Construction & Stabilization of Pavement Layers using Rice Husk and Rice Husk Ash

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Abstract— Roads construction projects require large quantities of suitable soils as a filling material. However, in urban areas, when roads are constructed, suitable filling soils have to be hired with enormous costs. Thus main objective of this research was to stabilize weak subgrade soils mixing with rice husk and rice husk ash. Weak sub-grade soil was obtained from construction site near gomti river front in lucknow. Rice husk and rice husk ash were obtained from power plant in Gazipur and rice mills in study area, respectively. Forty-eight weak subgrade soil samples were mixed with stabilizers (rice husk) in different ratio and then 16 specimens were cured for 7 days while other 32 (2×16) samples were cured for 14 and 28 days, respectively. In order to find out maximum strength of each soil sample, different soil tests viz Atterberg Limits, Proctor Compaction, Swell Index (SI) and California Bearing Ratio (CBR) were carried out. Results revealed that maximum CBR value was obtained, when 70% of soil blends with 8 to 10% of rice husk ash at 28 days curing period. Reason for the increment of CBR may be due to formation of cementitious compound in the mixture is due to chemical reactions of SiO2 in stabilizers and CaOH present in soils. Based on results, policy implications are discussed in relation to need of stabilizers in road construction projects in order to improve stabilizing weak subgrades while decreasing project cost and utilizing waste materials.

Key words: California Bearing Ratio, Rice Husk Ash, Soil Stabilization

I. INTRODUCTION

A roadway section consists of a complete pavement system (Figure 01) including its associated base course, sub-base course, sub-grade, and required system drainage components. The construction of long lasting, economical flexible pavement structures requires sub-grade materials with good engineering properties. The sub-grade should possess desirable properties to extend the service life of the roadway section and to reduce the required thickness of the flexible pavement structure. These desirable properties include strength, drainage, ease and permanency of compaction, and permanency of strength. (Yadav R.K. May 2014)

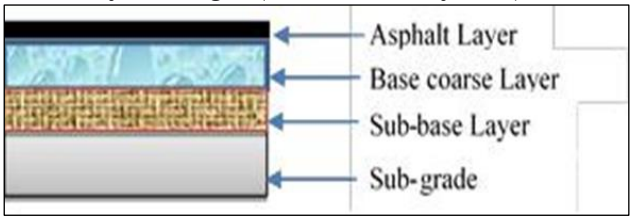


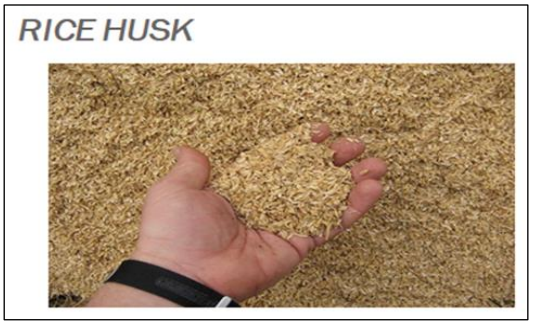
Fig. 1: Road way cross section Figure

A land-based structure of any type is only as strong as its foundation. For that reason, soil is a critical element influencing the success of a construction project. Soil is either part of the foundation or one of the raw materials used in the construction process. Therefore, understanding the engineering properties of soil is crucial to obtain strength and economic permanence. Geotechnical properties of problematic soils such as soft fine-grained and expansive soils are improved by various methods. Generally problematic soil is removed and replaced by a good quality material. In urban areas, borrow earth is not easily available which has to be hauled from a long distance. (Gandhi S.R. 2000)

Stabilization soils by using Rice husk ash and mixture of lime or cement and rice husk is gaining more importance in recent times since it has widespread availability. This method is inexpensive and takes less time than other stabilization methods. Rice husk may be mixed with soil during excavation right in the field. Rice husk does have strength properties but together with water possess some cementation characteristics.

II. RICE HUSK

The influence of stabilizer types and dosages on fresh and mechanical properties is evaluated through marshal and California bearing ratio (CBR) tests. Wherever paving blocks are used it is found that at many places the removals of the paving blocks have been observed. The conditions of road are deteriorating over the period time because of presence of poor quality materials, improper construction procedure and lack of proper maintenance. The study is limited to Pune region but same may be applicable for other cities. The rice husk (or hull) is the outermost layer of the paddy grain that is separated from the rice grains during the milling process. Globally, approximately 770 million tons of rice paddy is produced each year. On average 21.2% of the rice paddy is husk, giving an annual total production of 120 million tones was from India that produces about 18% of rice husk ash (RHA) which is about 4.43 million tones in india.



