



Improvement of safe bearing capacity of Moorum using cement as admixture

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Abstract:

In recent years the growth in the Infrastructure is at a faster rate in India. The construction of high rise buildings and Multi storeyed structures is playing a prominent role in the development of infrastructure. All these structures require Durable and Tough foundation material to ensure the safety of the structure. Safe Bearing Capacity is the essential parameter which is a deciding factor for selecting type of foundation. In the present study an attempt has been made to enhance the SBC of Moorum using cement as admixture. Initially all basic Geotechnical parameters such as Specific gravity, Grain Size Distribution, Liquid limit, Plasticity Index, OMC(Optimum Moisture Content), MDD(Maximum Dry Density) were determined. In the later stages Moorum mixed with various proportions of cement i.e 2, 5, 8 and 10. After that these mixes were tested under Direct Shear Apparatus to find out the shear parameters like Cohesion and Angle of Shearing Resistance. 8% addition of cement has shown optimum results which was considered for the calculation of SBC. Eventually this research provides a tough and Durable foundation material for sustaining heavy loads and it can facilitate the construction of high rise buildings.

Key words: Cement, Cohesion, Moorum, Safe Bearing Capacity, Resistance.

Introduction:

Moorum is the product of decomposition and weathering of parent rock. Visually there are similar to gravel expect presence of high content of soil. Moorum is one of the best suited soils for constructions. It is generally available in hilly regions. The disintegration and decomposition of hard rock and Soft Disintegrated Rock leads to the formation of Moorum. Moorum is a Coarse

Grained soil which consists of Single Grained structure. The single Grained Structure has more void spaces in it, so that the permeability increases which is a undesirable situation for the constructions. If the Moorum consists more percentage of sand then the Safe Bearing Capacity (SBC) decreases, in such cases it is essential to enhance the SBC of Moorum by adding some admixtures. Cement is one of the best suited admixture for soil to make it



suitable for constructions. The addition of cement reduces the void spaces. So that the density would increase and the single grained structure convert into dispersed structure. The cohesion and shearing resistance values would increase which would cause in increase of Safe Bearing Capacity. Improvement of soil strength using cement admixtures was studied by Bulbul Ahmed, Md. Abdul Alim, Md. Abu Sayeed in 2013 from department of Civil Engineering, Rajshahi University of Engineering & Technology (RUET), Rajshahi -6204, and Bangladesh. Venkatappa Rao and Pandey was Studied on geotextile friction evaluation in 1988 for the Moorum. In the present study,

Results and discussions:

modified shear box tests are conducted as per the procedure given by Hussaini and Perry (1978) to determine the interfacial friction angles of Moorum with synthetic woven geotextile under study. Mr. Umesh N. Waghmare¹ and Dr. K. A. Patil was studied on Investigation of Soil and Bearing Capacity in Different Site Conditions in 2012.

Materials used:

Moorum: soil sample was collected from AITAM campus located at Tekkali in Srikakulam district. The soil taken at a depth of 6 feet.

Cement: The cement used for the present project work is OPC 53grade (priya cement).

Geotechnical properties of Moorum:

The basic Geotechnical properties of Moorum were determined in the laboratory the experimental findings are as follows

No.	Property	Soft Moorum
1	Specific gravity	2.7
2	Particle size analysis	Poorly graded
	Gravel (20 to 4.75mm.)	24.92%
	Sand (4.75 to 0.075mm)	63.87%
	Fines (Silt and clay) (below0.075mm.)	11.21
3	Atterberg Limits	
	Liquid limit	28.83%
	Plastic limit	Non plastic
	Plasticity index	28.83
4	Maximum dry density (g/cc)	2.1
	Optimum Moisture Content (%)	11.4

Table 1

SIEVE ANALYSIS: The particle size distribution was carried out for Moorum. The curves are as shown below.

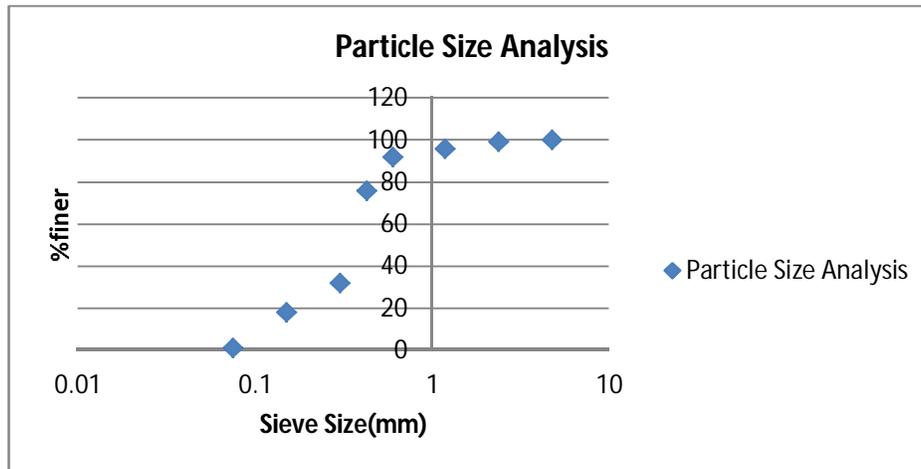


Figure 1

Compaction characteristics:

The parameters like OMC and MDD were determined for individual Moorum and cement stabilized Moorum mixes. The test was performed based on IS2720 Part-7. The experimental results and curves are as shown below.

