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Performance evaluation of Alccofine stabilized Marine clay as subgrade.

Evaluación del desempeño de arcilla marina estabilizada con Alccofine como subrasante.

Tania Rose Jelton[1], Elba Helen George[2]

[1] M Tech Student, Dept. of Civil Engineering, Toc H Institute of Science and Technology, Kerala, India

[2]Asst. Prof., Dept. of Civil Engineering, Toc H Institute of Science and Technology, Kerala, India

[1]taniarosejelton55@gmail.com [2]elbaheleng@tistcochin.edu.in

ABSTRACT

Soil stabilization is a remedial measure that reduces permeability and compressibility, increases bearing capacity and shear strength of soil mass, which helps in reducing these telemen of structures. Marine clay is one of the major regional soil deposits in India, widely found in offshore and coastal areas. This is a type of low strength soft clay which majorly causes failure in pavements and foundation structures due to high settlements and low strength characteristics. The scope of this project is to improve the strength of marine clay by stabilizing it with alccofine. The work Includes determination of index properties of marine clay by Hydrometer method, Atterberg's test, Specific Gravity test, Free Swell test. The engineering properties of both virgin soil and soil stabilized with 3%, 6%, and 9% of alccofine are determined by various tests such as Standard Proctortest, California Bearing Ratio test. On the basis of CBR test, the optimum percentage of alccofine in marine clay is found out to be 6%.

Keywords: Soil Stabilization, Marine Clay, Alccofine, Geotechnical properties

RESUMEN

Soil stabilization is a remedial measure that reduces permeability and compressibility, increases bearing capacity and shear strength of soil mass, which helps in reducing these telemen of structures. Marine clay is one of the major regional soil deposits in India, widely found in offshore and coastal areas. This is a type of low strength soft clay which majorly causes failure in pavements and foundation structures due to high settlements and low strength characteristics. The scope of this project is to improve the strength of marine clay by stabilizing it with alccofine. The work Includes determination of index properties of marine clay by Hydrometer method, Atterberg's test, Specific Gravity test, Free Swell test. The engineering properties of both virgin soil and soil stabilized with 3%, 6%, and 9% of alccofine are determined by various tests such as Standard Proctortest, California Bearing Ratio test. On the basis of CBR test, the optimum percentage of alccofine in marine clay is found out to be 6%.

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INTRODUCTION

Subgrade is a prepared natural layer of earth surface on which the pavement structure is placed. The properties of subgrade soil are important in the pavement design as its main function is to support the load transmitted from overlying pavement layers. Subgrade must have sufficient strength and stability even under bad traffic and climate conditions. Soil with good qualities should be used as subgrade but not all soil possesses the required abilities as there are some locations that have poor qualities of in-situ soil. Marine clay is a type of clay found in coastal regions around the world. It consists of clayey and silty soils that have poor drainage properties, low bearing strength and are expansive in nature. The marine clays, because of the specific physico-chemical make-up, are subjected to volume change with the changes in their ambient environment. These soils are widely occupied in coastal corridor and not easy to avoid marine clay regions for the construction of pavements and foundations due to the population density.When the subgrade soil is not suitable to support the traffic load then additional work should be done to build over unstable soil.

There are various methods used to improve subgrade performance: • Removal and replacement of poor subgrade soil with high quality fill. • Stabilization with addition of an appropriate material can reduce swelling tendency and increase subgrade stiffness. • Additional base layers.

The stabilization of soil is done to improve the poor subgrade; hence it may reduce the thickness of pavement design and also increase life of the pavement.In this paper, different percentages of alccofine (0%, 3%, 6% and 9%) was added to marine clay for stabilisation.

MATERIALS AND METHODS

A. Materials Used: The materials used in the experimental work are marine clay and alccofine 1203

1. Marine Clay: Marine clay was collected from Kannamaly, Ernakulam, Kerala. It was collected from adepth of 1-2m from ground level. The clay obtained contained a lot of organic matter, was greenish black incolor and had an undesirable smell. The marine clay used for the test was air dried beforethetests. Fig1 shows the marine clay.

