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A Comparative Study on Dynamic Properties of Marine Clay Mixed Partially With Murram Soil

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Abstract - Marine structure are various kind of engineering structure which are constructed and installed under ocean for exploration and development of the coastal area. Needs of marine structure is high where the land area or unstable land area is very less compare to ocean or sea area. Due to industrialization various costal area are in heavy demand. Industry included various type of trading of goods and machines. Machines used for loading-unloading create heavy vibration which is not carried by the loose soil in coastal areas, So that the stabilization of this type of soil is required. Dynamic parameters of soil are useful for designing parameters of foundation. The murram soil is easily available in kutch area. In this work, the dynamic properties of marine clay and murram soil were studied considering the effect of different mixing ratio and the change of properties through triaxial test. The present work describes a study carried out to check the improvements in the properties of Marine clay with murrum soil in varying percentages(0-40%). The laboratory tests have been carried out and results are reported

Keywords – Dynamics properties, Marine clay, Murram soil, Stabilization, Triaxial, Laboratory test.

I. INTRODUCTION

Every civil engineering structure, i.e., building, bridge, highway, tunnel, dam and tower etc. must be founded in or on the surface of the earth. For stable structure proper foundation soil is necessary. For proper evaluation of the suitability of that soil as foundation and as construction materials, information about its properties is frequently necessary. To know the detailed geotechnical properties, physical and engineering properties are very much essential.

Due to an increase in the use of marine resources like petroleum products, biological products etc. a coastal activities are increased tremendously. Due to this, there is a huge necessity to build marine structures like offshore platforms, storage structures like fuel storage tanks, temporary halt structures and so on. Such offshore structures considered under heavy structures and give much impact on the soft clay settlement which affects the structural stability. Hence settlement analysis is needed to be performed for such type of heavy structures. In general a very soft clay in sea bed or onshore clay called as marine clay, has very poor shear strength.

Construction of buildings, roads and other civil engineering structures on weak or soft soil is highly risky because such soil is susceptible to differential settlements due to its poor shear strength and high compressibility, Hence, there is a need to improve certain desired properties like bearing capacity, shear strength (c and φ), elastic and dynamic parameters, etc.

II. MARINE CLAY

▪ GENERAL

Generally, the natural water content of the marine clays is always greater than its liquid limit. The comprehensive review of literature shows that a considerable amount of work is related for the determination of Engineering behavior of marine clay has been carried out worldwide almost since last 50 years.

The soil found in the ocean bed is classified as marine soil. It can even be located onshore as well offshore. The properties of marine soil depend significantly on its primary conditions. The properties of saturated marine soil different 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 found in the soil

▪ CHARACTERISTICS OF THE MARINE CLAY

Marine clay is very soft and plastic clay found in coastal area around the world. The marine clay is found at fully saturated condition in the costal area and the natural water content of the marine clays is always greater than its liquid limit. Many attempt has been performed to determine the characteristics and strength parameters of the marine clay. Study indicate that the compressibility and the strength of the marine clay causes more differential settlement in the supporting structure. According to the previous studies it has been indicate that the soft marine clay is very sensitive to change the stress system, moisture content and system chemistry of the pore fluid.

The mineral structure of the clay also pays a vital role in exhibiting its behavior under load for e.g. clay minerals with expanding lattice structure shows high compressibility and moderate swelling when comes in contact with moisture. The marine clay is very hard when it is dry but loses its strength on wetting

III. SOIL DYNAMICS

Soil dynamics is that offshoot of geotechnical engineering, which deals with material properties of soil under dynamic stress. Soil dynamics essentially consists of classical dynamics of elastic continuum and yet relies on dynamics of vibrations. The dynamics parameter for evaluation of soil behavior under dynamic state are the same as those of any other mechanical system, specific improvisation and adaptation are needed for soil as an engineering material.

The soil are natural material so that their engineering properties are complex and can be only evaluated by field and laboratory tests, Although treated as elastic material, soil is very different from concrete or steel and hence there is specific need for study of soil mechanics in general and soil dynamics in particular.
The dynamics soil properties are of great importance in the study of dynamics behavior of foundation, substructure, soil retaining structure, and other soil structure, such as earth and rock fill dam, during earthquakes and also for their earthquake resistant design. The soil is polyphase material consisting of solid soil particles, water and air. The dynamics soil properties should be determine by the properties of the solid particles, the mixture of soil, water and air..