Cement Content (%)	OMC(%)
0	11.4
2	11.2
5	11
8	10.9
10	10.7

Table2

Cement Content (%)	MDD(g/cc)
0	1.6
2	1.83
5	1.93
8	2
10	2.1

Table3

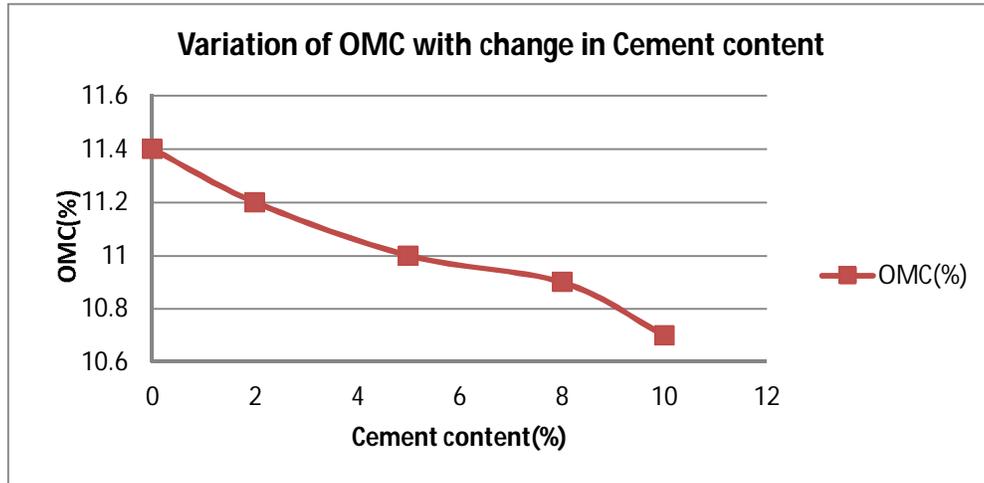


Figure2

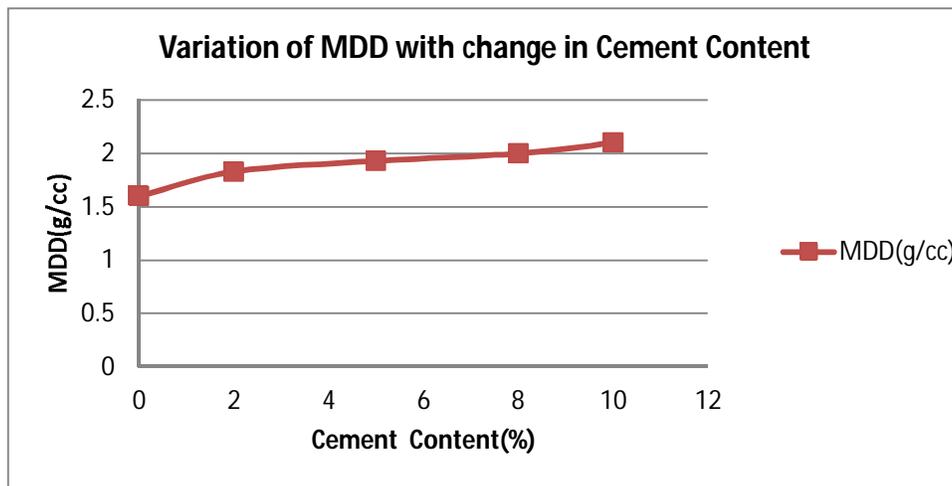


Figure3

The addition of cement content to Moorum results in decrease of OMC values and increase of MDD values. Cement addition to Moorum helped in agglomeration mechanism in which the smaller size particles combine together to form bigger size particles. The formation of bigger particles took less amount of water for hydration. Consequently there is marginal decrease in OMC

values. The increase in MDD is due to dispersed structure.