Fig 1. Marine Clay

2. Alccofine 1203: Alccofine is a waste material generated from the iron ore industries. It was collected from Ambuja cements, Ernakulam. Fig 2 shows Alccofine 1203.

Fig 2. Alccofine 1203

B. Properties of Materials: Table 1 gives the properties of marine clay, Table 2 gives the physical properties of alccofine 1203 and Table3 shows the chemical properties of alccofine 1203.

Table 1. Properties of marine clay

Sl. No	Properties of soil sample	Values obtained
1	Natural water content	134.88%
2	Specific Gravity	2.46
3	Liquid Limit (%)	81.2
4	Plastic Limit (%)	33.87
5	Plasticity Index	47.33
6	Freeswell	88.88%
7	Percentage of sand	3%
8	Percentage of silt	29%
9	Percentage of clay	68%
10	Soil Classification	CH
11	Optimum moisture content (%)	30.9
12	Maximum dry density (g/cm^3)	1.313
13	California Bearing Ratio (%)	3.639

Table 2. Physical Properties of alccofine 1203

Test Parameter	Values obtained
Specific Gravity	2.8
Particle size (μm) D10	1.5
D50	4.6
D90	9.3
D95	10.9
Bulk Density (kg/m^3)	680

Table 3. Chemical Properties of alccofine 1203

Parameter	Values obtained
Magnesium Oxide (MgO), % by mass	6.2
Sulphate (SO_3), % by mass	0.07
Silicon dioxide (SiO_2), % by mass	34.2
Aluminium oxide (Al_2O_3), % by mass	23.1
Calcium Oxide (CaO), % by mass	34
Iron Oxide (Fe_2O_3), % by mass	0.80
Moisture Content, % by mass	0.10

METHODS

The various soil properties are determined by conducting tests like Specific gravity, Hydrometer analysis, Atterberg's limit, Standard Proctor test and California Bearing Ratio test.

A.Standard Proctor Test

This experiment is carried out to determine the link between the soil's dry density and moisture content. The air was driven out of the voids during the compaction process, which helped to increase the bulk density. When the soil is compacted at reasonably high moisture content and practically all of the air is forced out, the maximum dry density (MDD) is obtained; this moisture content is referred to as optimum moisture content (OMC).

B.California Bearing Ratio Test

The California Bearing Ratio test is conducted for evaluating the suitability of the subgrade and the materials used in sub-base and base of a flexible pavement. The plunger in the CBR test penetrates the specimen in the mould at the rate of 1.25mm per minute. The loads required for a penetration of 2.5 mm and 5.0 mm were determined. The penetration load is expressed as a percentage of the standard loads at the respective penetration level of 2.5 mm or 5.0 mm.

CBR value = $\frac{Penetration\ load}{Standard\ load}$ x 100

The CBR value was determined corresponding to both penetration levels. The greater of these values were used for the design of the pavement.

RESULTS AND DISCUSSION

A. Standard Proctor Test

Table 4. Results of OMC and MDD with addition of different percentages of alccofine

Percentage of alccofine	Maximum dry density (g/cm^3)	Optimum moisture content (%)
0	1.313	30.9
3	1.370	34
6	1.306	27.5
9	1.245	32.5

The compaction test was carried out at different percentages (0%, 3%, 6%, and 9%) of alccofine on marine clay. The variation of MDD and OMC of soil sample obtained with the addition of alccofine is shown in fig 3,4,5 and 6. Table 4 shows the results of variation of MDD and OMC of marine clay with addition of different percentages of alccofine.

