

# Stabilization of Marine Clay Using Foundry Sand

Anjaly P S<sup>1</sup>, Akshara George Pallippadan<sup>2</sup>, Aswathi V Sasi<sup>3</sup>, Mufeedha E B<sup>4</sup>, Bincy Babu<sup>5</sup>

UG Scholars, Department of Civil Engineering, Mar Baselios Institute of Technology and Science, Nellimattom, Ernakulam, Kerala, India<sup>1,2,3,4</sup>

Assistant Professor, Department of Civil Engineering, Mar Baselios Institute of Technology and Science, Nellimattom, Ernakulam, Kerala, India<sup>5</sup>

**ABSTRACT:** In recent times the demands for sub grade materials has increased due to increased constructional activities in the transportation sector. In this situation, a means to overcome this problem is to utilize the different alternative waste materials, which cause not only environmental hazards but also the depositional problems. Keeping this in view stabilization of weak soil in situ may be done with suitable admixtures to considerably save the construction cost. Soil with low-bearing capacity can be strengthened economically for building purposes through the process of “soil stabilization” using different types of stabilizers. Soil stabilization may be defined as the process of changing engineering properties of soil to improve the bearing capacity and durability property of weak soil. Design of the various pavement layers is very much dependent on the strength of the sub grade soil over which they are going to be laid. Weaker sub grade essentially requires thicker layers whereas stronger sub grade goes well with thinner pavement layers. The pavement and the sub grade mutually must sustain the traffic volume. The aim of this project is to study the stabilization of marine clayey soil using Waste Foundry sand. The waste sand collected is added to the soil in different proportions to study the soil properties and various tests are conducted. Also design of the flexible pavement is done.

**KEYWORDS:** Soil stabilization, Marine clay, Waste foundry sand, Design of flexible pavement.

## I. INTRODUCTION

Stabilization means the improvement of stability or bearing capacity of sub-grade soil by the use of controlled compaction, proportioning and/ or addition of suitable admixtures or stabilizers. It is required, when the 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 and to increase its shear strength. It also increases the bearing capacity of foundation soils. However, the main use of soil stabilization is to improve the natural soils for the construction of highways and airfields. Commonly used methods for soil stabilization are traditional mechanical methods and chemical methods. A wide variety of waste materials from agriculture and industry have been used for soil stabilization.

Foundry sand is top quality silica sand that's a by-product from the assembly of every ferrous and nonferrous metal casting. Metal foundries use massive amount of sand as a part of the metal casting method. Once used sand should not be reused within the metal works, which termed as foundry sand. Design of the various pavement layers is very much dependent on the strength of the sub grade soil over which they are going to be laid.

As per IRC recommendation, California Bearing Ratio (CBR) value of sub-grade is used for design of flexible pavements. CBR value of soil may depends on many factors like maximum dry density (MDD), optimum moisture content (OMC), liquid limit (LL), plastic limit (PL), plasticity index (PI), type of soil, permeability of soil etc. These tests can easily be performed in the laboratory. In this study, attempts have been made to seek the values of CBR of different soil samples and compare their CBR values for the design purpose of flexible pavement as per guidelines of IRC37-2012.

## II. RELATED WORK

We selected three locations for the collection of marine clay; Elamkunnapuzha- vypin, Vallarpadam and Fort Kochi. Foundry sands typically comprise of >80% high-quality silica sand, 5-10% bentonite clay, 2-5% water and less than 5% sea coal. The physical and chemical characteristics of foundry sand will depend on the type of casting process and the industry sector from which it originates. Foundry sand was collected from HMT Machines and tools, Kalamassery.

### III. METHODOLOGY

[1] Material collection [2] Material testing [3] Pavement design

The weak soil used for the study was marine clay. Marine clay is a very weak soil having high settlement and extremely low shear strength. In order to improve the properties of this weak soil various waste materials like foundry sand is added in different proportions, tested and their effect on the weak soil was evaluated.



(1) (2)  
Figure (1) Marine clay, Figure (2) Foundry sand

First of all the initial properties of collected sub grade soil is studied. Then the strength characteristics of the same soil with addition of varying percentages of waste foundry sand was studied. Index properties of soil were found using specific gravity test and Atterberg limits test and Engineering properties of soil were found using compaction test, unconfined compressive strength test, California bearing ratio test.

