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Soil Stabilization using Brick Kiln Dust and waste Coir Fibre

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***Abstract**: Stabilization of clay soil has been carried out for improving its engineering properties of soil. To stabilize the clayey soil use Brick Kiln Dust of and waste Coir Fibre, an experiment is conducted to evaluate the properties of soil mixing with 10%, 20% &30% percentage of Brick Kiln Dust and Coir Fibre contents of 0.5%, 0.75% and 1.0% by weight of soil sample and then the tests are performed. Tests conducted for clayey soil mixed with Brick Kiln Dust and Coir Fibre are Liquid Limit, Plastic Limit, Compaction (OMC & MDD), and California Bearing Ratio (CBR). Flexible pavements sections were degined for non-stabilized and stabilized subgrades to be standard axles traffic intensities. The preamble of brick kiln dust and coir fiber is analyzed to improve the features of expansion subgrade materials and other sub-base materials. Also design the thickness of pavement when it is stabilized with optimized brick kiln dust and coir fiber. The results reveal that CBR value increased with increase of Brick Kiln Dust and Coir fibre. The soil stabilization treatment significantly improved the engineering properties of the soil, and reduced the pavement thickness and also cost of the project.*

***Index Terms**: Soil stabilization, Brick Kiln Dust, waste Coir Fibre CBR Test,*

I. INTRODUCTION

Clayey soil is made up of very small particles usually consisting of silicates of aluminum and/or iron and magnesium. In clayey soil the flow of water is mostly obstructed, as the clayey soil is known for absorbing water very slowly and retaining it for a long time. The main property of the clayey soil is that it starts to swell up in wet condition and shrinks in dry condition[1].

According to geotechnical engineering, soil stabilization can be defined as the process of improving one or more chemical and mechanical characteristics of the soil which is useful in various engineering applications. The other definition for stabilization of soil can be termed as, the technique of mixing the soil with different stabilizers in suitable amount so as to eliminate any change in volume, Thereby, improving the physical and chemical properties of the soil. The use of stabilizers for soil stabilization is not a new concept; in the past it has been reported to have used different varieties of additive materials too such plant saps, animal dung, natural oils, lime (Khandakerand Hossain, 2011)[2].

Another important characteristics of the soil is that it significantly changes its volume with respect to the variation in the content of the water; these phenomena commonly referred to as expansive clay. During monsoon, water absorption is very quick causing it to swell while during summer they shrink due to evaporation of water. Due to this alternating characteristics of swelling and shrinkage, it becomes fatal for different structures which are usually constructed on such expansive soil. Hence immediate solution for the optimization of such clay soil is vital for the safety and to further prevents cracking of the structures. For improvement of such soil, different methods such as modifications or stabilization procedure is performed. In soil stabilization, different admixtures such as lime, fly ash, rice husk, cement, geogrids or goemembranes etc. are used for soil reinforcement. There has also been report of successful implementation of stabilizations used in clay soils using various additives too. One of them is adding brick dust with highly compressive clay soil for enhancing the strength of the soil.

Kumar et al.(2016)used brick dust(5%, 10%, 15%, 20%, 25%) blended with lime(3%,6%,9%) as a stabilizing ingredients to stabilize the soil. It was noticed that the admixture is added with soil the values Optimum Moisture Content (OMC) gradually decreased. The maximum reduction of 6% and 25 % in OMC was establish for lime and brick dust respectively. Optimum value was found of maximum dry density and unconfined compressive strength to be at 6% lime & 25 % brick dust. It was concluded that by combining lime and brick dust, there was an effect of maximum improvement in strength properties, as compared to that of using either lime or brick dust individually [3].

Pokale et al. (2015) studied the shear characteristics of the soil by using an admixture of 30% brick dust. When the brick dust was added, the Moisture content and swelling index of black cotton soil starts to decrease but up to a certain limit. It was also observed that, when the soil sample is being replaced with 30% brick dust, an improvement in UCS was obtained [4]. Neha Pundir et al. (2017) conducted an experiment to stabilize the clayey soil and evaluate the properties of soil blending with different percentage of 10%, 20%, 30%, 40% and 50% of Burnt Brick Dust by weight.

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Various tests were performed for clayey soil and soil, mixed with Burnt Brick Dust, and observed that by mixing the clayey soil with Burnt Brick Dust, the properties of the soil have been improved drastically[5].

