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Soil Stabilization by Using Lime and Fly Ash

Kalyani Dilip Bhoi[1], Prajakta Parasharam Desai[2*], Aarati Ashok Kambale[3], Madhumati Raghunath Patil[4], Rohit Vijay Savyanavar[5]
[1,2,3,4]Student, Department of Civil Engineering, Dr. A. D. Shinde College of Engineering, Bhadgoan, India
[5]Assistant Professor, Department of Civil Engineering, Dr. A. D. Shinde College of Engineering, Bhadgoan, India

***Abstract*: Now a days, inefficient properties of soils are a critical issue in engineering projects. In some cases, improve the characteristic of unsuitable soil is a fundamental step for making construction. Pavement structures on poor soil sub grades show early distress causing the premature failure of the pavement. Clayey soil usually has the potential to demonstrate undesirable engineering behaviour, such as low bearing capacity, high shrinkage and swell characteristics and high moisture susceptibility. Stablilzation of this soil is a usual practice for improving the strength. Soil stabilization performed the use of technique to adding a binder to the soil in order to improve the engineering performance of soil. This study reports the improvement in the strength of a locally available cohesive soil by addition of both lime and fly ash. Researches were illustrated that adding the additives leads to progress in workability and mechanical behaviour of soil after stabilization lime and fly ash as local natural and industrial resources were applied for chemical stabilization. Lime alone has traditionally been used in clay-bearing, highly cohesive soil whereas fly ash has been used to bind non-cohesive soil, granular or poorly cohesive soil. Fly ash is mainly used to stabilize the sub base or base course.**

***Keywords*: Atterberg's test, Black cotton soil, CBR, Fly ash, Lime, Maximum dry density, Optimum moisture content, Proctor compaction test, Stabilization, Water content.**

1. Introduction

Stabilization of soils is an effective method for improving the properties of soil and pavement system performance. The objectives of any stabilization technique used are to increase the strength and stiffness of soil, improve the workability and constructability of the soil and reduce the Plasticity Index. For any given soil many stabilization methods, using different stabilizing agents like cement, lime, motor, bitumen, plastic, fly ash, etc. may be effective to improve the soil properties in place rather than removing and replacing the material. Availability or financial considerations may also be the determining factor on which a stabilizing agent is selected. Every manmade structure resting on the ground needs safe and stable soil. To attain these safety and stability requirements the engineering properties of the soil beneath the structure or on the structure must be identified. However, obtaining these engineering properties of soils requires relatively more time and money. On the other hand, investigating the index properties of a soil is much easier than other engineering properties in terms of time, money, and efforts research dwells on how black cotton soil (BCS) could be stabilized and made into a suitable subgrade material using saw dust readily and cheaply available material. Fly ash mixed with BCS in varying proportions of 10%, 20%, and 30%. The BCS treated with optimum fly ash content was further stabilized with 5%, 10%, and 15% lime. Optimum reduction in liquid limit, differential free swell, plasticity index as wean all as an optimum increase in CBR was achieved treated tread with fly ash was stabilized with lime. Moreover, most of the engineering properties of soils depend upon their index properties. Therefore, by obtaining the index property of soil that involves a simpler and quicker method of testing, the engineering properties can beasties factors satisfactory. Soil compaction, California bearing ratio, and direct shear test are the most commonly used techniques in engineering projects such as highways, sub-grades, pavements, and foundations. The ins of these tests are to improve engineering proportion s of soils such as increase in dry density, reduction in compare sensibility the leading to reduction in the settlement, and reduction in permeability, reload-bearing strength and its load-bearing capacity Atterberg's limit.

2. Scope of the Study

The scope of the present work includes the addition of proportionally ash with different proportions to the locally available black cotton soils to enhance the engineering properties. The work presented in this paper aims to investigate the improvement of soil properties such as shear strength, maximum dry density (MDD), and CBR values by adding lime and the d fly ash which is collected from sugar cane factory. A series of laboratory tests are conducted on both virgin soils as well as on fly ash and lime reinforced soil to compare the improvement of soil properties. We have the chosen project because of its following advantages.

1. It improves the strength of the soil, thus, increasing the soil bearing capacity.
2. It is more economical both in terms of cost and energy to increase the bearing ca capacity of the soil rather than going for a deep foundation or raft foundation.
3. It is also used to provide more stability to the soil on slopes or other such places.
4. Sometimes soil stabilization is also used to prevent soil erosion or formation of dust, which is very useful, especially in dry and arid weather.
5. Stabilization is also done for soil water-proofing; this prevents water from entering the soil and hence helps

*Corresponding author: desaipraju1435@gmail.com

Table 1
Liquid limit

Liquid limit	Only soil	5%lime &10%fly ash	10% lime & 20% fly ash	15% lime & 30% fly ash
Water content	43.33%	26.13%	22.18%	21.25%

Table 2
Plastic limit

Plastic limit	Only soil	5% lime & 10% fly ash
Water content	52.77%	47.22%

Table 3
Optimum moisture content

Optimum moisture content	Only soil	5% lime & 10% fly ash	10% lime & 20% fly ash	15% lime & 30% fly ash
Water content	9.39%	10.99%	14.21%	13.81%

Table 4
Maximum dry density

Maximum dry density	Only soil	5%lime &10%fly ash	10% lime & 20% fly ash	15% lime & 30% fly ash
Water content	0.68%	0.69%	0.57%	0.45%

the soil from losing its strength.

