:01	0.143	0.164
3	Loose State	6:01	0.175	0.196
4	Loose State	4:01	0.189	0.21
5	Medium Dense	10:01	0.154	0.188
6	Medium Dense	8:01	0.168	0.21
7	Medium Dense	6:01	0.193	0.22
8	Medium Dense	4:01	0.233	0.25

Fig.10 shows the Comparative chart of Permeability with the curing period for grouted sample after 14 and 28 days of curing in loose state. From the obtained results it can be concluded that the permeability of the soil sample depends on the void ratio (i.e 0.82) of the soil.

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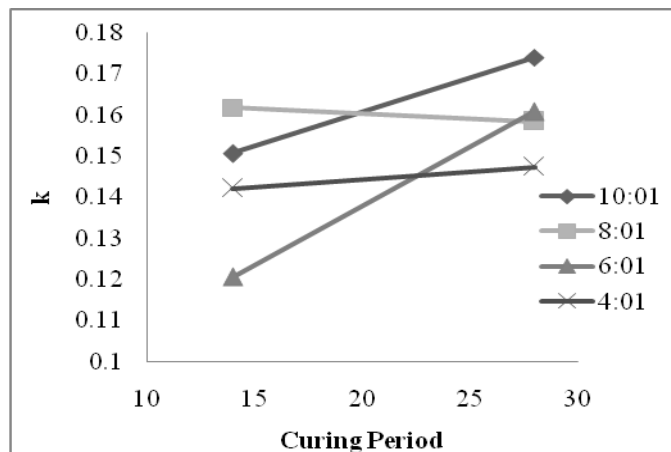


Fig.10 Comparative chart of permeability of the grouted soil sample with cement chebulic myrobalan grout solution after executing the plate load test on the sample for a curing period of 14 and 28 days in loose state

Fig.11 shows the Comparative chart of Permeability with the curing period for grouted sample after 14 and 28 days of curing in medium dense state. From the obtained results it can be concluded that the permeability of the soil sample depends on the void ratio (i.e 0.75) of the soil.

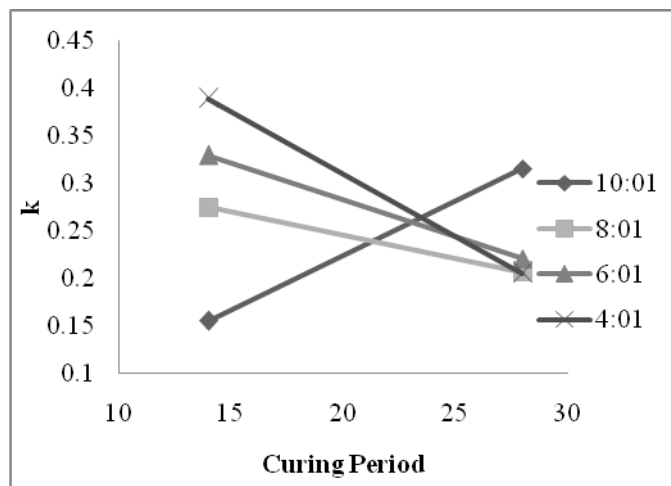


Fig.11 Comparative chart of permeability of the grouted sample with cement chebulic myrobalan grout solution after executing the plate load test on the sample for a curing period 14 and 28 days of curing in medium dense state.

V. CONCLUSION

This study examines the scope of the improvement in the granular soil of low strength with cement and Chebulic myrobalan grout combination. Based on the experimental investigation and the test results the following conclusions are made. The plate load tests show the efficiency of grouting mainly depends upon the penetration of cement grout through the pores of sand. It can be seen that as the grout ratio decreases the ultimate load increases by 3 to 4 times for 14 days curing and 7 to 9 times for 28 days curing in case of loose state of soil (void ratio – 0.82). In the case of medium dense state (void ratio – 0.75) it can be seen that as the grout ratio decreases the ultimate load increases by 12

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to 15 times for 14 days curing and 18 to 20 times for 28 days curing. Finally in this analysis it is termed that the replacing water with chebulic myrobalan grout solution with cement in different ratio of grout is decrease the displacement also decrease i.e., it shows strength or the barring capacity of soil increase.

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