International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 05 Issue: 03 | Mar-2018 www.irjet.net p-ISSN: 2395-0072

EFFECT OF FOUNDRY SAND ON GEOTECHNICAL PROPERTIES OF MARINE CLAY

Jais Jose[1], Nirmal Raju Jose[2], Amrutha P.M[3], Ghanashyam S[4], Dr. Solly George[5]

[1,2,3,4] B Tech Students, Mar Athanasius College of Engineering Kothamangalam, Kerala, India
[5] Professor, Mar Athanasius College of Engineering Kothamangalam, Kerala, India

---

Abstract – *Soil stabilization means the improvement of stability or bearing capacity of soil by the use of controlled compaction, proportioning and/ or addition of suitable admixtures or stabilizers. The main objective of this study is to investigate the effect of foundry sand on the geotechnical properties of marine clay. The experiments were done on marine clay. The tests were conducted on soil admixed with foundry sand at different percentages and the results were compared with that of blank soil. Data presented includes maximum dry density, optimum moisture content, California bearing ratio and unconfined compressive strength. The study reveals that the CBR value of soil increases with the addition of foundry sand. The proposed technique can be used as an effective method in the field of soil stabilization and an effective disposal technique for foundry sand.*

Key Words: Stabilization, Marine clay, Foundry sand

1. INTRODUCTION

Soil stabilization is a physical, chemical, biological, or combined method of changing a natural soil to meet an engineering purpose. It is required, when soil available for the construction is not suitable for the intended purpose. Soil stabilization is used to reduce the permeability and compressibility of the soil mass in earth structures and to increase its shear strength. It also increases the bearing capacity of foundation soils.

The soil found in the ocean bed is classified as marine clay. It can even be located onshore as well. The properties of saturated marine clay differ significantly from moist soil and dry soil. Marine clay is microcrystalline in nature and clay minerals like chlorite, kaolinite and illite and non-clay minerals like quartz and feldspar are present in the soil. The soils have higher proportion of organic matters that acts as a cementing agent.

Marine soils in particular can present great problems in pavement design due to uncertainty associated with their performance. They are often unstable beneath a pavement and they are the most susceptible to problems from changes in moisture content. Marine soils tend to swell and become soft when wetted and may shrink and becomes stiff when dried. Marine clay deposits are found both in the coast and in several offshore areas spread over many parts of the world. India being peninsular country has a large area coming under coastal region and also it has been the habitat for considerable percentage of population. The marine clays are found in the states of West Bengal, Orissa, Andhra Pradesh, Tamil Nadu, Kerala, Karnataka, Maharashtra and some parts of Gujarat. These soils are highly saturated, soft, sensitive and normally consolidated, these usually have low density and low shear strength and expansive in nature. The construction over marine clay may experience bearing capacity failure and excessive settlement, stabilization using foundry sand is an optional to solve this problem. It has no economical value. So it can effectively use for marine clay stabilization.

2. METHODOLOGY AND MATERIALS

The main purpose of this project was to evaluate the effect on the marine soil properties due to the addition of foundry sand. Mainly the study was concentrated on the strength property. Foundry sand was taken in different percentage by weight of the marine clay for the experimental studies.

2.1 MARINE CLAY

Soil which was collected from the highway side of Vallarpadam was used for this study. The geotechnical properties of soil samples were tested as per Indian Standard specification (IS 2720) and as shown in table 1.

Table -1: Basic properties of marine clay

MARINE CLAY			
NO.	TESTS CONDUCTED	PROPERTIES	RESULT
1.	GRAIN SIZE ANALYSIS	D10 D30 D60 Cu Cc % Silt % Clay % Sand	0.015 mm 0.025 mm 0.08mm 5.33 0.52 44 40 16
2.	INDEX PROPERTIES	Specific Gravity	2.35
3.	CONSISTENCY LIMITS	Liquid limit Plastic limit Plasticity index	62% 32.29% 29.71%
4,	STANDARD PROCTOR TEST	Maximum dry density(g/cc) Optimum moisture content (%)	1.27 28.3
5.	UNCONFINED COMPRESSION TEST	Compressive strength(kg/cm2) Cohesion(kg/cm2)	0.082 0.041
6.	CALIFORNIA BEARING RATIO	CBR value (%)	1.6

Grain size distribution curve is shown below:

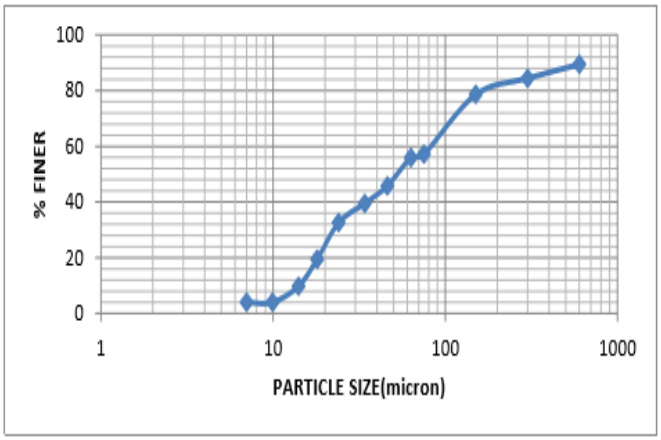

Chart -1: Grain size distribution curve of marine clay

2.2 FOUNDRY SAND

Metal foundries use large amount of sand as part of metal casting process. Foundries successfully recycle and reuse the sand many times in a foundry. When the sand can no longer be used in the foundry, it is removed from the foundry and is termed "Foundry Sand". Foundry sand is high-quality uniform silica sand that is used to make moulds and cores for ferrous and nonferrous metal castings. Foundry sands typically comprise of >80% high-quality silica sand, 5-10% bentonite clay, 2-5% water and less than 5% sea coal. The metal casting industry annually uses an estimated 100 million tons of foundry sand for production; the physical and chemical characteristics of foundry sand will depend in great part on the type of casting process and the industry sector from which it originates. The geotechnical properties of foundry sand were tested as per Indian Standard specification (IS 2720) and as shown in table 2. The grain size distribution of foundry sand is shown in chart 2.

Table -2: Basic properties of foundry sand

NO.	TESTS CONDUCTED	PROPERTIES	RESULT
1.	GRAIN SIZE ANALYSIS	D10 D60 D30 Cu Cc	160μm 460μm 300μm 2.89 1.22
2.	DIRECT SHEAR TEST	Angle of internal friction	28.52^{o}
3.	INDEX PROPERTIES	Specific gravity	2.52

Grain size distribution curve of foundry sand is given below:

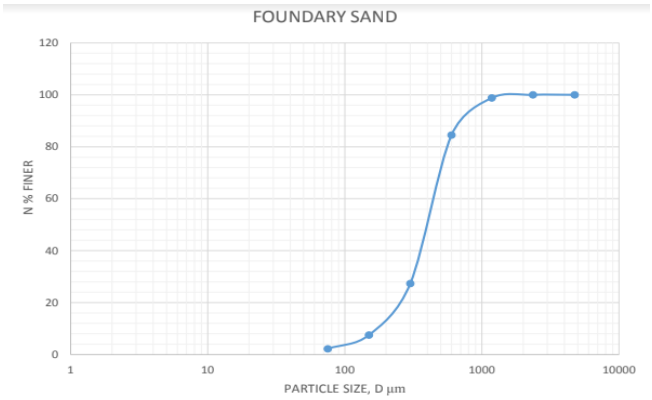

Chart -2: Grain size distribution curve of foundry sand

3. RESULTS AND DISCUSSIONS

The basic properties of clay were determined. The experiments are conducted by using soil without foundry sand and with foundry sand in varying percentage. The percentage of foundry sand were taken are 2%, 4%, 6%. The results were compare among themselves.

3.1 PROCTOR'S COMPACTION TEST

The optimum moisture content and maximum dry density of the soil samples for various percentage of foundry sand (0%, 2%, 4%, 6%) were determined by performing the Standard Proctor's test. The dry density was determined and plotted against the corresponding water content and the corresponding maximum dry density. The values of OMC and MDD of various percentage of foundry sand are tabulated in Table 3.

Table -3: Proctor's Test

% Foundry sand	OMC (%)	Max. Dry Density (g/cc)
0	28.3	1.27
2	19	1.45
4	15.2	1.52
6	26.2	1.36

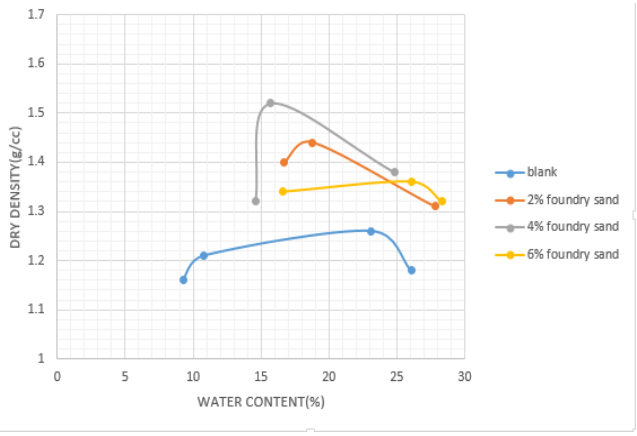

Chart-3: Proctor's compaction curve for different proportions of foundry sand

Chart 3 shows the proctor's compaction curve for different proportion of foundry sand. By the addition of 4% of foundry sand by weight the maximum dry density increased from 1.27g/cc to 1.52g/cc. Further the addition of foundry sand its dry density decreased. And the optimum moisture content (OMC) is decreased from 28.3% to 15.2% by the addition of 4% of foundry sand.

3.2 CALIFORNIA BEARING RATIO TEST

California Bearing Ratio test is one of the most commonly used method to evaluate the strength of subgrade soil for the design of pavement thickness. The CBR value of the marine clay for various percentages (0%, 2%, 4%, 6%) of foundry sand were determined. From the load penetration curve, the CBR value corresponding to 2.5mm and 5mm penetration was determined. The CBR value corresponding to these penetrations for different percentage of foundry sand is shown in the table below.

