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Efficacy of Lime and Fly Ash on CBR value of Dredged Marine Soil

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ABSTRACT:- Developing works in coastal areas involves dredging works for construction of structures and other facilities. Utilizing the dredged marine soil for land reclamation becomes more popular as the over exploitation of naturally available sands or hill-cut materials causes serious environmental concerns. In order to achieve the satisfactory engineering properties for construction, they should be modified with physical or chemical methods prior to construction. This paper discusses about the variation in CBR value of Vizhinjam dredged marine soil upon addition of lime and fly ash. The study was carried out by performing compaction and CBR test by adding lime (2%, 4%, 6 % and 8%) and fly ash (5%, 10%, 15% and 20%) in different concentrations. Test results indicate that the optimum moisture content increases and maximum dry density reduces upto 2% of lime, beyond which it is vice-versa. The optimum moisture content decreases and maximum dry density increases upon addition of the fly ash. Addition of lime upto (6%) and fly ash upto (15%) enhanced the unsoaked CBR value when compared to the untreated soil mass, thereby indicating the optimum amount of additive to be added.

Keywords:- *Lime, Flyash, Stabilization, Dredged Soil, Land Reclamation, CBR value.*

1. INTRODUCTION

The development of works in coastal areas involves dredging works for the construction of structures such as ports, waterways and breakwaters, land reclamation and the widening sections of streams or sea to facilitate economic activities and to set up coastal protection systems. Dumping activities from dredging could have a negative impact on the physical and biological elements of the sea. Contaminated dredged soils are harmful and may damage the marine environment and cause irreversible long - term damage. Therefore, if the potential for reuse of dredged soils can be derived, dumping can be avoided and thereby environmental and ecological impacts can be reduced. Recently many studies were carried out assessing the suitability of dredged soils as structural and embankment fills. The engineering properties of the soil can be improved by the addition of various additives. CBR values of soil forms an essential engineering property in geotechnical structures design like pavements and foundation etc.

This paper attempts to understand and evaluate the effect of additives, namely lime and flyash on engineering properties of Vizhinjam dredged soil. Additives were added in different concentrations in this study and their effects on compaction characteristics and CBR value were evaluated.

2. MECHANISM OF LIME AND FLYASH ON CLAYS

The addition of lime to a fine grained soil in the presence of water initiates several reactions. Cation exchange and flocculation cause immediate improvement in soil plasticity, workability, and uncured strength and load deformation properties. A soil- pozzolanic reaction may also occur to form various cementing agents that increase compacted mixture strength and durability.

Flyash has little cementitious value, however, this changes in presence of moisture, with which it reacts chemically, and forms cementitious compounds. These compounds attributes to the improvement of compressibility and strength characteristic of a soil. Flyash can produce an assortment of divalent and trivalent cations under conditions that are ionized in nature, which in return can encourage flocculation of dispersed clay particles. Expansive soils thus can theoretically stabilize in an effective manner by cation exchange with fly ash.

3. MATERIALS

3.1. VIZHINJAM DREDGED SOIL

From Vizhinjam Harbour Site, Mullur, Kerala the dredged soil (Fig. 1) is obtained at a depth of 20m. The geotechnical properties of the soil are given below in the Table 1.

Fig.1. Vizhinjam Dredged Soil

Table 1. Properties of Vizhinjam Dredged Soil

PROPERTIES	VALUE
Specific Gravity	2.14
Natural Moisture Content (%)	61.5
Max Dry Density (g/cc)	1.53
Optimum Moisture Content (%)	27
Liquid Limit (%)	61
Plastic Limit (%)	32
Plastic Index (%)	29
Shrinkage Limit (%)	11
Unconfined Compressive Strength (kN/m^2)	31.6
Organic Content (%)	16.66
Differential Free Swell Index	40
Grain Size Distribution (%)	
Clay (%)	36
Silt (%)	53
Sand (%)	11
Soil Classification	MH

3.2. LIME

Lime, used for the study is locally available hydrated lime (Fig. 2) in the form of fine powder. It is a white, caustic, alkaline crystal solid at room temperature. The chemical composition of lime is given in the Table 2.

Fig.2. Lime

Table 2. Properties of Lime

Components	Amount (%)
Calcium Hydroxide	90
Silica	1.5
Ferric oxide	0.5
Magnesium Oxide	1
Alumina	0.2
Carbon dioxide	3

3.3. FLY ASH

Class F flyash collected from Thoothukudi thermal power plant, TamilNadu. The properties of fly ash is given in the Table 3.