- **STRESS CONDITIONS OF SOIL UNDER DYNAMIC LOADING**

Stress conditions, shear deformations and strength characteristics of soil subjected to static loads depend on soil characteristics such as initial void ratio, density, initial statics stress level and all stress history. The stress deformation and strength characteristics of soil subjected to dynamic loads also depend upon initial static stress field, initial void ratio, stress level and the frequency of the loading. In this context various problems in geotechnical engineering require determination of the dynamic soil properties. In case of dynamic loading such problems are either of small strain amplitude response type or of large strain amplitude response type. Machine foundation subjected to dynamic loads can sustain small levels of strains while structural element subjected to seismic force or bomb blast loading must sustain large strain level.

- **SIGNIFICANCE OF SETTLEMENT IN SOFT SOIL STRATA**

Prediction of settlement is an important part of foundation design to provide the future stability and serviceability of the structure supported by the foundation. As per the codal guideline the prediction of settlement required the proper site investigation and various laboratory test or field tests identifying the conditions of the groundwater and the ground that contribute to the settlement of the foundation. The range of settlement varies with the local sit condition and the characteristics of the superstructure. In case of differential settlement the settlements are governed by the strength and serviceability of the superstructure. In practice, the settlement caused even by self-weight is predicted based on the effective stress. The concept of effective stress has been widely accepted in settlement prediction. In soft marine clay where the pore water pressure is one of the governing parameter which defines the strength of clay, thus in such cases strength or stiffness can be simply correlated with effective stress

IV. EXPERIMENTAL WORK

- **COMBINATION FOR TESTING**

Table1: Combination For Testing

Combination Name	Marine Clay	Murram Soil
S-1	100%	0%
S-2	0%	100%
S-3	90%	10%
S-4	80%	20%
S-5	70%	30%
S-6	60%	40%

- **GRAIN SIZE DISTRIBUTION**

The sieve Analysis tests were conducted to determine the grain size distribution of the marine clay as per IS 2720 (Part IV), 1965. The above tests have been conducted for the purpose of identification and classification of the soil

Table 2: Grain size distribution

Sample Name	Silt & Clay (%)	Gravel (%)	Sand (%)
S-1	97.8	0	2.2
S-2	50.51	10.94	38.55
S-3	83	2	15
S-4	77.77	1.9	20.33
S-5	70.79	2.8	26.41
S-6	61.95	4.3	33.75

- **SPECIFIC GRAVITY**

The Specific gravity of the marine clay and various combination with murram soil was determined by using the density bottle method , As per the IS 2720(Part III)

Table 3: Specific Gravity

Sample Name	Specific Gravity
S-1	2.631
S-2	2.611
S-3	2.614
S-4	2.617
S-5	2.619
S-6	2.622

- **ATTERBERG LIMITS**

The liquid limits of the marine clay was determined by using a cone penetrometer device as per the procedure laid down in IS 2720 (Part V), 1985

Table 4: Atterberg limit and classification

Sample Name	LL	PL	PI	Classification
S-1	56.2	27.1	29.1	CH
S-2	22.43	12.5	9.93	CL
S-3	52.3	25.13	27.17	CH
S-4	46.5	21.37	25.13	CI
S-5	41.7	18.75	22.95	CI
S-6	36.7	16.22	20.48	CI

- **COMPACTION TEST**

The standard Proctor compaction test was conducted on air dried marine clay soil samples with varying moisture content as per IS code: 2720 (part – 7), 1979 In each test, the standard Proctor mould (size :100mm diameter and 127mm height) was filled with homogeneously mixed soil sample with water in three layers, each layer being compacted by 25 blows of a 25N rammer with a height of fall of 300mm The Plot was drawn between the moisture content and the dry density as shown in the Table 5

Table 5: MDD & OMC

Sample Nmae	MDD(gm/cc)	OMC(%)
S-1	1.51	17
S-2	2.14	9.8
S-3	1.65	18.15
S-4	1.73	19.29
S-5	1.74	19.3
S-6	1.75	19.51