6. It helps in reducing the soil volume change due to changes in temperature or moisture content.

A. Objectives

The objectives of the present study are to

1) To determine the optimum content of fly ash. A tertiary section heading and lime by conducting the liquid limit test, plastic limit, and plasticity index.
2) To determine the optimum moisture content and maximum dry density by conducting the proctor compaction test.
3) To determine the CBR value of black cotton soil mixed with different percentages of lime and fly ash.
4) To compare the different parameters (liquid limit, plastic limit, standard proctor test) of black cotton soil for stability improvement.

B. Methodology

Stabilization of soils is an effective method for improving the properties of soil and pavement system performance. The objectives of any stabilization technique used are to increase the strength and stiffness of soil, improve the workability and constructability of the soil and reduce the Plasticity Index. For any given soil many stabilization methods, using different stabilizing agents like cement, lime, motor, bitumen, plastic, fly ash, etc. may be effective to improve the soil properties in place rather than removing and replacing the material. Availability or financial considerations may also be the determining factor on which a stabilizing agent is selected.

The various tests were conducted on the Geotechnical Parameters, which are following,

a) Water Content [oven dry method]: The knowledge of the natural moisture content is essential in all soil mechanics studies. To sight a few, natural moisture content is used in determining the bearing capacity and settlement.

b) Atterberg Limit: 1. Liquid Limit: If the natural moisture content of soil is closer to the liquid limit, the soil can be considered as soft if the moisture content is lesser than liquids limit, the soil can be considered as soft if the moisture content is lesser than liquid limit. 2. Plastic Limit: Soil is used for making bricks, tiles and soil cement blocks in addition to its use as foundation for structures. 3. Plastic index: in general, plasticity index depends only on the amount clay present. It indicates the fineness of the soil and its capacity to change shape, without altering its volume.

c) Compaction test (Standard proctor test): It is used to determine the compaction of different type of soil and the properties of soil with a change in moisture content.

d) California Bearing Ratio test: The California bearing ratio test is penetration test meant for the evaluation of sub grade strength of roads and pavements. This is the most widely used method for the design of flexible pavement.

Fig. 1. Determination of liquid limit

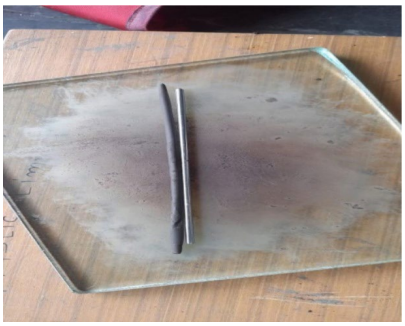

Fig. 2. Determination of plastic limit

3. Result

California bearing ratio (CBR):

Without lime and fly ash:

1. C.B.R. of specimen at 2.5 mm penetration: 189/1370*100=13.79%.
2. C.B.R. of specimen at 5 mm penetration: 235/2055*100=11.43%.

With lime 5% and fly ash 10%:

1. C.B.R. of specimen at 2.5 mm penetration: 202/1370*100=14.74%.
2. C.B.R. of specimen at 5 mm penetration: 248/2055*100=12.06%.

With lime 10% and fly ash 20%:

1. C.B.R. of specimen at 2.5 mm penetration: 211/1370*100=15.40%.
2. C.B.R. of specimen at 5 mm penetration: 258/2055*100=12.55%.

With lime 15% and fly ash 30%:

1. C.B.R. of specimen at 2.5 mm penetration: 216/1370*100=15.76%.
2. C.B.R. of specimen at 5 mm penetration: 266/2055*100=12.94%.

4. Conclusion

According to results obtained from laboratory tests, we have concluded that,

1) The liquid limit and plastic limit of Black cotton soil decreases with an increasing percentage of lime and fly ash.
2) Maximum dry density, and California bearing ratio of black cotton soil increase with an increase in the percentage of stabilizing materials.
3) With increase in percentage of lime and fly ash maximum dry density start increasing and optimum moisture content increasing up to 5%lime and 10%fly ash and after start decreasing.
4) As addition 5%lime and 10%fly ash gives maximum value. of optimum moisture content and standard proctor test.
5) With increase in percentage of lime and fly ash resulting from (5%, 10%, 15% and 10%, 20%, 30%) optimum moisture content and California bearing ratio of black cotton soil increases.
6) With increase in percentage of lime and fly ash, maximum dry density starts increasing & optimum moisture content starts decreasing.

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