Study on Soil Stabilization with Partial Replacement of Rice Husk in Subgrade Soil

Yasir Ahmad Bhut[1], Dr. Rakesh Gupta[2], Er. Neeraj Kumar[3]

[1]M.Tech Scholar Civil Engineering Department, SRMIET Khora Bhura, Ambala
[2]Professor and Director, Civil Engineering Department, SRMIET Khora Bhura, Ambala
[3]Assistant Professor, Civil Engineering Department, SRMIET Khora Bhura, Ambala

---

Abstract - In today climatic changes, lack of stable ground for development of infrastructures is very common. In fact of this, construction of buildings on unsuitable ground is unavoidable and making a suitable ground before constructions is real difficult issue for Geotechnical Engineers. To overcome the difficulties experienced with problematic soil in geotechnical applications on one side and safe disposal of solid wastes on the other side, an attempt is made in this investigation to explore the possibilities of utilizing wastes to improve the engineering behavior of problematic soil. In this, in this present investigation the type of waste namely Rice Husk Ash for stabilization is selected to study the effects of same on the properties of problematic soil.

Key Words: Rice husk, Alluvial soil, clayey soil

1. INTRODUCTION

Soil Stabilization is the alteration of soils to enhance their physical properties. Stabilization can increase the shear strength of a soil and/or control the shrink-swell properties of a soil, thus improving the load bearing capacity of a sub-grade to support pavements and foundations. Soil Stabilization can be utilized on roadways, parking areas, site development projects, airports and many other situations where sub-soils are not suitable for construction. Stabilization can be used to treat a wide range of sub-grade materials, varying from expansive clays to granular materials. This process is accomplished using a wide variety of additives, including rice husk, lime, fly-ash, and Portland cement, marble dust and foundry sand. Other material byproducts used in Stabilization include lime-kiln dust and cement-kiln dust.

There are advantages and disadvantages of many of these soil stabilizing agents:

I. Many of the "green" products have essentially the same formula as soap powders, merely lubricating and realigning the soil with no effective binding property. Many of the new approaches rely on large amounts of clay with its inherent binding properties. Bitumen, tar emulsions, asphalt, cement, lime can be used as a binding agents for producing a road base. When using such products issues such as safety, health and the environment must be considered.

II. The National Society of Professional Engineers (NSPE) has explored some of the newer types of soil stabilization technology, specifically looking for "effective and green" alternatives. One of the examples utilizes new soil stabilization technology, a process based on cross-linking styrene acrylic polymer. Another example uses long crystals to create a closed cell formation that is impermeable to water and is frost, acid, and salt resistant.

III. Utilizing new soil stabilization technology, a process of cross-linking within the polymeric formulation can replace traditional road/house construction methods in an environmentally friendly and effective way.

IV. There is another soil stabilization method called the Deep Mixing method that is non-destructive and effective at improving load bearing capacity of weak or loose soil strata. This method uses a small, penny-sized injection probe and minimizes debris. This method is ideal for re-compaction and consolidation of weak soil strata, increasing and improving load bearing capacity under structures and the remediation of shallow and deep sinkhole problems. This is particular efficient when there is a need to support deficient public and private infrastructure.

2. MATERIAL USED IN STUDY

Soil stabilization can do with many additives. In this study, to stabilize the soil, rice husk is used and is discussed on next page:

I. SOIL

The biologically active, porous medium that has developed in the uppermost layer of Earth's crust. Soil is one of the principal substrata of life on Earth, serving as a reservoir of water and nutrients, as a medium for the filtration and breakdown of injurious wastes, and as a participant in the cycling of carbon and other elements through the global ecosystem. It has evolved through weathering processes driven by biological, climatic, geologic, and topographic influences. In this study two types of soil used as material i.e. alluvial soil and clay soil.

II. RICE HUSK

Rice husk are the hard protective coverings of rice grains which are separated from the grains during milling process.