DIRECT SHEAR TEST:

The shear parameters like cohesion and angle of internal friction were found out for individual Moorum and various percentage additions of cement with Moorummixes. The tests were conducted as per IS2720 Part - The experimental results are as



follows

Cement Content(%)	Cohesion(kg/cm ²)
0	0
2	0.04
5	0.08
8	0.10
10	0.12

Table4

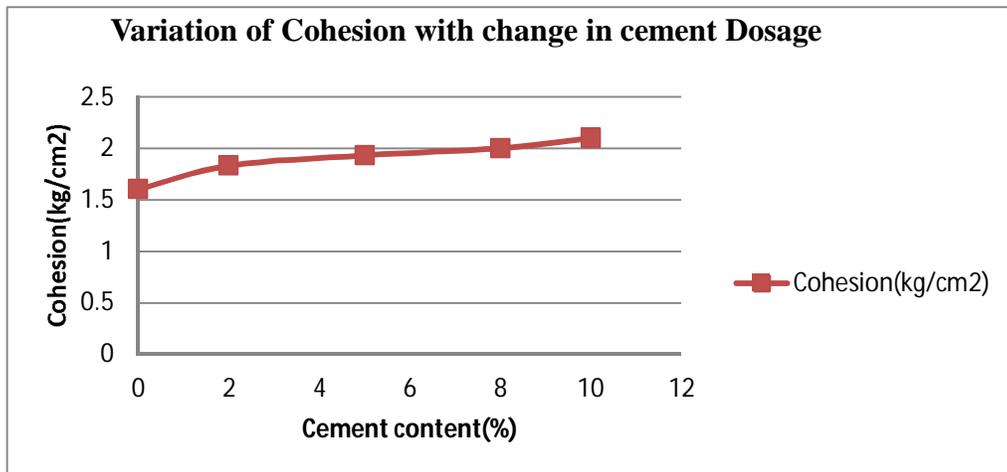


Figure4

Cement Content(%)	Angle of shearing resistance(Φ)
0	16 ⁰
2	19 ⁰
5	24 ⁰
8	27 ⁰
10	28 ⁰

Table5

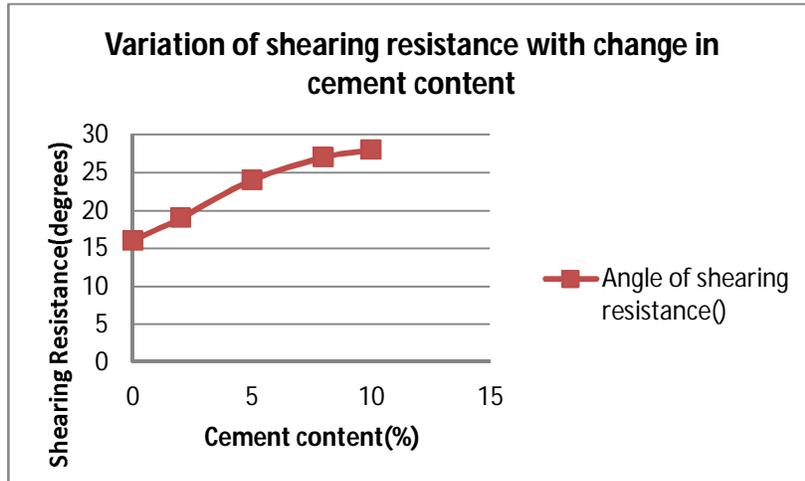


Figure5

It is observed from Fig no4.18, 4.19 that both cohesion and angle of shearing resistance were increased with increase in percentage of cement. This is due to aggregation of particles. The single grained structure of Moorum converted into dispersed structure. The fine particles of cement took place in the voids among the bigger size particles. Consequently a marginal decrease in void ratio took place which leads to

the increase of strengths of the mixes. The content of Calcium oxide also played a vital role in enhancing the shear parameters. The optimum dosage was decided as 8% cement with Moorum which has shown optimum values this is due to more percentage of Calcium oxide and dispersed structure. Further addition of cement did not show any remarkable change in the shear parameters.

Safe Bearing Capacity of Moorum is 16t/m²

5 Calculation of Safe Bearing Capacity (8% cement+Lime mix):

Data:

- Angle of Shearing resistance $\phi = 16^\circ$
- Cohesion $C = 0$
- Unit weight $\gamma = 21 \text{KN/m}^2$
- Depth of the footing $D_f = 1.5 \text{m}$
- Width of the footing $d = 2 \text{m}$
- Angle of Shearing resistance failure. $\phi = 16^\circ < 28^\circ$ so the failure is local shear failure.