Design of flexible pavement was done as per IRC method which is an empirical method where the thickness value of a pavement used was read from the CBR value of the sub-grade. From the design chart the total pavement thickness could be read for a given CBR value and cumulative standard axle load.

### IV. RESULTS

For the determination of various properties, experimental studies were conducted on foundry sand, untreated marine clay(0%), and stabilized marine clay by the addition of various percentages of Waste Foundry Sand(3%,6%,9%).

Sl No	Test conducted on foundry sand	Properties	Result
1	Index property	Specific gravity	2.57
2	Grain size analysis	Cu	2.07
		Cc	0.95

Sl No	Test conducted on marine clay	Sample 1				Sample 2				Sample 3			
		0%	3%	6%	9%	0%	3%	6%	9%	0%	3%	6%	9%
1	Liquid limit(%)	58	60	71	65	20	25	31	27	62	25	31	27
2	Plastic limit(%)	40	45.45	53	49	45	48	54	52	32.3	48	54	52
3	Plasticity index(%)	18	14.55	18	16	25	23	23	25	29.7	23	23	25
4	Dry density(g/cc)	1.06	1.126	1.4	1.33	1.53	1.54	1.69	1.62	1.27	1.45	1.52	1.36
5	Optimum moisture content(%)	25.2	21	17.5	19.6	17	14	12	20	23	19	15.2	26.2
6	CBR(%)	1.89	2.19	2.3	2.06	1.63	1.86	2.89	2.51	1.62	9.12	9.94	8.15
7	UCC(kg/cm <sup>2</sup> )	0.05	0.19	0.26	0.132	0.032	0.09	0.15	0.08	0.07	0.29	0.39	0.19

Based on the performance of existing designs and using analytical approach, simple design charts and a catalogue of pavement designs are added in the code. The pavement designs are given for sub grade CBR values ranging from 3% to 15% and design traffic ranging from 1 msa to 150 msa for an average annual pavement temperature of 35°C. The later thicknesses obtained from the analysis have been slightly modified to adapt the designs to stage construction. Using the following simple input parameters, appropriate designs could be chosen for the given traffic and soil strength:

- Design traffic in terms of cumulative number of standard axles; and
- CBR value of sub grade.

The method considers traffic in terms of the cumulative number of standard axles (8160 kg) to be carried by the pavement during the design life. This requires information on Initial traffic in terms of CVPD, Traffic growth rate during the design life, Design life in number of years, Vehicle damage factor (VDF), Distribution of commercial traffic over the carriage way.

For the design of flexible pavements, pavement composition has been suggested in the form of design charts presented in plates 1-8. (Granular base and granular sub base- CI 10.1, IRC 37-2012). Traffic surveys were conducted on the project road and traffic volume counts were done for 1 day, November 16, 2019, Saturday, and the number of vehicles plying on the road was recorded. From the classified traffic volume counts, the number of commercial vehicles were considered for the pavement design. CBR value of sample 3 is taken for the design.

- Thickness of pavement - natural clay soil

Total thickness = 810 mm

Thickness of base coarse = 250 mm

Thickness of sub base coarse = 460 mm Thickness  
of surface coarse = 100mm

- Thickness of pavement - stabilized soil with 6% WFS

Total thickness = 500 mm

Thickness of base coarse = 250 mm

Thickness of sub base coarse = 168.6 mm Thickness  
of surface coarse = 80.58 mm

## V. CONCLUSION

The effect of foundry sand on the soil samples were studied by conducting various laboratory experiments on Marine Clay with varying percentage of these additives. The additive showed significant increase in the CBR value. From the analysis of graphical representations, Optimum percentage of foundry sand was found to be 5-6% by dry weight of soil, within the framework of present investigation. CBR value increased by the addition of 5-6% of foundry sand for the various samples taken. Unconfined Compressive Strength has also increased by the addition of 5-6% foundry sand. Hence from the results foundry sand waste can be effectively used for stabilization of weak soil like Marine Clay.

As per IRC 37-2012, the design of flexible pavement is done both for the raw and treated stages of marine clay for the usage as sub-grade. The total thickness of pavement is obtained as 810 mm using the CBR value of untreated marine clay, and the total thickness is 500 mm for the pavement designed with the use of CBR value of marine clay treated waste foundry soil. The thickness of pavement is reduced to an extent, the construction cost can be make economical.

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