The present investigation has been carried out with agricultural waste materials like Raw Rice Husk (RRH) and Rice Husk Ash (RHA) individually mixed with soil and also in combination with different percentage of hydrated lime with several mix proportions to study improvement of weak road subgrade. 2,4,6 and 8 percentages of RH were mixed with soil stabilized several combinations and compacted at a water content of OMC+5% and tested for California Bearing

Ratio(CBR) and Unconfined Compressive Strength(UCS) tests. The results show marked improvement in CBR & UCS values of the mixed soils in comparison with that of the original soil. The high percentage of siliceous materials present in RHA promises it to be used as a potential ground stabilizing/improving materials. The effect of curing of specimens was also investigated. It has been found that with increase in curing period UCS values as well as CBR value of lime RHA stabilized soil as well as lime RRH stabilized soil are increasing remarkably. (Biswas G. 2003)

Rice husk ash can be successfully used for stabilizing clayey peat soil. Rice husk and rice husk ash, which are waste materials comes from combustion of solid waste and rice husk. Rice husk ash attains good cushioning property when it is blend with rice husk ash and soil. Solid waste is generally defined as non-soluble material that is discarded in a solid or semi-solid form. This includes garbage, refuse, sludge and other discarded domestic materials, as well as waste from infrastructure development can be completed at lesser cost and will also help for environmental protection of our country. Thus main objective of this research was identify the best

Rice Husk Ash proportion to upgrade the bearing capacity of weak sub grade soil while other specific Objectives Reduce the construction cost of roads, Increase the durability of roads and reduce the maintenance cost, Reduce quantity of solid waste and reduce the environmental pollution.

A. Rice husk Ash (RHA)

Rice Husk Ash (RHA) is obtained from the burning of rice husk. The husk is a byproduct of the rice milling industry. By weight, 10% of the rice grain is rice husk. On burning the rice husk, about 20% becomes RHA.

III. METHODOLOGY

A. California Bearing Ratio(CBR)

It is the ratio of force per unit area required to penetrate a soil mass with standard circular piston at the rate of 1.25 mm/min. to that required for the corresponding penetration of a standard material.

$$C.B.R = (P/Ps)100$$

The california bearing ratio test is penetration test meant for the evaluation of subgrade strength of roads and pavements. The results obtained by these tests are used with the empirical curves to determine the thickness of pavement and its component layers. This is the most widely used method for the design of flexible pavement.

B. Standard penetration test Values

Penetration of plunger (mm)	Standard load (kg)
2.5	1370
5.0	2055
7.5	2630
10.0	3180
12.5	3600

IV. RESULT & DISCUSSION

A. Use of Rice Husk in Subgrade

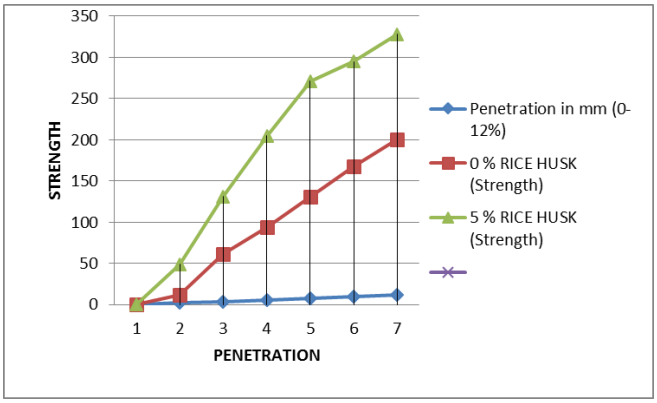
Rice husk will be used in subgarde by mixing it with subgrade material. 5% Rice husk is replaced by subgrade soil and is tested for CBR Test with following observed values for penetration at 2.5mm and strength at that particular penetration.

Penetration	Strength
0	0
2	12.3
4	61.5
6	94.3
8	131.2
10	168.1
12	200.9

Table 1: Data with penetration and strength value at 2.5mm when 0% Rice Husk is added

Penetration	Strength
0	0
2	49.2
4	131.2
6	205
8	271
10	295
12	328

Table 2: Data with penetration and strength value at 2.5mm when 5% Rice Husk is added