Rice husk is an abundantly available waste material in all rice producing countries, and it contains about 30%–50% of organic carbon. In the course of a typical milling process, the husks are removed from the raw grain to reveal whole brown rice which upon further milling to remove the bran layer will yield white rice. Current rice production in the world is estimated to be 700 million tons. Rice husk constitutes about 20% of the weight of rice and its composition is as follows: cellulose (50%), lignin (25%–30%), silica (15%–20%), and moisture (10%–15%). Bulk density of rice husk is low and lies in the range 90–150 kg/m^3. Sources of rice husk ash will be in the rice growing regions of the world, as for example China, India, and the far-East countries. RICE HUSK ASH is the product of incineration of rice husk. Most of the evaporable components of rice husk are slowly lost during burning and the primary residues are the silicates. The characteristics of the ash are dependent on, composition of the rice husk, burning temperature and burning time. Every 100 kg of husks burnt in a boiler for example will yield about 25 kg of RICE HUSK ASH. In certain areas, rice husk is used as a fuel for parboiling paddy in rice mills, whereas in some places it is field-burnt as a local fuel. However, the combustion of rice husk in such cases is far from complete and the partial burning also contributes to air pollution.

3. SCOPE OF STUDY

Dissertation entitled "Study on soil stabilization with partial replacement of rice husk in subgrade soil" Improvement in CBR value of Soil by adding rice husk aims at conducting laboratory investigation on some selected soils of Haryana with the addition of rice husk in varying proportions to determine changes in California Bearing Ratio of the soils. The soil used from Naraingarh, Ambala, Haryana. Improved subgrade soil with higher CBR value reduces the pavement crust requirements. The soil which possesses low CBR value can be improved by the use of additives such as rice husk.

4. LITERATURE REVIEW

Over the years a lot of research has been carried out on the possible use of different materials for soil stabilization. The summary of few such researchers is given below:

Anand, et al., (2000) accomplished the study on improving the characteristics of organic soil by adding lime. The results show that fibers with different percentages improve the UCS of the soil and reduce both volumetric shrinkage strain and swell pressure of the expansive soil.

Parsons, et al., (2004) based on this investigation uses of cement kiln dust in soil stabilization. Durability test were followed by strength test and atterberg limits. Relative values of soil stiffness were also tracked over a 28 days curing period. The test results show a significant improvement in performance with addition of cement kiln dust.

A. K. Choudhary., (2010) studies the effect of high density polyethylene on highway subgrade. CBR tests were conducted with varying percentage and length of high density polyethylene. Results showed the improvement in strength and deformation behavior of soil.

Brooks, et al., (2012) have studied the performance of subgrade and sub grade layers by addition of demolished waste quite effective in the stabilization process.

Yadu, and Tripathi., (2013) studied the effects of granulated blast furnace slag in the engineering behaviour of stabilized soft soil. The performance of GBS stabilized soil was evaluated using physical and strength performance tests. Based on strength performance tests the optimum GBS was determined as 9% among 3%, 6%, 9% and 12%. Inclusion of GBS increases the strength of soil as well as the soaked and unsoaked CBR values.

Jadhav, and Kulkarni., (2014) premeditated the feasibility study of Improving Properties of Black Cotton Soil Using Industrial Wastes. The studies revealed that stabilization using industrial wastes from 0% to 60% saves the natural materials. The pavement thickness for stabilized road is reduced by 280 mm and cost saving is 21.91% with respect to flexible pavement of 1km road length. It is economical to construction as well as maintenance of road.

Parte Shyam Singh, and R. K. Yadav., (2014) carried out study on the effect of marble dust on the index properties of black cotton soil. Marble dust was taken in the ratio of 0% to 40% by the dry weight of the soil. Results concluded that the plasticity index of the black soil decreased gradually from 28.35% to 16.67%, while the shrinkage limit increased from 8.06% to 18.34% at 40% addition of marble dust. Apart from this the expansiveness of the soil reduced from being very high to low on addition of marble powder, thus making the soil suitable for construction.

Kunal R. Pokale, et al., (2015) carried out an experimental investigation for Stabilization of Black Cotton soil by using waste material-Brick Dust. On the basis of experimental test results, it is observed that the moisture content reduces after 7 days and 28 days results respectively. MC of 30% BD is reduces to 26.46%. Hence replacement of brick dust is more effective.

Jaglan, and Mital., (2015) reviewed of stabilization of soil by steel industry waste. According to study, it shows that due to the addition of steel waste the maximum dry density increases and the optimum moisture content decreases. In geotechnical engineering applications steel waste may be feasible. By the addition of steel waste in the poorly graded soil may improve the bearing capacity of soil.