Table 3. Properties of Fly ash

PROPERTIES	VALUE
Specific Gravity	2.18
Max Dry Density (g/cc)	1.16
Optimum Moisture Content (%)	31.3
Liquid Limit (%)	28.3
Plastic Limit (%)	Non Plastic

Plastic Index (%)	Non Plastic
Shrinkage Limit (%)	11
Unconfined Compressive Strength (kPa)	92.33
Organic Content (%)	16.66
Sand (%)	46
Silt(%)	29.75
Clay (%)	16.25
Class	F

4. EXPERIMENTAL PROGRAMME

The various physical and engineering properties of the soil were determined by different laboratory experiments such as specific gravity test, grain size analysis test, Atterberg limit test, modified Proctor compaction test, Unconfined compressive strength test and Unsoaked California bearing ratio tests. All the tests were carried out as per standards.

4.1. MIX PREPARATION

The study was carried out by performing compaction and CBR test by adding lime (2%, 4%, 6 % and 8%) and fly ash (5%, 10%, 15% and 20%) in different proportions to the dry weight of soil.

5. RESULTS AND DISCUSSIONS

5.1 EFFECT OF LIME ON COMPACTION

Percentage of lime used for the test was 2%, 4%, 6% and 8%. The result shows that the OMC increases and the dry density decreases upon addition of lime upto 2% and then vice-versa. The result of compaction test is shown in Table 4. The variation of OMC and dry density is shown in the Fig. 3 and 4 respectively.

Table 4. Compaction characteristics of soil – lime mix

Concentration(%)	2	4	**6**	8
OMC (%)	41.6	37.8	**34.4**	32.2
DRY DENSITY (kN/m^3)	13.22	15.12	**16.21**	15.4

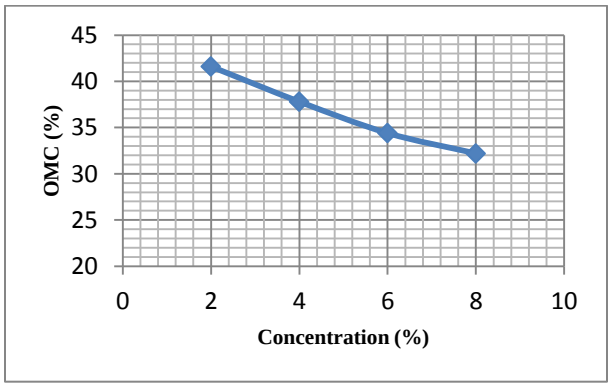

Fig.3. Variation of OMC with Lime

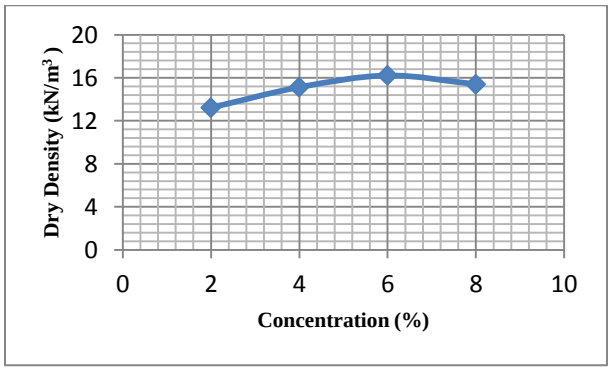

Fig.4. Variation of Max Dry Density with Lime

5.2 VARIATION IN CBR VALUE

The test is carried out as per IS 2720-16.T The increase in strength is due to the pozzolanic reaction between the lime and the soil and filling up of the voids by lime. The variation in CBR value is given in Table 5 and graph representing the variation is shown in the Fig 5. From the results it is clear that the CBR value increases upto addition of 6% of lime and further it decreases, thereby indicating the optimum amount of lime to be added is 6%.

Table.5. Variation in CBR value with lime content

Mix	CBR Value (%)
MC + 0% Lime	1.86
MC + 2% Lime	2.89
MC + 4% Lime	4.42
MC + 6% Lime	5.92
MC + 8% Lime	4.81

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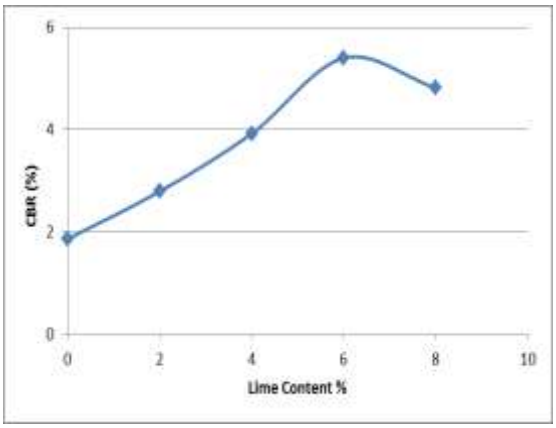

Fig.5. Variation of CBR value with lime content

5.3 EFFECT OF FLY ASH ON COMPACTION

The result of compaction test is shown in Table 6. Percentage of fly ash used for the test was 5,10,15 and 20%. The variation of OMC and dry density is shown in the Fig. 6 and 7 respectively. The result shows that the OMC decreases and the dry density increases upon addition of flyash.