GRAPH SHOWING IMPROVING STRENGTH OF SOIL BY ADDITION OF 5% RICE HUSK

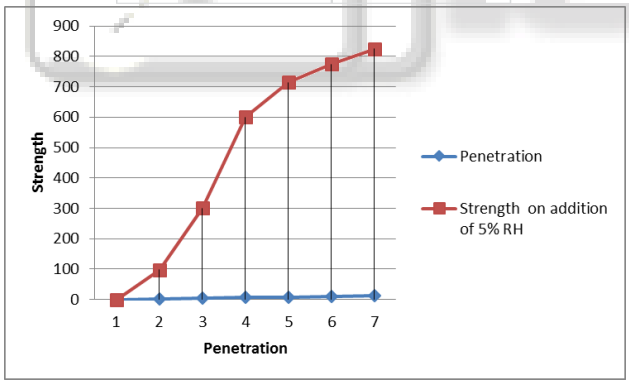
B. Use of Rice Husk in Subbase

In Sub base grading is prepared by specification for road and bridge work given in IRC. In preparation of grading aggregates of different sizes are taken. Aggregates are passed

through sieve size of 75 mm, 26.5mm, 4.75mm & 0.075mm.Now with the materials Grading 3 of code is prepared 0f which the CBR was 20%. Now 5% of the soil sample in the above grading is replaced by Rice husk. Now the sample is divided into three parts and the whole process of calculation of CBR is performed.

Table 3: Data with penetration and strength value at 2.5mm when 5% Rice Husk is added

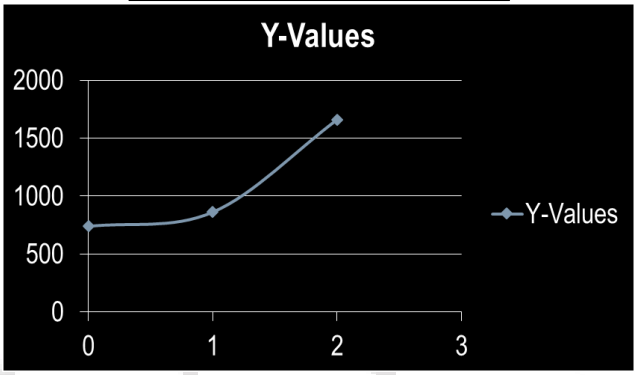
Penetration	Strength
0	0
2	98
4	300
6	600
8	715
10	775
12	825



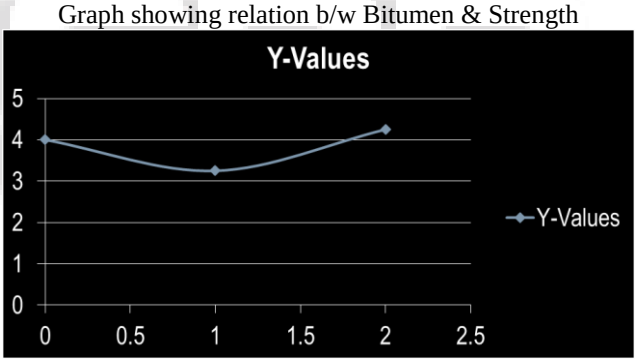
GRAPH SHOWING IMPROVING STRENGTH OF SOIL BY ADDITION OF 5% RICE HUSK

C. Use of RHA in Surface Course

The grading of the sample was prepared as per IRC specification. Now the sample is heated up to 160 degree centigrade. Now bitumen Now 57 blows are given to the sample from both the sides. The sample is then weigh on the weighing machine. Now the sample is placed in water for half hour and is then weighed. Now the sample is given water bath at 60 degree for 20 minutes. Now the sample is cooled and is placed in the marshal machine and is test @5% is mixed with in the sample of its weight. Now the sample is heated at 160 degree for 1 hour. Now the sample is placed in the marshal mould.



Graph showing relation b/w Bitumen & Strength



Graph showing relation b/w Bitumen & Flow

V. CONCLUSION

- When plain and simple soil is tested for CBR the value came out to be 3.64% but when the same soil sample after addition of RH is tested for CBR it came out to be 7.1% which shows the strength of soil increases with addition of Rice Husk.
- CBR Value of 5% Rice Husk in Soil 7.1% > CBR Value of Plain soil is 3.64%
- When soil sample soil is tested for CBR the value came out to be 21.89%.
- The sample when taken from bitumen surface and mixed with rice husk ash shows increase in strength when 1% of rice husk ash is added in it.

VI. OTHER RECOMMENDATIONS

In this study, the geotechnical performances of rice husk and rice husk ash (RHA) in stabilizing the weak sub-grade were presented. However, rice husk and rice husk ash (RHA) can

contain materials like heavy metal that are harmful to the natural environment. The risks imposed on the environment by possible geotechnical applications of fly ash and rice husk ash (RHA) must be carefully weighed against creating new pollution sources elsewhere. Therefore, to define more clearly the conditions for a safe application from an environmental point of view this research must be extended by performing leachate analyses of the samples used in this study.

It should identify the field application of this method, by using suitable technology. Also cost-benefit analysis should be made to evaluate the effectiveness of this technology.

Only two types of stabilizers, Rice husk and Rice Husk Ash, were used as a stabilizing agent in this study, further research could be done with wide range of chemical stabilizers.

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