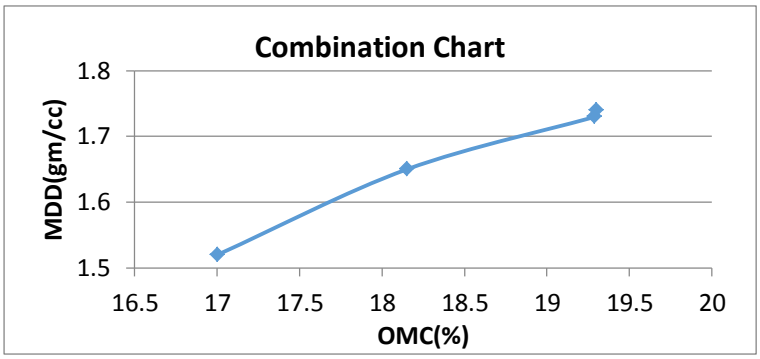

Fig1: Combination chart

- **CONSOLIDATION TEST**

Table 6: Consolidation Results

Sample Name	Compression Index(Cc)	Pre-Consolidation Pressure(Pc)
S-1	0.268	1.2
S-2	0.094	0.750
S-3	0.255	0.91
S-4	0.248	0.87
S-5	0.222	0.86
S-6	0.198	0.82

- **UN-CONSOLIDATED UN-DRAINED TRIAXIAL TESTS**

The unconsolidated undrained Triaxial was conducted on the prepared remoulded marine clay soil samples at OMC condition. From the Mohr Circle diagram the values of C and Φ were obtained.

Table 7:Triaxial Result

Sample Combination	Cell Pressure (σ_3) (Kg/Cm^2)	Deviator Stress at Failure (σd) (Kg/Cm^2)	Major Principle Stress ($\sigma_1=\sigma_3+\sigma d$) ($Kg/Cm^2$)	Cohesion (C) (kg/cm^2)	Angle of internal Friction(φ)
S-1	0.5 1 1.5	1.44 1.53 1.67	1.94 2.53 3.17	0.65	3˚
S-2	0.5 1 1.5	0.56 1.00 1.55	1.06 2.00 3.05	0.08	20˚
S-3	0.5 1 1.5	1.70 1.80 2.00	2.20 2.80 3.50	0.52	5˚
S-4	0.5 1 1.5	1.00 1.31 1.50	1.50 2.31 3.00	0.40	8˚
S-5	0.5 1 1.5	0.90 1.30 1.40	1.40 2.30 2.90	0.33	12 ˚
S-6	0.5 1 1.5	0.80 1.19 1.60	1.30 2.19 3.10	0.24	14˚

- **FREE SWELL INDEX**

The differential free swell of the marine clay, Murram soil and its combination has been determined by using the standard method and it is observed as following in table 8

Table 8: Free Swell Index

Sample Name	Free Swell Index (%)
S-1	60
S-2	25
S-3	55
S-4	48
S-5	42
S-6	38

- **SWELLING PRESSURE**

Swell pressure is defined as the maximum force per unit area that needs to be placed over a swelling soil to prevent volume increase**.** Swelling pressure is a very use full index of the trouble potential of an expansive soil. The Swell pressure of the marine clay was determined as per IS:2720 (Part XLI)-1977. The swell pressure of an undisturbed or remoulded soil is measured for no volume change condition. The method required continuous change on the soil specimen taken in a consolidation cell, so that the soil volume at any time is equal to its initial volume. The remoulded specimens are taken carefully at the density and moisture content of the field soil condition.

Table 9: Swelling Pressure

Sample Name	S-1	S-3	S-4	S-5	S-6
Swelling Pressure (Kg/cm^2)	0.39	0.36	0.29	0.24	0.19

V. SOIL SAMPLE COLLECTION AND TESTING

Fig 2: Marine Clay and Murram soil

Fig 3: Photos of testing done

VI. CONCLUSION

The following conclusions are drawn based on the laboratory studies carried out on this study..

1. The present study explains the knowledge about the Soft Marine Clay in connection with its Engineering Characteristics. It is noticed that the collected marine clay is very weak in nature.
2. It is observed that the liquid limit, plastic limit and the plasticity index were significantly high and the optimum moisture content was below the plastic limit.
3. As we increase the various percentage of murram soil in the marine clay the Liquid limit, Plastic limit, and plasticity index are reduces.
4. It is noticed from the U.U Triaxial test of a remoulded marine clayey soil sample, the value of Cohesion and Angle of internal friction were estimated as 0.65 Kg/cm^2 and 3˚, When increase the murram soil in Clay the Cohesion was reduces and Angle of internal friction is Increases.
5. As we increase the percentage of murram in clay the Settlement is reduces (Cc and Pc are reduced).
6. It is noticed from the test results that the Swelling of marine clay is reduces as we increase percentage of murram soil.
7. The murram soil is easily available in kutch region so that we can economically stabilize the marine clay by use of muram soil as partially replacement in various percentages before the construction of any structure

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