Table -4: CBR Value

% of Foundry sand	CBR Value for 2.5mm penetration (%)	CBR Value for 5mm penetration (%)
0	1.6	0.96
2	9.12	8.6
4	10.51	9.71
6	9.74	8.66

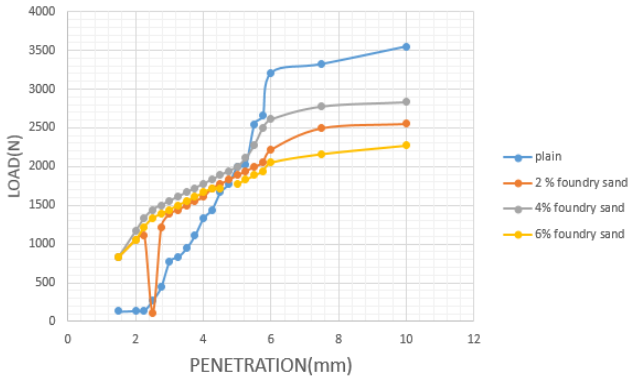

Chart-4: Load penetration curve for different proportions of foundry sand

By the addition of 4% of foundry sand the CBR value was increased from 1.6% to 10.51%. On further addition of foundry sand its CBR value decreased. The optimum percentage of foundry sand was found to be 4%.

3.3 UNCONFINED COMPRESSION TEST

The primary function of this test is to determine the unconfined compressive strength. The compressive load per unit area required to fail the specimen is called the unconfined compressive strength of the soil. The test is conducted on marine clay with various percentage of foundry sand. And the unconfined compressive strength of marine clay increased from 0.082kg/cm^2 to 0.32kg/cm^2 by the addition of 4% of foundry sand. On further addition of foundry sand its compressive strength is decreased.

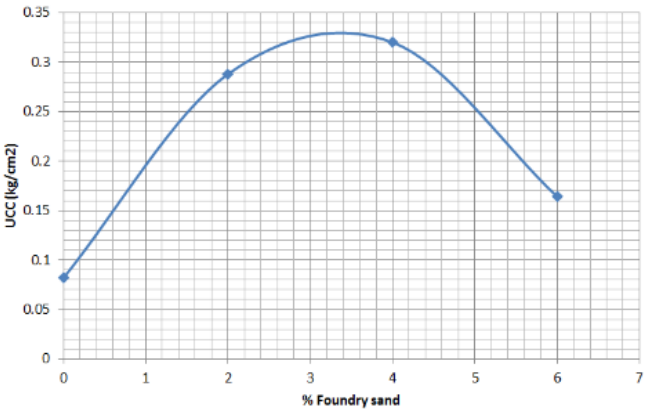

Chart-5: Unconfined compressive strength Vs. % Foundry sand

Table -5: Unconfined compressive strength

% Foundry sand	0	2	4	6
UCC (kg/cm^2)	0.082	0.288	0.32	0.164
Cohesion (kg/cm^2)	0.041	0.144	0.16	0.08

3.4 OTHER TEST RESULTS FOR MARINE CLAY WITH DIFFERENT PROPORTIONS OF FOUNDRY SAND

Table -6: Comparison of Test results

% Foundry sand	0	2	4	6
Liquid limit %	62	64	57	60
Plastic limit %	32.29	47.67	48.06	46.2
Shrinkage limit %	30.23	40.08	46.19	36.42
Plasticity index %	29.71	16.33	8.94	13.8

4. CONCLUSIONS

The effect of foundry sand on marine clay was studied by conducting various laboratory experiments on the marine clay with varying percentages of foundry sand. Foundry sand can be effectively used for stabilization of weak soil like marine clay. The optimum percentage of foundry sand was found to be 4%.

- Maximum Dry Density was obtained when 4% by weight of foundry sand was added to the marine clay
- CBR value was found to increase from 1.6% to 10.51%
- Unconfined Compressive strength of marine clay was found to be increased from 0.082kg/cm^2 to 0.32kg/cm^2

5. REFERENCES

[1] Agarwala, V.S and Khanna, J.S (1969), Construction techniques for foundations of buildings on black cotton soils, proceedings of the symposium on characteristics and construction techniques in black cotton soil, the college of military Engg., Poona, India

[2] Al-Rawas, N.M (2000), Effect of curing and temperature on Rice Husk Ash stabilization, Proc. Of Second Australian Conf. on Engineering Materials, Sydney, 1981, pp.611-662.

[3] D. KoteswaraRao (2004), The performance studies on Geo-grid as reinforcement in the flexible pavement construction, IGC-2004.

[4] IS: 2720 part- 4 (1975): Grain size analysis

[5] IS: 2720 part- 5 (1970): Determination of Liquid limit and Plastic limit.

[6] IS: 2720 part- 6 (1972): Determination of Shrinkage limit.

[7] IS: 2720 part- 6 (1974): Determination of Dry density and Optimum moisture content.

[8] IS: 2720 Part-10 (1973): Determination of Unconfined compressive strength.

[9] IS: 2720 Part-16 (1979): Determination of California bearing ratio.

[10] IS: 2720 part-40 (1977): Determination of Free Swell Index.