Ishfaq Ahmad Lone et al. (2018) had studied that CBR value of the soil can be increased by adding Coir fibre and Fly Ash. With increase in coir fibre contents and fly ash, it resulted in further increase of CBR value of the soil; 0.9% for coir and 11% for fly ash, while the OMC was found to increase at 0.9% and 11% respectively [6].

Novita Pradani et al. (2017)effect of the value of CBR and soil bearing capacity through the addition of coco fiber to sandy soil. Under soaked conditions, through various experiments performed, the maximum CBR value of 38.50% was obtained with 1% of coco fiber mixed with sandy soil and having optimum fiber length of 1.5-2 cm. In unsoaked condition, effect of fibre percentage on bearing capacity and CBR value kept on increasing as the added fiber percentage increases. It is also concluded that soil mixed with 0.78% coir fiber and 1.5-2 cm of coir fiber length, the optimum percentage to gave maximum soaked bearing capacity value of about 8.60. By this experiment it is concluded that such proportion may be useful for construction of road pavement and embankments economically [7].

II. MATERIALS

A. Soil

The soil sample used in this investigation is a local clayey soil. The soil sample was collected by excavating the ground surface and from physical observation, it was found that, According to IS classification (IS 1498:1970) the soil is classified as clay of medium plastic in nature (CI). After testing,Table-1 and Table-2 presents various Geotechnical characteristics of soil and Engineering properties of soil respectively.

Table 1. Geotechnical Characteristics of Soil

Properties	*Values*
Classification	CI
Liquid limit (%)	41
Plastic Limit (%)	17.53
Plasticity Index (%)	23.47

Table 2. Engineering properties of Soil

Properties	*Values*
OMC (%)	11.83
MDD (g/cc)	1.97
Unconfined Compressive Strength (kg/cm^2)	3.575
CBR (Soaked) Test	1.67

B. Brick Kiln Dust

The brick kiln dust is a waste fine material generated through the burning of bricks with the soil, which covered by surroundings it. It is red in color and fine texture in nature. Due to burning of soil bricks, it becomes hardened; after which when the set-up covering is removed, the powder in the form of brick is obtained. It has great ability to reduce the swelling potential for highly expansive clay soil.

C. Coir Fibre

Coir Fibre is acquired from the husk of the coconut, having the characteristics of a hard structural fibre. Since the coir fibre is hard, it is soften and gets swollen by soaking the fibre in nets with slow flowing body of water. The process called, 'wet milling' is performed underneath the skin by separating the long bristle fibre with the short ones and is useful in commercial product used for mattress. There is the observation of the coir fibre twisting without breaking and curling in a permanent wave because of its elasticity. For this thesis work, the coir was purchased from local market. For experimentation purpose, its diameter taken was 0.2 to 0.3mm. Further the coir was cut into pieces of 30mm length, and mixed with soil taking a percentage of 0.50%, 0.75%, and 1%.

III. METHODOLOGY

The study was carried out in two stages. Firstly a number of laboratory tests were carried out on clay soil with brick kiln dust and reinforced with coir fibre. Brick kiln dust in proportions of 0%, 10%, 20% and 30% replaced with the soil. Soil with the optimized brick kiln dust was further mixed with coir fibre proportions of 0.5%, 0.75% and 1.0%. Modified Proctor compaction tests for determining optimum moisture content (OMC) and maximum dry density (MDD), unconfined compressive strength (UCS) test and California bearing ratio (CBR) tests were performed. The CBR samples were immersed in water for 96 hours before testing.

IV. ANALYSIS AND INTERPRETATION OF RESULTS

For the following experiments performed, the methods were used relative to the addition of varying percentages of brick kiln dust and coir fibre. Further through the experiment, with the addition of brick kiln dust and coir fibre, its effect on the relationship between OMC & MDD is being studied. The UCS and CBR values are taken into consideration.

A. Compaction Test

Effect of brick kiln dust on OMC and MDD

For conducting a study on the effect on the maximum dry density (MDD) and optimum moisture content (OMC) of the soil, a modified proctor test is being performed after treating the soil with the brick kin dust. By mixing the soil samples obtained with varying percentages of the brick dust in 10%, 20% and 30%, the sample is further compacted in this modified proctor to form a mould, and the values of OMC and MDD is being determined. When 10% of the brick kiln dust is being replace with soil, the OMC value decreases. As the percentage of the brick kiln dust is increased, the value of OMC starts to increase. Also with the addition of the brick kiln dust in soil, the effect of MDD decreases.

