North Asian International Research Journal of Sciences, Engineering & I.T.

IRJIF. I.F. : 3.821

ISSN: 2454-7514 Vol. 8, Issue-7 July-2022

Index Copernicus Value: 52.88 Indian Citation Index Thomson Reuters ID: S-8304-2016

NAIRJC A Peer Reviewed Refereed Journal

DOI: 10.5949/NAIRJC_joe_00007.72

SOIL STABILIZATION OF FLEXIBLE PAVEMENT

BASIT AALAM[1], SHAKSHI CHALOTRA[2]

[1]*Scholar, Department of Civil Engineering, RIMT University Mandi Gobindgarh, Punjab, India*

[2]*Assistant Professor, Department of Civil Engineering, RIMT University, Mandi Gobindgarh, Punjab, India+-*

ABSTRACT

Soil has long been used as a building material. It provides support for both the superstructure and the substructure. Soil characteristics must be improved in order for the soil to be safe in bearing the load of these structures. Failure of black cotton soil is caused by a lack of strength and a high degree of expansion and contraction due to the presence of montmorillonite mineral. Stabilization is the process of improving soil properties through the use of specific additives. Road construction is increasing rapidly as a result of rapid urbanization and industrialization for easy and fast transportation. Because adequate land is not always available to build good roads, roads are forced to be built on locally available soil such as loose soil or expansive soil.

The study provides a laboratory study of subgrade soil stabilised with fly ash (FA) and rice husk ash (RHA) and its effect on flexible pavement design. The soil was stabilised with various percentages of FA (5, 10, and 15 %) and RHA (i.e., 5, 10, and 15 %). The addition of FA and RHA reduces the plasticity index (PI) and specific gravity of the soil, according to the results. The moisture and density curves show that the addition of RHA results in an increase in optimum moisture content (OMC) and a decrease in maximum dry density (MDD), whereas the addition of FA results in a decrease in these values. The addition of stabilisers (FA and RHA) raises UCS and CBR values, indicating an improvement in the soil's strength properties. Based on the CBR and UCS tests, the optimal amount of FA and RHA was determined to be 15% and 10%, respectively.

The percentage reduction in pavement thickness was found out to be 30% and 35% for Fly ash and Rice husk ash respectively

KEYWORDS: *Stabilization, Flexible, Soil, Pavement*

1. INTRODUCTION

Under various topographical situations, highways provide the most reliable mode of transportation.As of March 31, 2020, India's road network totaled 6,215,797 kilometres (3,862,317 miles).Pavement is a sort of hard surface comprised of durable surface material that is placed down on an area to carry automobile or pedestrian activity.Its primary role is to spread applied vehicle loads across multiple strata of the sub-grade. The road surface should have enough skid resistance, good ride quality, good light reflecting properties, and low noise pollution.The purpose is to keep the vehicle transmitted load below the sub-bearing grade's capacity. In the development of any construction, the road paving plays an important role. Flexible and stiff pavements are the two most common forms of road pavement.

Subgrade is a crucial foundation layer of any pavement, which is usually produced by natural or borrowed soil and is built on top of which other layers such as sub-base, base, and surface courses are built.Soil stabilisation is a technique for enhancing soil qualities by mixing in other elements. Soil stabilisation is a technique for improving the soil's shear strength parameters and consequently its bearing capacity.It's usually required when the soil beneath the foundation for a building isn't strong enough to support the structural load.Soil stabilisation procedures are a remedial measure that reduces the permeability and compressibility of soil mass in earth structures, increases its shear strength, and aids in the minimization of structural settlement.The use of stabilizing compounds in poor soils to increase geotechnical parameters such compressibility, strength, permeability, and durability are examples of soil stabilisation procedures..The addition of specific soil, cementing material, or other chemical compounds to natural soil to improve one or more of its qualities is known as soil stabilisation.To improve the qualities of road base soil, soil stabilization techniques are applied. These soil stablizers and sustain soil moisture content, promote soil particle cohesion, and act as cementing and waterproofing agents, among other things.While road base soil is discovered to be clay soil, civil engineering faces tough issues.Clay-rich soils have a greater tendency to swell when the moisture content of the soil is allowed to rise.