Mobilised Angle of Shearing resistance $\phi_m = \tan^{-1}(2/3 \tan \phi)$

$$\phi_m = \tan^{-1}(2/3 \tan 16) = 10.8$$

Formula:

$$Q_{nu} = C_m N_c S_c i_c d_c + \gamma D_f (N_q - 1) S_q d_q i_q + 0.5 \gamma B N_\gamma S_\gamma d_\gamma i_\gamma$$

Shape factors for strip footing:

$$S_c = S_q = S_\gamma = 1$$

Inclination factor for strip footing:

$$i_c = i_q = i_\gamma = 1$$

Depth factor:

$$d_c = 1 + 0.2 \tan(45 + \phi/2)$$

$$d_q = d_\gamma = 1 + 0.1 \tan(45 + \phi/2)$$

$$d_c = 1 + 0.2 \tan(45 + 10.8/2) = 1.18$$

$$d_q = d_\gamma = 1 + 0.1 \tan(45 + 10.8/2) = 1.09$$

Bearing Capacity factors:

$$N_q = \tan^2(45 + \phi/2)$$

$$N_c = (N_q - 1) \cot \phi$$

$$N_\gamma = 2(N_q + 1) \tan \phi$$

$$N_q = \tan^2(45 + 10.8/2) = 2.66$$

$$N_c = (N_q - 1) \cot \phi = (2.66 - 1) \cot 10.8 = 8.7$$

$$N_\gamma = 2(N_q + 1) \tan \phi = 2(2.66 + 1) \tan 10.8 = 1.39$$

$$N_c = (N_q - 1) \cot \phi = (2.66 - 1) \cot 10.8 = 8.7$$

$$N_\gamma = 2(N_q + 1) \tan \phi = 2(2.66 + 1) \tan 10.8 = 1.39$$

4.5 Calculation of Safe Bearing Capacity (8% cement):

Data:

Angle of Shearing resistance $\phi = 27$

Cohesion $C = 10 \text{ kN/m}^2$

Unit weight $\gamma = 21 \text{ kN/m}^3$

Depth of the footing $D_f = 1.5 \text{ m}$

Width of the footing $d = 2 \text{ m}$



Angle of Shearing resistance $\Phi = 27^\circ < 28^\circ$ so the failure is local shear failure.

Mobilised Angle of Shearing resistance $\Phi_m = \tan^{-1}(2/3 \tan \Phi)$

$$\Phi_m = \tan^{-1}(2/3 \tan 27) = 18.76^\circ$$

Mobilised cohesion $= C_m = 2/3 * C = 2/3 * 10 = 6.67 \text{ KN/m}^2$

Formula:

$$Q_{nu} = C_m N_c S_c i_c d_c + \gamma D_f (N_q - 1) S_q d_q i_q + 0.5 \gamma B N_\gamma S_\gamma d_\gamma i_\gamma$$

Shape factors for strip footing: $S_c = S_q = S_\gamma = 1$

Inclination factor for strip footing: $i_c = i_q = i_\gamma = 1$

Depth factors:

$$d_c = 1 + 0.2 * \tan(45 + \Phi/2)$$

$$d_q = d_\gamma = 1 + 0.1 * \tan(45 + \Phi/2)$$

$$d_c = 1 + 0.2 * \tan(45 + 18.76/2) = 1.2$$

$$d_q = d_\gamma = 1 + 0.1 * \tan(45 + 18.76/2) = 1.1$$

Bearing Capacity factors:

$$N_q = \tan^2(45 + \Phi/2)$$

$$N_c = (N_q - 1) \cot \Phi$$

$$N_\gamma = 2(N_q + 1) \tan \Phi$$

$$N_0 = \tan^2(45 + 18.76/2) = 12.5$$

$$N_c = (N_q - 1) \cot \Phi = (12.5 - 1) \cot 18.76 = 38.14$$

$$N_\gamma = 2(N_q + 1) \tan \Phi = 2(12.5 + 1) \tan 18.76 = 8$$

$$Q_{nu} = 6.67 * 38.14 * 1 * 1.2 * 1 + 21 * 1.5 * (12.5 - 1) * 1.1 * 1 * 1 + 0.5 * 21 * 2 * 8 * 1.1 * 1 = 890 \text{ KN/m}^2$$

$$Q_{ns} = Q_{nu} / F.O.S = 890 / 3 = 297 \text{ KN/m}^2$$

$$Q_s = Q_{ns} + \gamma D_f = 297 + 21 * 1.5 = 328.5 \text{ KN/m}^2$$

$$\text{Safe Bearing Capacity } Q_s = 328.5 \text{ KN/m}^2 = 33 \text{ ton/m}^2$$



Conclusion

The values of Cohesion and Shearing resistance were increased with increase in dosage of cement. The addition of 8% of Cement to Moorum has decided as optimum mix which has shown maximum shear parameters. The further addition of cement beyond 8% did not show much variation in the values. The values of cohesion and angle of internal friction obtained are 0.1 kg/cm² and 27° respectively. From the experimental findings it is observed that normal stress is directly proportional to shear stress. Increase in Cement dosage to Moorum results in increasing MDD values and decreasing of OMC values.

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