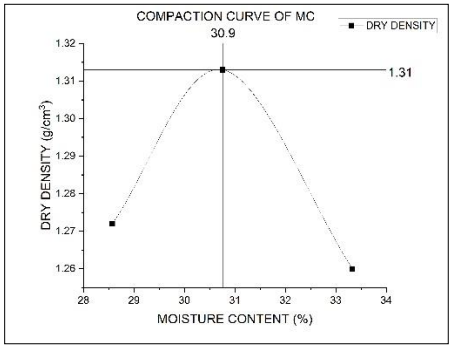

Fig 3. 0% Alccofine

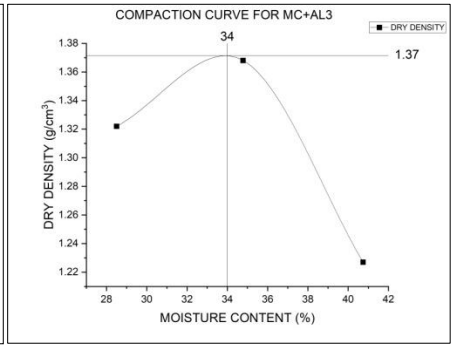

Fig 4. 3% Alccofine

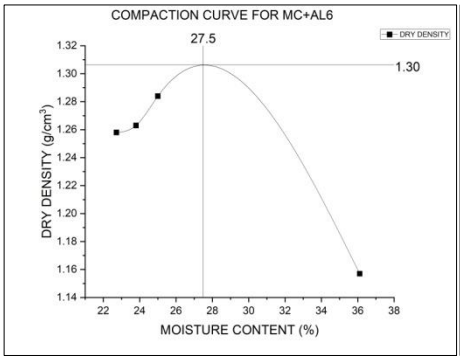

Fig 5. 6% Alccofine

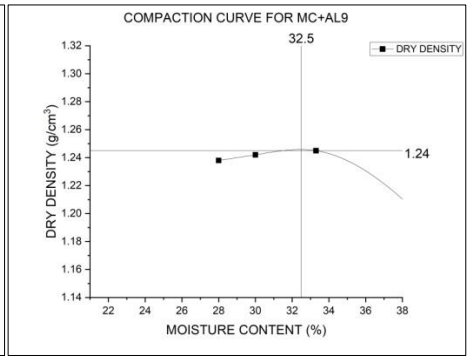

Fig 6. 9% Alccofine

From the above figures 3,4,5,6, it is observed that the addition of alccofine to the soil sample, decreases the maximum dry density and increases the optimum moisture content. Fig 7 shows the variation on MDD in addition of different percentages of alccofine.

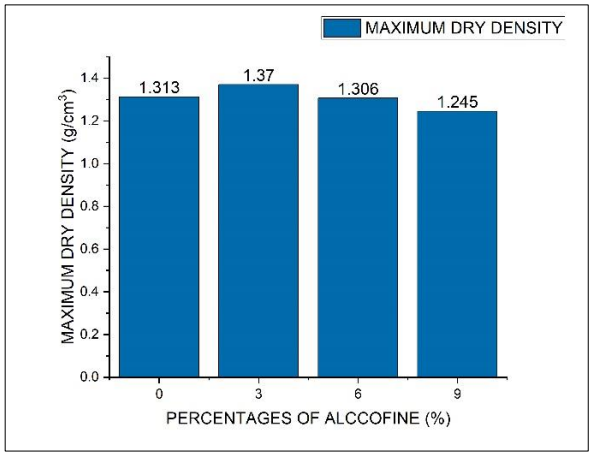

Fig 7. Variation on Maximum Dry Density with different percentages of alccofine

B.California Bearing Ratio (CBR) Test

Table 5 shows the results of CBR with addition of different percentages of alccofine.

Percentage of alccofine	California Bearing Ratio (CBR) Test (%)
0	3.639
3	1.659
6	8.661
9	3.138

The California bearing ratio test was carried out for different percentages of alccofine. The bar chart showing the variation of CBR in different percentages is shown in fig 8.