1.1. Pavement

The fundamental function of a highway pavement is to disperse the applied vehicle loads to the subgrade. It is made up of overlaid layers of selected and processed materials.The ultimate goal is to ensure that the transmitted stresses are lowered to the point where they do not exceed the subgrade's bearing capability.The following are characteristics of an excellent pavement:It should have the requisite thickness to transmit wheel load loads on the sub-grade soil to a safe level; it must be structurally sound in order to withstand all forms of stresses.It should have a sufficient coefficient of friction to prevent cars from skidding; it should have a smooth, flat surface that provides road users with comfort even at high speeds, when the car is moving on it, make sure there is less noise, It should be dustproof so that traffic safety is not jeopardized, It must have an impervious covering to preserve the sub-grade soil, and it must be aesthetically pleasing, It should also be low-maintenance and long-lasting.

1.2 Rigid Pavement

Rigid pavements are those with enough beam strength to bridge over localized sub grade failures and areas of insufficient support. Because of its structural capabilities, the concrete slab can bridge over localized failures and areas of inadequate support when the sub grade deflects beneath a rigid pavement. As a result, as long as the sub grade achieves certain minimal specifications, its thickness is generally unaffected by its quality.

1.3 Flexible Pavement

It is made up of several layers (asphalt concrete, base, and sub-base) as well as roadbed dirt (sub grade).In contrast to rigid pavements, the strength of the sub grade is the primary determinant of flexible pavement design. The overlaying flexible pavement is expected to deform to a comparable shape and extent as the sub grade. The depth of pavement required to transmit the imposed surface load to the sub grade is thus the main design criterion; the sub grade must not be overstressed and caused to flex without compromising its structural integrity.

1.4 Mechanical Stabilization

Granular adjustment is one more term for mechanical adjustment. The crucial standards at work are extent and compaction. This strategy includes the blending of different kinds of soils with changing slopes. This is finished to get a compacted soil mass (Tiwari and Tiwari, 2016).

1.5 Chemical Stabilization

The desired soil properties are achieved using this technique by adding chemically active materials to the soil. Lime, cement, bitumen, fky ash, and other soil stabilisers are examples (Tiwari and Tiwari, 2016).

2. OBJECTIVES

1. Substituting poor grade soils with aggregates possessing more favorable engineering properties.
2. Enhancement of the strength and therefore bearing capacity of the soil
3. To evaluate the effects on the design of the flexible pavement
4. To promote the use of waste geo materials in constructions.
5. Waterproofing for conservation of natural or manmade structures.

3. MATERIAL & METHODOLOGY

3.1 Soil

Soil samples were collected from near our college campus and tested for geotechnical properties and strength. The soil type under investigation is black cotton soil, also known as expansive soils.

Fig 1: Soil

3.2 Fly ash

Fly ash is a fine Gray powder composed primarily of spherical glassy particles that are a by-product of coal-fired power plants. Fly ash was purchased online via India mart.

Fig 2: Fly ash

3.3 Rice husk ash

Rice husk is an organic waste and is produced in large quantities. It is a major byproduct of the rice milling and agro based biomass industry. Rice husk used here was bought from a local vendor.

Fig 3 Rice husk

3.4 EXPERIMENTAL PROCEDURES

The stages involved in this are as follows:

STAGE 1: Collection of specimen, which included soil, Rice husk ash and Fly ash.

STAGE 2: Tests were carried out to determine the properties of soil Rice husk ash And Fly ash like specific gravity, liquid limit, plastic limit, OMC, MDD, UCS and CBR value.

STAGE 3: Addition of the stabilizers in the percentages of, 5, 10 and 15% for Fly Ash was done and then 5, 10, and 15% for RHA in other soil specimens.

STAGE 4: Tests like Standard proctor test, UCS and CBR test was carried on the Samples with varying percentages of stabilizers.

STAGE 5: Using the design charts, thickness of the pavements for both soils with and without stabilizers were found.

STAGE 6: The values were compared and reduction in pavement thickness was Calculated.The various physical properties of the soil like Specific Gravity, Optimum moisture content (OMC), Maximum dry density (MDD), unconfined compressive strength (UCS) and California Bearing Ratio (CBR) values were found out in laboratory.