Veena Uma Devi, and Adarsh Minhas., (2016) accomplished the stabilization of soil using marble dust. The proportion of marble dust used was 10%, 15% and 20% by the weight of soil. Tests carried out were the standard proctor test and the California bearing ratio test. The test results showed that addition of marble dust showed an increase in the optimum moisture content of the soil from 8% to about 12%. While the maximum dry density decreased with addition of marble dust. The CBR value of the soil increased up to 15% addition of marble dust and after that on more addition of the same it decreased.

Prashant Kumar, et al., (2016) studied the stabilization of the sub grade soil using waste foundry sand. Foundry sand was used in varying percentage starting with 5%, 10%, 15% and 20%. The tests performed on the soil samples were the Standard Proctor test, Direct Shear Test, California Bearing Ratio test.

5. Tests Performed on Materials

The following tests are carried out to find out the properties of materials:

- **I.** Specific Gravity Test
- **II.** Liquid Limit Test
- **III.** Plastic Limit Test
- **IV.** Plasticity Index
- **V.** Free Swell Index Test
- **VI.** Standard Proctor Compaction Test
- **VII.** California Bearing Ratio Test

6. Observations

The various index properties test like Specific gravity test, Liquid Limit test, Plastic Limit test, Free swell index test and Standard proctor compaction tests were conducted on natural soil and soil with various proportions like 10%, 20%, 30%, and 40% of Rice Husk Ash. The observations are shows below:

6.1 Specific Gravity

I. Specific gravity of alluvial soil is 2.66,
II. Specific gravity of clay soil is 2.78.

6.2 Liquid Limit

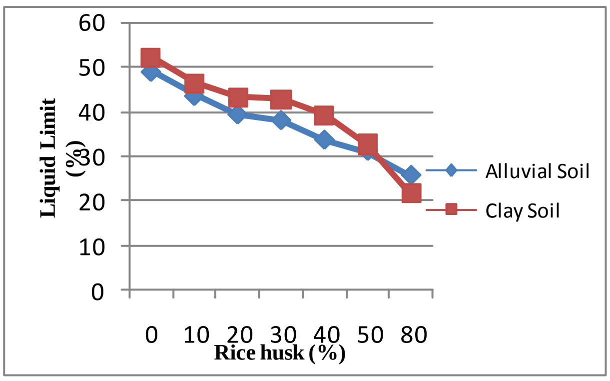

Fig. 1.1 Graphical representation of liquid limit and different percentages of rice husk in alluvial and clayey soils

6.3 Plastic limit

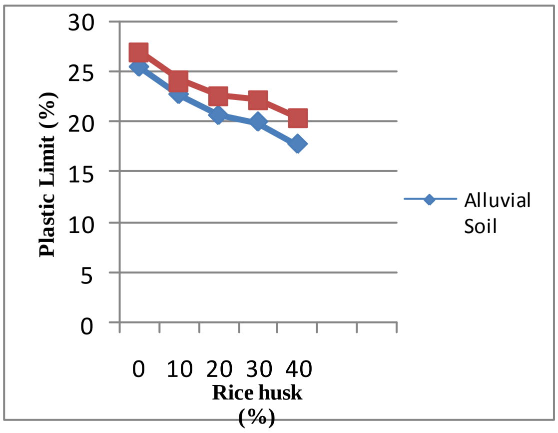

Fig. 1.2 Graphical representation of plastic limit and different percentages of rice husk in alluvial and clayey soils

6.4 Free Swell Index

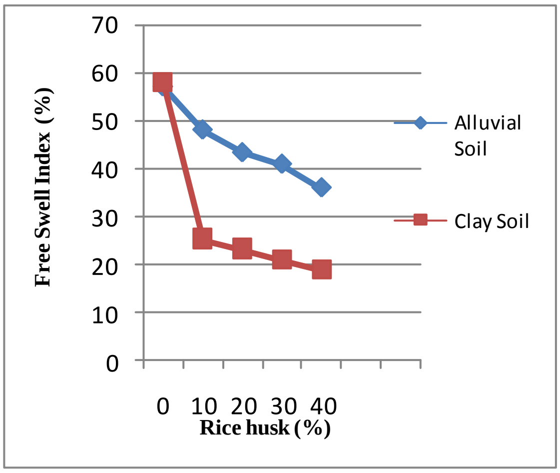

Fig. 1.3 Graphical representation of free swell index and different percentages of rice husk in alluvial and clayey soils

