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Utilization of Rice Husk Ash in Highways

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Abstract:- **Rice husk is major agricultural by-product obtained from the food crop of paddy. So far it has been totally a waste material posing difficulty problem of disposal wherever it is produced. Rice husk is formed to contain highly reactive silica of the magnitude of 80% to 97% which possesses excellent pozzolanic properties, equivalent to silica fume when ground to fine powder. In this study, various experiments have been conducted for optimum stabilization of sub grade soil to improve the engineering properties of soil.**

1. INTRODUCTION

To achieve economy in construction, we should maximize the use of local material. Emerging trend is use of waste material in soil stabilization due to excessive production of waste material like plastics, fly ash, rice husk ash, etc.

Use of rice husk ash in embankments is also an important option in road construction material not only for economic consideration but also for environment consideration.

Rice husk contains 16%-18% pure silica by weight and on burning the rice husk yields 20%-25% ash with more than 90% silica.

About 35 million ton of paddy is produced in India, which yields more than 7 million ton of rice husk annually. One ton of rice husk on completion of combustion, produces 200 kg of ash.

2. SCOPE OF STUDY

The utilization of rice husk ash in highway as sub grade material has not gained popularity in India because of lack of information regarding the change in properties of sub grade soil blended with rice husk ash.

The main objective of present study is to analyse the change of properties of various type of soils by using rice husk ash.

3. REVIEW OF LITERATURE

Research in the use of rice husk in the recent past suggests several ways of its utilization and those relating to the development of material of construction are very important. These uses have the potential not only for a large scale consumption of rice husk but also for creating employment opportunities.

Although most of the work has been done on the rice husk ash produced in the laboratory under controlled conditions earlier attempts in the direction consisted in making building units from rice husk ash and hydrated lime by hydrothermal treatments

Subsequent work by Dr. P.K. Mehta of California University showed that sufficiently good quality product comparable to Portland cement could be made by the combination of hydrated lime and rice husk and produced at optimum temperature of burning under controlled conditions.

The central building research institute, Roorkee, India has adopted two new approaches in the utilization of rice husk by converting it into ashes. The first process consists of making rice husk ash pozzolana by burning rice husk ash balls or cakes bonded with clay. Almost carbon free ash quality of hydrated lime to produce a cementacious material. The balls or cakes burn quickly and completely as against the heap of husk, which burns very slowly and produces ash with an appreciable quantity of unburnt carbon. The same is also with the furnace where rice husk is commonly used as fuel.

The second process of CBRI is a further extension of the above approach. In place of clay, waste powdery calcium carbonate (known as lime sludge of sugar, paper and other industries) has been used. As a result of burning, fuel value of rice husk is used to convert calcium carbonate to lime and resulting ash is a mixture of lime and rice husk silica, which possesses hydraulic properties.

Considering the plentiful availability of rice husk, the improved performance of rice husk ash, concrete as a supplementary cementing material , investigation are carried out to study the properties and behaviour of RH.

3.1. NATURE OF RICE HUSK

Dehusking of paddy is carried out in shelter or huller type of dehusking machine. Rice husk or hull is the outer covering on the rice grains and constitute approximately one-fifth of paddy by weight. During process of shelling the outer covering is separated from the grains and is obtained as rice husk which is a waste material.

Rice husk is composed of two parts-

1. Organic matter
2. Inorganic matter

Organic matter constitutes approximately 70%-80% by weight of the dry hull composition of both organic and inorganic part varies considerably depending upon-

a) The strain of rice
b) Temperature
c) Geological distribution
d) Agricultural practices. Etc.

Average composition of rice husk-

Composition	Percentage by weight
1. Water	2-11.5
2. Crude protein	1.5-7
3. Crude fat	0.5-3
4. Nitrogen free extract	24.5-38.8
5. Crude fibre	31.5-50
6. Pentosans	16-22
7. Cellulose	34-45
8. Ash	15-30
	20-47.5

3.2 PHYSICAL PROPERTIES OF RICE HUSK

The husk is abrasive in nature due to presence of silica. Some of the physical properties are-

Name	Properties
1. Colour	Straw or gold
2. Length	4.5 mm
3. Hardness	6 (Mohr's scale)
4. Density	True density -672 kg/m^3 Bulk density – 96-100 kg/m^3
5. Thermal conductivity	3.35 K cal-cm/gm^2 ^{0}C 35 ^{0} (ungrounded)
6. Angle of response	2800-3700 K cal/kg
7. Fuel value	

3.3 PROPERTIES OF RHA

There is a presence of reactive amorphous silica in RHA, thus it is a source of pozzolana in the production of lime pozzolana type of blended cement. Development of many such products has been reported. Some of these are based on RHA produced by burning the husk in a controlled temperature furnace and some are based on RHA obtained from the rice mill boilers.

The pozzolanic properties of RHA will largely depend on the temperature provided. As the ash content of rice husk varies considerably the chemical constituent of RHA which affects the reactivity.

Another important factor which affects the pozzolanic property of RHA is the fineness to which it is ground.

The RHA is primarily composed of silica oxide (87.2%), potassium oxide (3.68%) and unburnt carbon (5.95%) where potassium oxide is originated mainly from soil or due to the use of fertilizers.