Table 1: Properties of soil

Soil properties	Description
Liquid limit	59.14
Plastic limit	30.92
Plasticity index	29.09
Optimum moisture content	14.3
Maximum dry density	1.71
CBR value (soaked)	5.9
CBR value (unsoaked)	2.04
Specific gravity	2.34
Shear strength	1.19

4. RESULTS AND DISCUSSION

4.1 Effect of compaction properties

Maximum dry density (MDD) and optimum moisture content (OMC) of all trial mixtures were determined in the laboratory in accordance with IS: 2720 (Part 8) - 1983. Standard proctor test was carried out to establish the relationship between dry density-moisture content. The test was carried out with 0%, 5%, 10% and 15% percentages of Fly ash mixed with soil and 0%, 5%, 10% and 15%percentages of Rice husk ash mixed with soil to find the effects on optimum moisture content and maximum dry density. The addition of fly ash caused a decrease in MDD as the percentage of fly ash is increased. The most decrease in MDD is seen for 15% addition of Fly ash of about 25.15%. The OMC gets decreased first as we increase the parentage of Fly ash up to 10% but at 15% increase there is an increase in OMC. The same can be seen in the graph below.

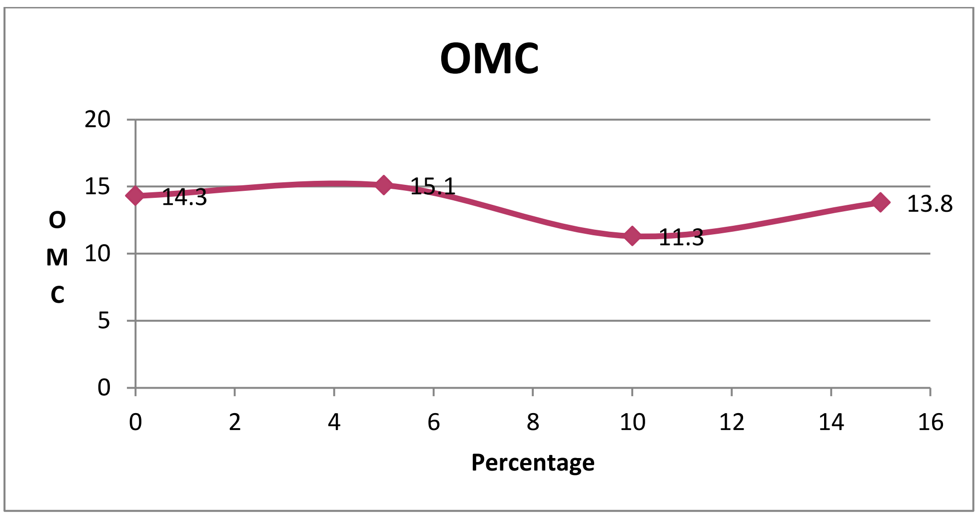

Fig 4. OMC and Fly ash content graph

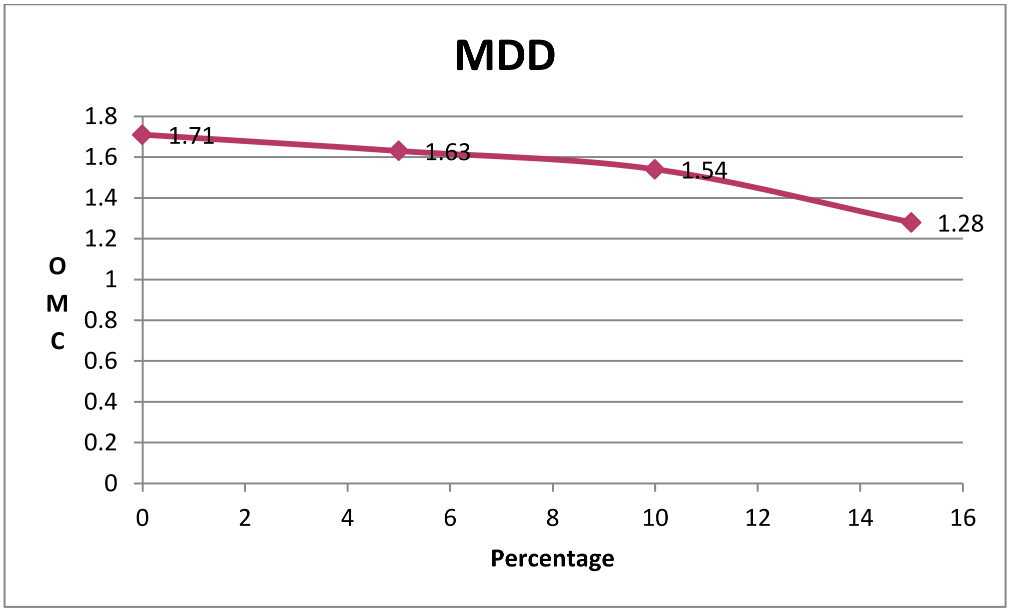

Fig 5: MDD and Fly ash content graph

The addition of Rice husk ash caused a decrease in MDD as the percentage of Rice husk ash is increased. The most decrease in MDD is seen for 15% addition of Rice husk ash of about 35.08 %. The OMC increases as we increase the parentage of Rice husk ash. The value of OMC for 15 % RHA increase is 23.7% more than that at 0% RHA addition. The same can be seen in the graph below.

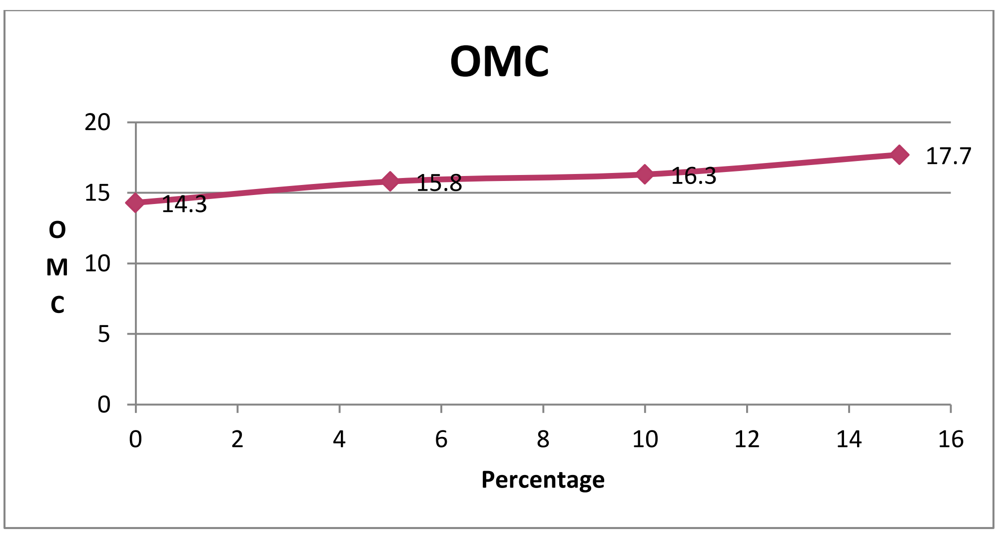

Fig 6: OMC and Rice husk ash content graph

The above graph shows the change in OMC as we go on increasing the percentage of RHA added to the soil.