Table 3. Variation of MDD and OMC values for soil and varying percentage of brick kiln dust.

Content	Clayey Soil	10% BKD	20% BKD	30% BKD
OMC (%)	11.83	11.98	12.31	12.36
MDDs (g/cc)	1.97	1.965	1.94	1.93

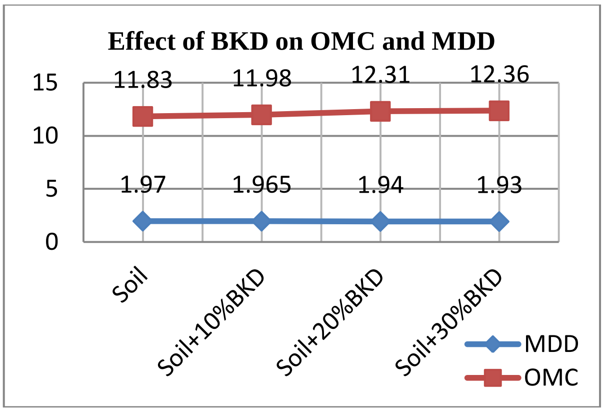

Fig.1. Graph showing OMC and MDD of mix proportions of soil, brick kiln dust (BKD)

Effect of 30% BKD and varying percentage of coir fibre on OMC and MDD

The amount of brick kiln dust was fixed 30% (optimized value), varying percentage of fibre content of coir fibre was mixed for different trails.

Table 4. Variation of MDD and OMC for different value of soil- 30% brick kiln dust-coir fibre mixtures

Content	30%BKD + 0.5% CF	30%BKD +0.75% CF	30%BKD +1.0% CF
OMC (%)	11.76	12.64	11.32
MDDs (g/cc)	1.92	1.908	1.92

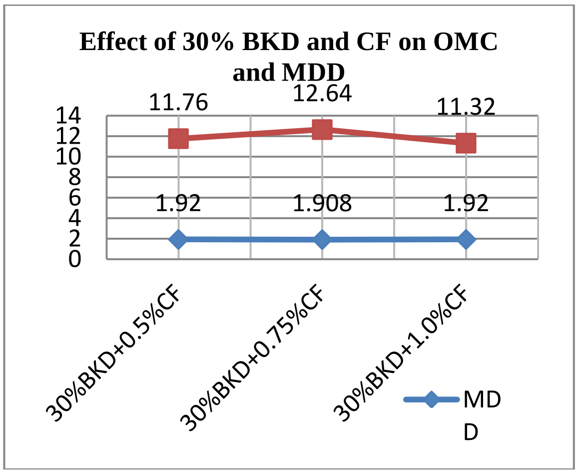

Fig.2. Graph showing OMC and MDD of mix proportions of soil, brick kiln dust (BKD) and CF

B. Soaked CBR Test

Effect of brick kiln dust on California Bearing Ratio

When the value of CBR effect is compared between the plain soil- which is basically a clayey Soil, and the soil combined with 30% brick kiln dust addition, the latter method gave a much better increase in value. The method of including the brick kiln dust in soil at a percentile of 10%, 20% and 30%, the CBR value is seen to increase continuously with increasing the percentage of brick kiln dust

Table .5 Soaked CBR Value for mix proportions of soil, brick kiln dust (BKD)

Percentages of BKD	CBR(%) at 2.5 mm	CBR(%) at 5 mm
Clayey soil	1.67	1.52
10% BKD	2.167	2.26
20% BKD	3.05	2.85
30% BKD	4.43	4.60

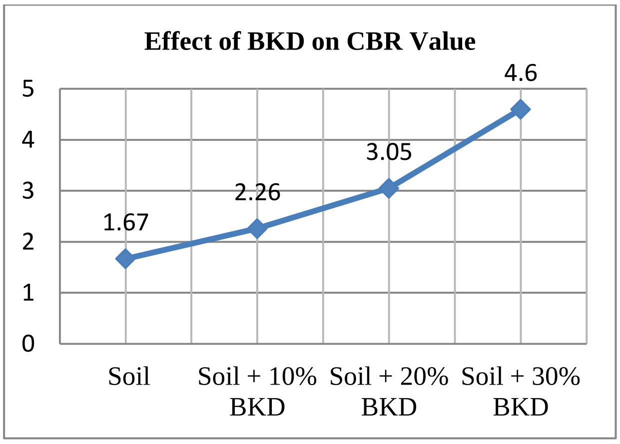

Fig. 3. Variation of CBR for Soil and different percentage of brick kiln dust.