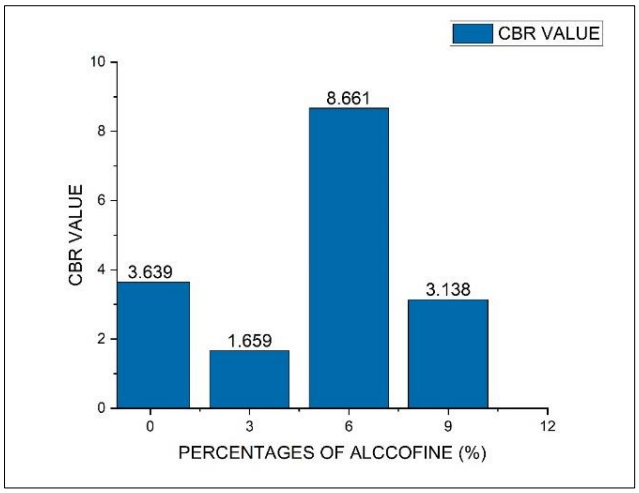

Fig 8. Variation of CBR with different percentages of alccofine

From the Fig 8, it is observed that the maximum strength is obtained when 6% alccofine is added.

Marine Clay is one of a problematic soil in which any type of construction is not possible due to its low shear strength and poor drainage. Therefore, an efficient method is requiredfor improving its load bearing capacity. The purpose of this project is to utilize the low strength clay in construction works after increasing its strength by stabilization using alccofine. The following are the conclusions obtained from the study.

- The Maximum dry density and Optimum moisture content of marine clay are 1.313g/cm^3 and 30.9% respectively. On addition of 3% of alccofine, both maximum dry density and optimum moisture content increased to 1.37g/cm^3 and 34%. On addition of 6%, both MDD and OMC is reduced to 1.306g/cm^3 and 27.5%. On addition of 9%, MDD is 1.245g/cm^3 and OMC is 32.5%.
- The CaliforniaBearing Ratiotest value obtained for marine clay is 3.639*%*. On addition of 3%, CBR value decreased to 1.659*%*. On addition of 6%, the CBR value is increased to 8.661*%*. On addition of 9%, the CBR value decreased to 3.138*%*.
- As per IRC:37-2018, the effective subgrade CBR should be more than 5% for roads estimated to carry more than 450 Commercial Vehicles Per Day (CVPD) (two-way) in the year of construction. CBR value obtained for marine clay was 3.639% which is less than the required limit, therefore stabilisation is done using alccofine. On addition of 6% of alccofine to marine clay, CBR value obtained was 8.661%, which more than the required limit.
- Therefore, marine clay stabilised with 6% of alccofine can be adopted for subgrade construction works
- Alccofine is a pozzolanic material that can improve the properties of marine clay, such as strength and durability, when added in the appropriate amount. To effectively implement the addition of alccofine on a large scale at a construction site, the following points need to be considered:

❖ Determine the optimum dosage of alccofine: The amount of alccofine needed to improve the properties of

marine clay depends on various factors, such as the type and quality of the marine clay, the project specifications, and the desired outcome. A laboratory test can be performed to determine the optimum dosage of alccofine.

- Mixing method: Mixing alccofine with marine clay should be done uniformly to ensure that the entire soil mass is treated. A mechanical mixing method such as a soil stabilizer can be used to achieve a homogeneous mixture.
- Storage and handling: Alccofine should be stored in a dry place to prevent moisture absorption, which can affect its properties. It should also be handled carefully to avoid any spillage or contamination.
- Quality control: Regular testing of the treated soil should be conducted to ensure that the desired improvement in properties is achieved. Quality control tests should include compaction tests, strength tests, and durability tests.
- Safety: Proper safety measures should be taken during the mixing and handling of alccofine to ensure that workers are protected from any hazards.
- Environmental considerations: Any environmental impact associated with the addition of alccofine to marine clay should be considered. The disposal of any waste materials generated during the mixing process should be handled appropriately.
- Overall, the addition of alccofine can be an effective way to improve the properties of marine clay. However, it is essential to carefully consider the above points to ensure a successful implementation on a large scale at a construction site.

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