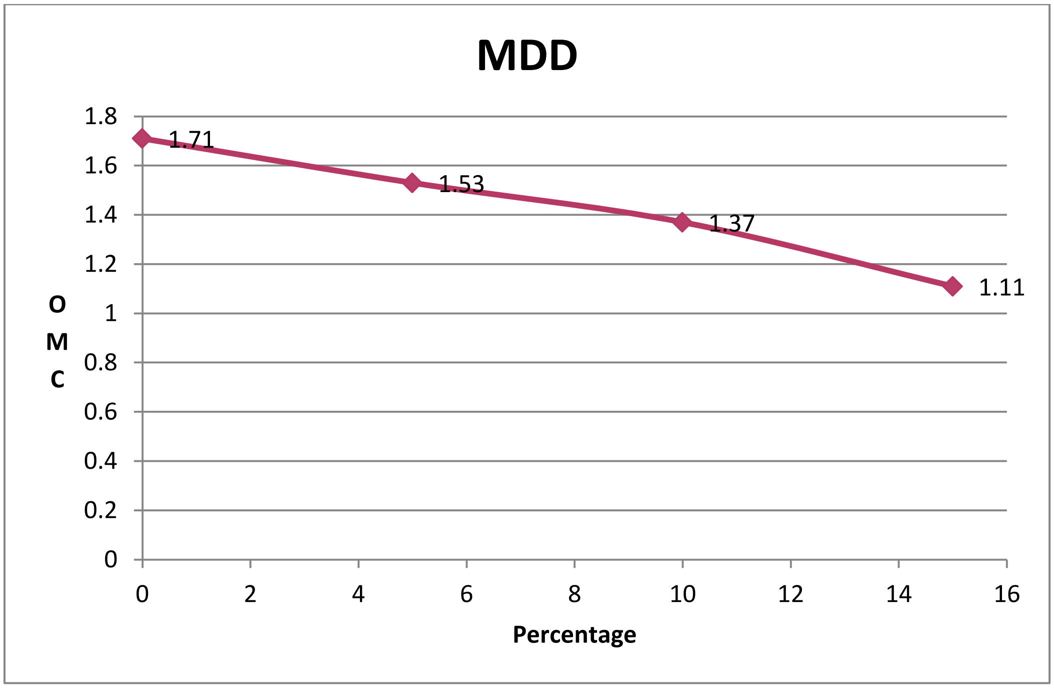

Fig 7: MDD and Rice husk ash content graph

4.2 Effect of Shear Strength

Shear strength is the internal resistance to failure or deformation caused by continuous shear displacement of soil particles. Unconfined compression test was carried out to find the shear strength of soil sample. The test was carried out with 0%, 5%, 10% and 15% percentages of Fly ash mixed with soil and 0%, 5%, 10% and 15% percentages of Rice husk ash mixed with soil.

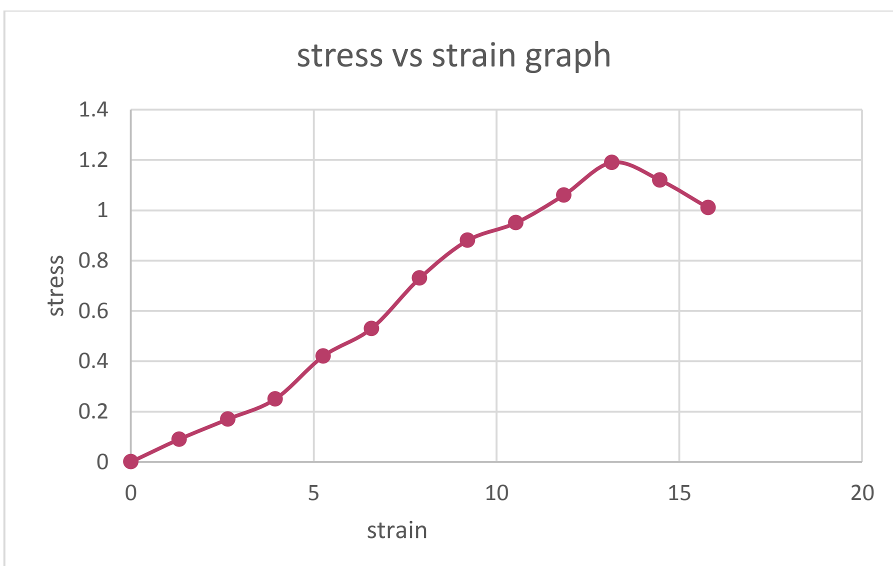

Fig 8: Stress strain graph

The above graph is drawn between stress and strain and shows us the max stress at the given strain.

The increase in the Fly ash percentage increases the UCS strength of the soil. The value increase till 10% fly ash addition up to 2.86 which is 140% increase compared to soil with no stabilization. However further increase of fly ash to 15% increase causes a decrease in UCS strength.