Effect of 30% brick kiln dust and varying percentage of coir fibre on California Bearing Ratio

The CBR value constantly increasing with increase the fibre content, at 30% brick kiln dust.

Table 6. Soaked CBR Value for mix proportions of soil, brick kiln dust (BKD) and CF

% of BKD	CBR(%) at 2.5 mm	CBR(%) at 5 mm
30% BKD+0.5%CF	5.091	6.256
30% BKD+0.75%CF	5.255	6.804
30%BKD+1.0%CF	5.31	7.24

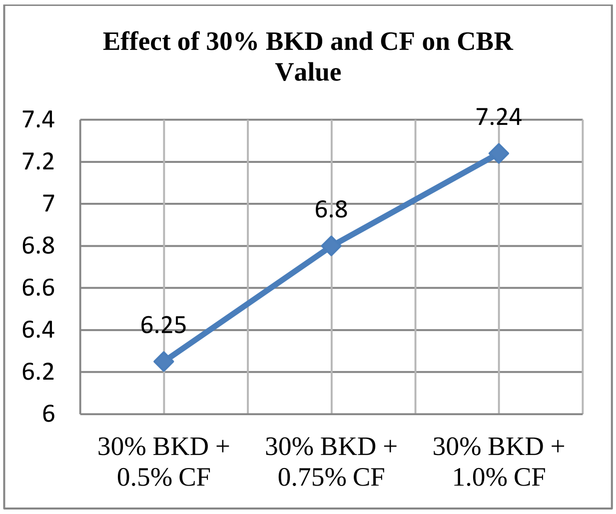

Fig.5 Variation of CBR for Soil, brick kiln dust and different percentage of Coir Fibre.

V. DESIGN OF FLEXIBLE PAVEMENT

Flexible pavement was design for single lane and length of 1km.

A. Pavement design with capping layer

As per IRC: 37-2001 clause 4.2.1.5, for design of flexible pavement, subgrade should have minimum CBR value of 2%. When soil has CBR value less than 2%, capping layer having 150 mm requires to be provided.

The pavement design is to estimate the cumulative number which is calculated by:

$$N= \{365 [(1+r)^n-1]\times A\times D\times F\}/r$$

Where,
N = Cumulative number (msa)
A = Initial traffic at the time of end of construction in terms CVPD (both direction)
D = 1 (Lane distribution factor)
F = 1.5 (Vehicle damage factor)
n = 15 Years (Design life in years)
r = Annual Traffic growth rate of commercial vehicles (7.5%)
The initial traffic in the year of completion of construction can be calculated as,

$$A = P (1+r)^x$$

Where,
P = number of commercial vehicles as per last count (assumed as 150)
x = no. of years between last count and year of end of construction (2years).
After the calculated:
A = 174
N = 3 msa
From IRC37:2001 (plate 1), for the minimum CBR value of 2%, the total pavement thickness is 750 mm. The recommended pavement structure is given in fig.6

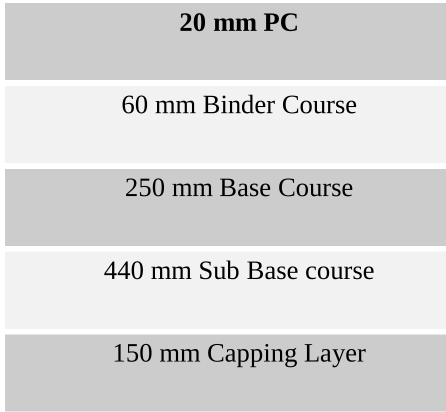

Fig.6.

Pavement structure with capping layer

B. Pavement design without capping layer

From plate 1, Since the treated subgrade has an enhanced CBR of 7.24%, for this CBR value total thickness of the pavement is 450mm

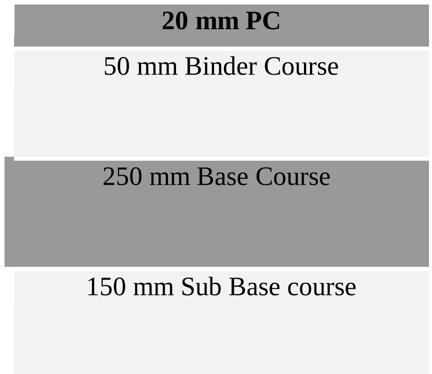

Fig.7. Pavement structure without capping layer

Comparison of table 6 and 7 shows a pavement thickness reduction of 40% when the clayey subgrade is stabilized with 30% brick kiln dust and 1.0% coir fibre.