Table.6. Compaction characteristics of soil – flyash mix

Concentration (%)	5	10	**15**	20
OMC	37.4	36.2	**34.8**	33.6
DRY DENSITY (kN/m^3)	15.12	16.4	**17.2**	16.6

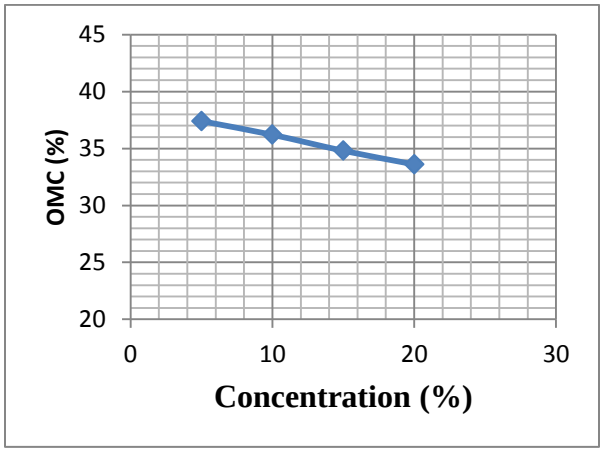

Fig.6. Variation in OMC with flyash content

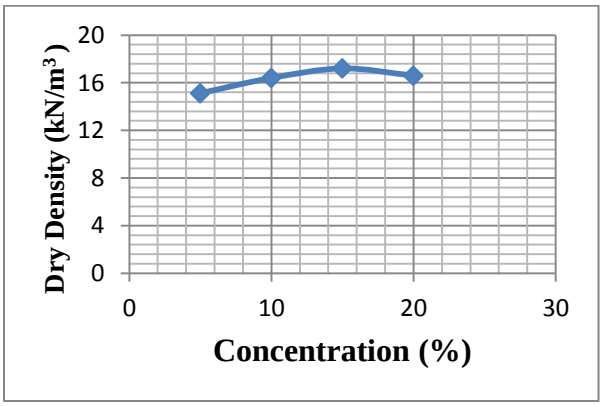

Fig.7. Variation in Dry Density with flyash content

5.4 VARIATION IN CBR VALUE

The increase in strength is due to the pozzolanic reaction between the flyash and the soil and filling up of the voids by fly ash. From the results it is clear that the CBR value increases upto addition of 15% of fly ash and further it decreases, thereby indicating the optimum amount of fly ash to be added is 15%.The variation in CBR value is given in Table 7 and graph representing the variation is shown in the Fig.8. The reason may be due to cation exchange in the soil-fly ash mix during which the sodium ions in the soil are replaced by the calcium ions in the fly ash thus reduces the settlement and hence increases the CBR value.

Table.7. Variation in CBR value with fly ash content

Mix	CBR Value (%)
MC + 0% flyash	1.86
MC + 5% flyash	2.29
MC + 10% flyash	3.46
MC +15% flyash	4.29
MC +20% flyash	3.10

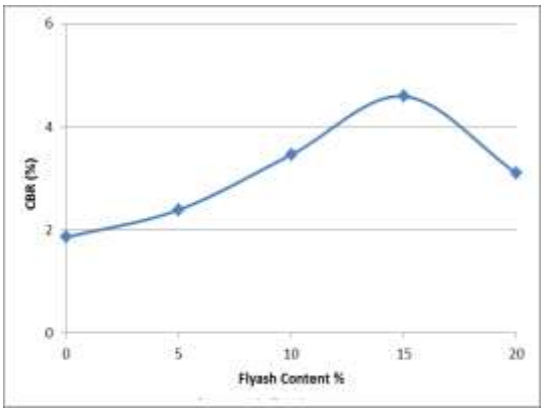

Fig.8. Variation in CBR with fly ash content

6. CONCLUSIONS

This study investigates the effect of two additives, namely lime and flyash on Vizhinjam dredged soil with different concentrations. Using experimental investigations, the following conclusions can be drawn:

- Test results indicate that the optimum moisture content increases and maximum dry density reduces upto 2% of lime, beyond which it is vice-versa.
- The optimum moisture content decreases and maximum dry density increases upon addition of the flyash.
- The CBR value shows an increased trend upon the addition of additives, lime (6%) and fly ash (15%) thereby indicating the optimum amount.
- The CBR value of the soil –lime mix is very high when compared to that of soil-fly ash mix, thereby indicating that the lime can be effectively used for improving the strength parameter of such type of soils.

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