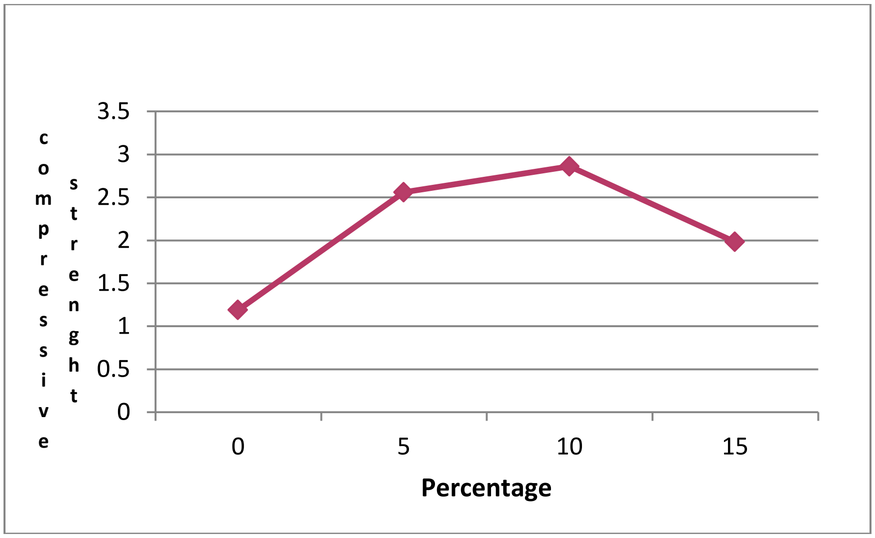

Fig 9: compression strength and Fly ash content Graph

The increase in the Rice husk ash percentage increases the UCS strength of the soil. The value increase till 10% Rice husk ash addition up to 1.72 which is 44.53% increases compared to soil with no stabilization. However further increase of Rice husk ash to 15% increase causes a decrease in UCS strength.

4.3 Effect of CBR

The analysis was carried for following percentages of 0%, 5%,10% and 15% Fly ash mixed with soil and 0%,5%,10% and 15% Rice husk ash. The samples were compacted at their OMC and MDD obtained from Proctor test and the test was conducted till 12.5mm of penetration. The test was carried out for both the soaked and unsoaked sample.

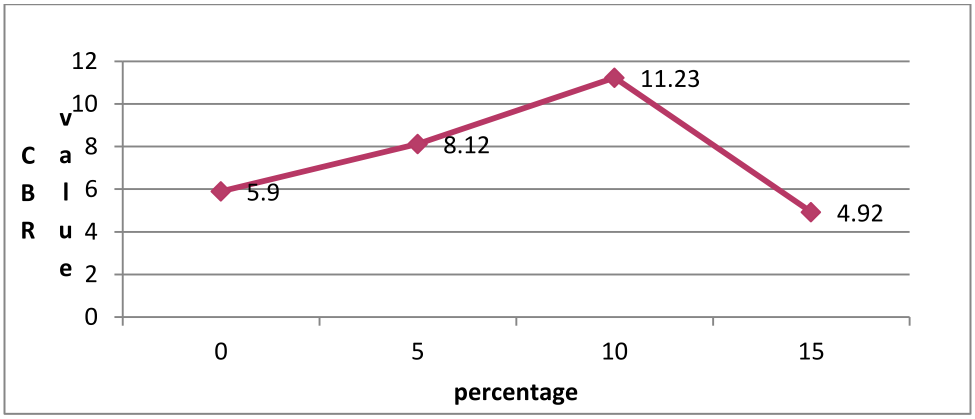

Fig 10 : CBR value vs Fly ash content Graph for unsoaked condition for 2.5 mm

The increase in Fly ash increases the CBR value. The CBR value increases up to 11.23 which is an increase of 90.33% for 10 % Fly ash addition. Further addition of Fly ash causes a decrease in CBR value.

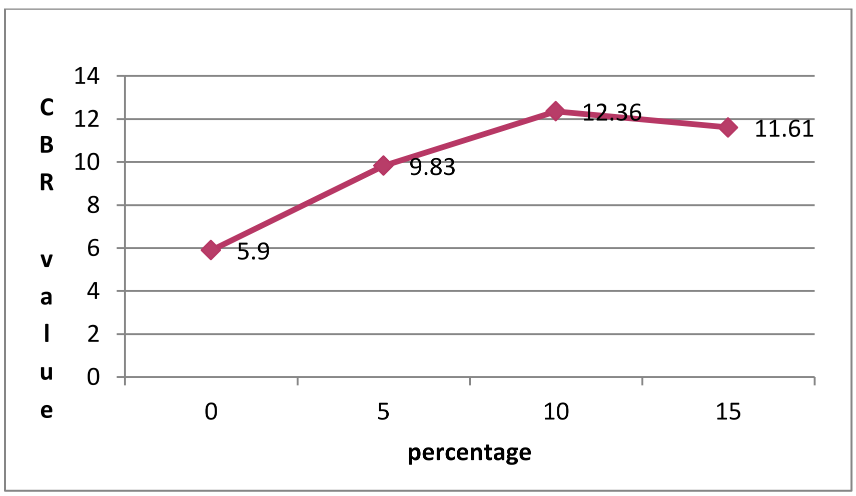

Fig 11: CBR value vs rice husk ash ash content Graph for unsoaked condition for 2.5 mm