VI. CONCLUSIONS

In this paper, the optimum percentile of the waste brick kiln dust and coir fiber mixed with the soil for strengthening its stability is being studied. The following observations are being made after performing several experiments:

1. The effect of adding brick kiln dust with soil, it results increase of optimum moisture content (OMC) and decrease of maximum dry density (MDD). When 30% of the soil is being replaced with brick kiln dust, the optimum moisture content (OMC) obtained 12.36% and maximum dry density (MDD) 1.93 g/cc. Next, when the soil is being mixed with a combination of coir fibre and BKD, there was an increase in value on OMC parameter and a decrease in the value on MDD.
2. To find the effect on CBR value, when brick kiln dust is being mixed with soil in varying percentile, its value was seen to rise and increase CBR. For combined addition of coir fibre and brick kiln dust in soil with varying percentile, the CBR value increases continuously.
3. From the experiments performed, it is established that the optimum value of brick kiln dust and coir fibre with the soil is 30% and 1.0% respectively.

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Such kind of findings is valuable in the consideration of economy and cost.

4. When the clayey subgrade becomes stabilized with 30% BKD and 1.0% Coir Fibre. Then 40% reduction in thickness

From the study, it is concluded that by mixing the clayey soil with waste brick kiln dust and coir fibre, it can result in stabilizing the soil. It is useful for construction of subgrade of the road, paths and embankment. Thus, the brick dust and coir fibre is suitable to be used as a suitable stabilizing agent for the purpose of admixture with the soft clay soil.

REFERENCE

1. C.J.Bronick, R.Lal,2014. Soil structure and management, carbon management and sequestration centre, OARDC/FAES, School of Natural Resources, The Ohio State University, Columbus, USA.
2. Khandaker, M., & Hossain, A. (2011), Stabilized Soils Incorporating Combinations of Rice Husk Ash and Cement Kiln Dust. American Society of Civil Engineers.
3. Kumar, A., Kumar, A., and Ved ,P.(2016). Stabilization of Expansive Soil with Lime and Brick Dust. International Journal of All Research Education and Scientific Methods (IJARESM) ISSN: 2455-6211, 4(9).
4. Pokale, K.R., Borkar, Y.R., and Jichkar, R. R.(2015). Experimental Investigation for Stabilization of Black Cotton Soil By using waste material - Brick Dust. International Research Journal of Engineering and Technology (IRJET), 2(5), pp. 726
5. Neha Pundir, M.K Trivedi, "Improvement of Pavement Soil Subgrade by Using Burnt Brick Dust"International Journal for Research in Applied Science &Engineering Technology, Vol. 5, Issue 5, pp. 218-221, 2017.
6. Ishfaq Ahmad Lone, Abhishek Bawa "Utilization of Fly-Ash and Coir Fibre in Soil Reinforcement" International Journal of Civil Engineering and Technology, Vol.9, Issue 8, pp. 341-346, 2018.
7. NavitaPradani, Iradhiani, Joko wibowo, "Analysis of Local sanded soil with coconut Coir Fiber reinforcement as subgrade on structural Pavement" International Journal of Civil Engineering and Technology, Vol. 8, Issue 10, pp. 787-795, 2017.
8. R.K. Sharma, "laboratory study on stabilization of clayey soil with cement kiln dust and fibre'' springer International Publication, Vol. 35, pp. 2291-2302, 2017.
9. Depaa. Ra. B, "Stabilization Of Pavement Material Using Waste Brick Kiln Dust" International Journal of Engineering Research & Technology, Vol. 2, Issue 4, pp. 1684-1691, 2013.
10. Ayhan Gurbuz, "Marble Powder To Stabilize Clayey Soil in Sub-Bases for Road Construction" Taylor & Francis, Vol. 16 Issue 2, pp. 481-492, 2015.
11. IRC: 37, Guidelines for the design of flexible pavements, IRC, 2001.

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