6.5 Optimum Moisture Content

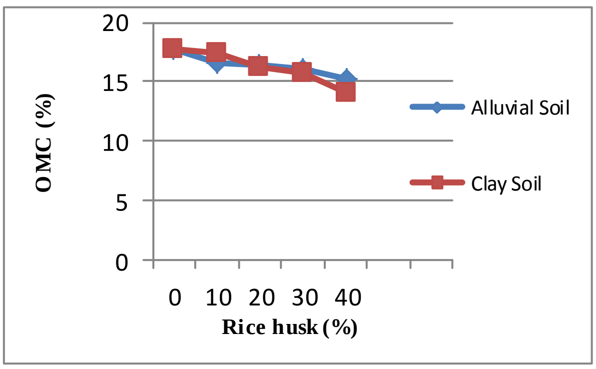

Fig. 1.4 Graphical representation of optimum moisture content and different percentages of rice husk in alluvial and clayey soils

6.6 CBR

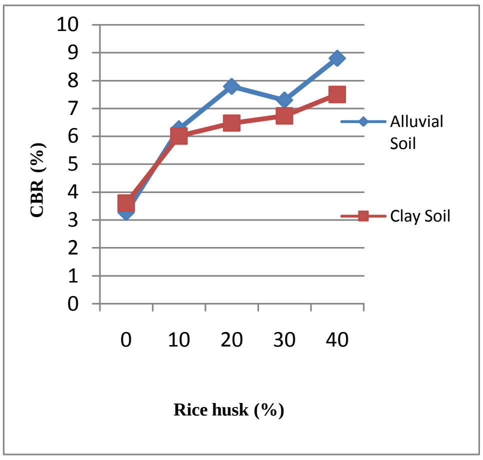

Fig. 1.5 Graphical representation of CBR with unsoaked sample and different percentages of rice husk in alluvial and clayey soils

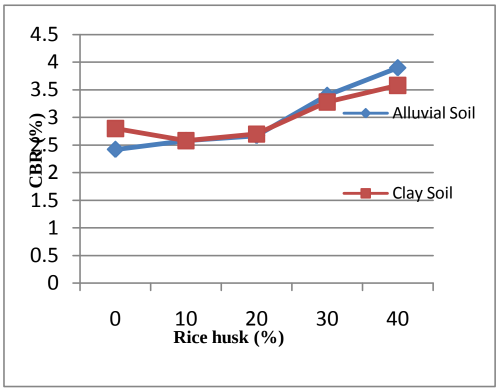

Fig. 1.6 Graphical representation of CBR with unsoaked sample and different percentages of rice husk in alluvial and clayey soils

7. CONCLUSIONS

The effect of rice husk ash in alluvial soil and clay soil on the index properties, compaction characteristics and CBR values were analyzed. From the results the following conclusions are drawn:

- The unsoaked CBR value of the soil increases from 3.27 to 8.80 whereas soaked CBR value from 2.42 to 3.90 only in the case of addition of rice husk to alluvial soil. The unsoaked CBR value in the case of addition of rice husk to clay soil increased from 3.60 to 7.50 and the soaked CBR value 2.80 to 3.58.
- The liquid limit and plastic limit of the soil decreased steeply with the increase in the %age of rice husk. In case of alluvial soil the liquid limit and plastic limit decreased from a value of 49.00% to 33.54% and 25.50% to 17.77% for the same quantum of addition of rice husk and in case of clay soil the liquid limit and plastic limit is also decreases with the increases of %age of rice husk i.e. reduced from 52.00% to 39.00% and from 27% to 20.50%. Free Swell index is also decrease in both soils with increase in %age of rice husk i.e. 57.00% to 35.93% and 58% to 18.83%.
- The maximum and minimum dry density of alluvial soil is 16.39kN/m3 and 19.38kN/m3 respectively. The Optimum moisture content decreased steeply with % RHA 17.8% to 16.00%. The maximum and minimum dry density of clayey soils is 16.39kN/m3 and 17.98kN/m3 respectively. The Optimum moisture content decreased steeply with % RHA 17.8% to 15.80%.
- The limitation of used of rice husk is that it is used in rice cropping areas. Further its use solves to a certain extend the waste disposal as well.

  Based on above findings addition of rice husk at rate of 30% by weight of soil is best.

8. SCOPE FOR FUTURE WORK

Instead of rice husk some other stabilizing additive like lime, rice bran, sugar mill waste, foundry waste be used.