The increase in Rice husk ash increases the CBR value. The CBR value increases up to 12.36 which is an increase of 109.4% for 10 % Rice husk ash addition. Further addition of Rice husk ash causes a decrease in CBR value.

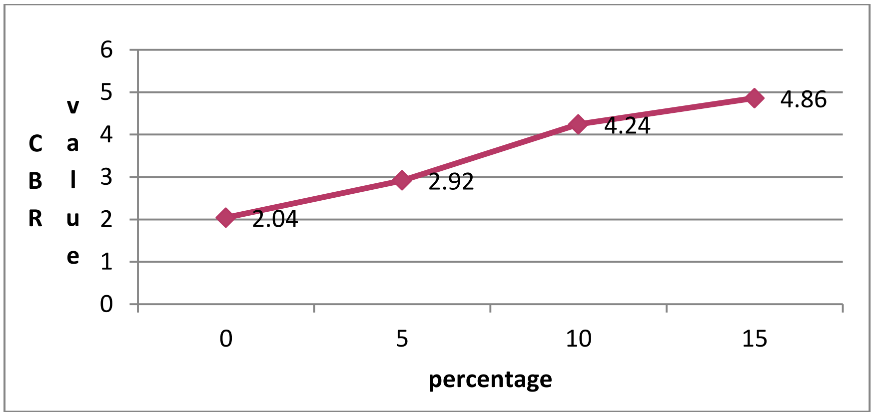

Fig 12: CBR value vs Fly ash content Graph for soaked condition for 2.5 mm

The increase in fly ash increases the CBR value. The CBR value increases up to 4.86 which is an increase of 138 % for 15 % fly ash addition.

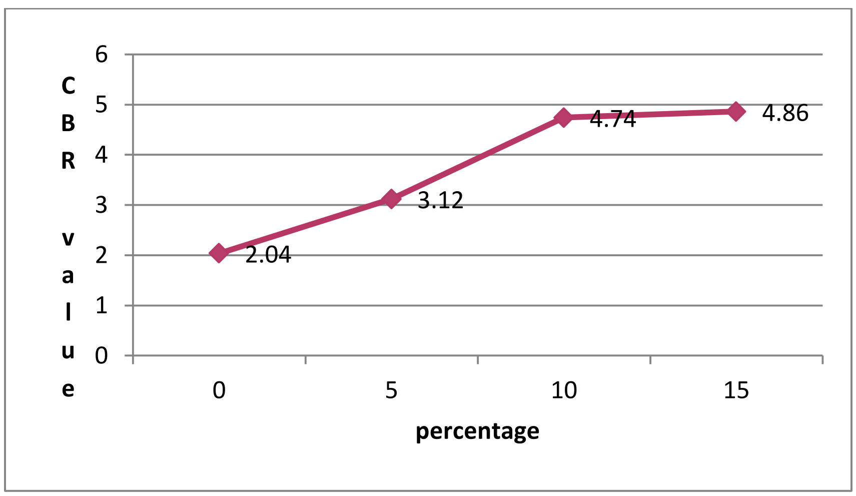

Fig 13: CBR value vs Rice husk ash content Graph for soaked condition for 2.5mm

The increase in rice husk ash increases the CBR value. The CBR value increases up to 4.92 which is an increase of 141 % for 15 % rice husk ash addition.

5. CONCLUSION

From the test carried out and design following this can be concluded:

- Liquid Limit ad Plastic limit both decrease as we increase the percentage of Fly ash and Rice husk ash.
- MDD and OMC value decreases with the increase in Fly-ash content.

- MDD decreases with increase in RHA content but OMC increases for the same. OMC saw an increase of 23.7% for 15% RHA added.
- UCS saw an increase of 140% for 10% addition of fly ash and an increase of 44.5% for 10% addition of RHA. Thus UCS saw more increase in strength for fly ash compared to RHA.
- The addition of RHA caused more increase in CBR value compared to Fly ash. The optimum percentages of addition of both Fly ash and RHA came out to be 10%.

REFERENCES

1. Boominathan and Ratna Kumar., 1996, Lime treated Fly ash as Embankment Material. Proc of IRC-96, Madras pp 523-526.
2. Henry vidal.,1968 The principles of Reinforced Earth, Highway Research , vol.30, No 3,July 2001, Record,.Indian Geotechnical Journal ,Vol 282,pp 1-16
3. IRC: 37, 2001 Guidelines for the Design of Flexible Pavements Khanna S.K & Justo C.E.G 2001.
4. Highway Engineering 8 th edition, New Chand & Bros Roorkee. Picornell .M & Lytton RL, Field measurement of shrinkage crack Depth in Expansive soils, TRR-1219, TRB 1989 pp121-130.
5. Singh, D.V and Murty. A.V.S.R., 1998, Fly ash in IndiaProblems and Possibilities, Proc of Experience sharing meet on use of fly ash in Roads and Embankments., CRRI- New Delhi,1-9.
6. Suryanarayana P.Action Plan for Utilization of fly ash as Alternative Construction materials and construction world, 5. Issue -8(2000) 50-58.
7. Veerendra Singh, Narendra Kumar and Devendra Mohan., 1996 Use of fly ash in soil stabilization for roads, Proceedings of IGC-96, Madras, pp 411-414.
8. Gallaway B. M. , and Buchanan, S. J., "Lime Stabilization of Clay Soil," Bulletin 124, Texas Engineering Experiment Station (1951).
9. Laguros, J. G., Davidson, D. T., and Chu, T. Y. , "Evaluation of Lime for Stabilization of Loess," Iowa Engineering E^eriment Station, Iowa State College, Ames, Iowa (1956).
10. Nanda Kishore. Y., (2003). ―Studies on minimizing heave of expansive clays with Lime stabilized Flyash cushion‖, M.Tech. Thesis, JNTU College of Engg, Kakinada.
11. Sree Rama Rao A, Seelam Prasad, .Madhuri Manmadha.B, and Dayakara Babu.R,(2003). ―Use of cement-stabilized flyash cushion in minimizing swell of expansive clays‖, IGC-2003, Dec. 18-20, 2003, Roorkee.
12. Maitra.S, Das.S, Das.A.K. And Basumajumdar.A, (2005). ―Effect of Heat Treatment on Properties of Steam Cured Flyash-Lime Compacts‖ proc. of Bull. Mater. Sci., Vol. 28, No. 7, December 2005, PP 697-702.

13. Picornell, M. and Lytton, R.L. (1989). ―Field Measurement of Shrinkage Crack Depth in Expansive Soils, TRR-1219, TRB, pp. 121-130.

14. Uppal, H.L. (1965). ―Field Study on the Movement of Moisture in Black Cotton Soils under Road Pavements‖, Symposium on Moisture Equilibria and Moisture Changes in Soils Beneath Covered Areas, Butterworths, Australia, pp. 687-693.

15. Mehta PK. The Chemistry and Technology of Cement Made from Rice Husk Ash. In: UNIDO/ESCAP/RCTT Workshop on Rice Husk Ash Cement; 1979, Peshawar. pp. 113–122.

16. Rahman MA. Effects of Cement-Rice Husk Ash Mixtures on Geotechnical Properties of Lateritic Soils. Journal of Soils and Foundations. 1987; 27(2): 61–65.

17. Ali FH, Adnan A, Choy CK. Geotechnical Properties of a Chemically Stabilized Soil from Malaysia with Rice Husk Ash as an Additive. Geotechnical and Geological Engineering. 1992; 10(2): 117–134.

18. Behak L. Stabilization of a Sedimentary Sandy Soil of Uruguay with Rice Husk Ash and Lime [MSc Dissertation]. Porto Alegre: Postgraduation Program in Civil Engineering, Federal University of Rio Grande do Sul; 2007.