3.4 REACTIVITY OF RICE HUSK ASH

Rice husk ash contains amorphous silica which is highly reactive ash is produced by a process of incineration and its reactivity is controlled by the thermal treatment, oxidation conditions, morphology of the hull, etc. Under suitably controlled condition, it is possible to produce ash with a large specific surface and high reactivity.

3.5AVAILABILTY AND DISPOSAL OF RICE HUSK

Many efforts are made to assess the availability and disposal of rice husk in India which indicates that in all high productivity rice cultivating areas there are many centres of processing paddy, which produces an average of 25,000 tons of paddy husk per year.

Ash produced in the different industries is partly used by the farmers as fertilizers and also for the aeration of the soil. Most of the ash is generally dumped outside, which is carried away by the wind, rain water and by other ways, causing different ecological and health problems.

3.6 USES OF RICE HUSK ASH

The rice husk ash can be used in place of fine aggregates or sand. After its combination with lime will leads to gain in some binding property, so it can be used as a partial substitute for cement. Rice husk is the former product which is used in its natural form i.e. as obtained from the rice milling factory, whereas the latter product is obtained by burning rice husk at a controlled temperature. After burning it requires a grinding machine to grind it into the powdered form. It is clear that different equipments such as furnace and grinding machine are required in the treatment process. As a result, the scheme of using rice husk ash as a partial substitute for cement is feasible only when the rice husk ash is available in abundant quantity. The main advantage of using rice husk ash in place of the sand is that it reduces the unit weight when compared with clay bricks or cement mortar blocks. Hence this will reduce the overall weight of the superstructure, which ultimately reduces the foundation cost. The use of the light weight blocks could results in high rise buildings in the countries where the foundation is the major problem.

As the colour of the rice husk ash is black so it can also be used to make permanent black concrete for glare free pavements and architectural applications.

1. Some studies have shown that the mixing of lime with the expansive soil will leads to decrease in maximum dry density and increases the optimum moisture content. The addition of rice husk ash to the expansive soil treated with lime will further decreases the maximum dry density and increases the optimum moisture content. Soaked CBR values of soil + lime + RHA are much higher than those of the corresponding soil.
2. The studies also have concluded that when RHA is used as secondary additive along with lime and cement, then it contributes to development of strength upto certain extent.
3. As compared to untreated soil, the RHA slightly increases the coefficient of consolidation. In combination with lime, it considerably decreases the compression index.
4. RHA is found to be a very good source material for making blended Portland rice husk ash cement by integration. This results in the high early strength, good long term durability, better acid resistant properties and better ultimate strength then Portland cement.

5. The rice husk ash is when mixed with sand and lime with suitable proportion and desired quantity of water, can be used to cast bricks/ pavement blocks.
6. Rice husk ash is highly resistant to acidic environment.
7. Rice husk ash is also suitable for masonry mortar, foundation concrete and mass concrete work.

4. EXPERIMENTAL ACTIVITIES:

OMC (optimum moisture content): This test was performed to determine the maximum dry density and optimum moisture content of Rice husk ash, sand, clay and silt separately.
CBR (California Bearing Ratio): In this test the CBR of different soils with Rice husk ash with varying proportions was calculated and after that the lime was also added to check the change in the CBR values for all soils with rice husk ash and with the addition of lime.

5. RESULTS AND CONCLUSIONS:

5.1 RESULTS:

TABLE 1. OMC of Rice Husk ash

Weight of mould (W_m) gm	4064	4064	4064	4064	4064
Volume of mould (V_m)	944	944	944	944	944
Weight of mould + Compacted soil (W) gm	4948.5	5008.5	5168.5	5090.0	4997.5
Weight of container (W_1) gm	10	12	12.5	12	12
Weight of container + Wet soil (W_2) gm	42.5	40.5	50.5	47.5	50
Weight of container + Dry soil (W_3) gm	36.5	34.5	40.5	37.5	37.5
Wet Density (ρ_d) gm/cc	0.937	1.001	1.17	1.087	0.989
Moisture content (w)%	23.08	26.67	35.71	39.22	49.02
Dry density (ρ_d) gm/cc	0.761	0.79	0.862	0.781	0.664

TABLE 2. OMC of Clay

Weight of mould (W_m) gm	4064	4064	4064	4064	4064
Volume of mould (V_m)	944	944	944	944	944
Weight of mould + Compacted soil (W) gm	6045	6155	6145	6145	6015
Weight of container (W_1) gm	11	11	9	10	12
Weight of container + Wet soil (W_2) gm	72	73	65	70	76
Weight of container + Dry soil (W_3) gm	65.0	64.5	57.0	61.0	64.5
Wet Density (ρ_d) gm/cc	2.009	2.215	2.204	2.204	2.067
Moisture content (w)%	12.96	15.89	16.67	17.82	21.90
Dry density (ρ_d) gm/cc	1.858	1.911	1.89	1.87	1.695

TABLE 3. OMC of Silt

Weight of mould (W_m) gm	4064	4064	4064	4064	4064
Volume of mould (V_m)	944	944	944	944	944
Weight of mould + Compacted soil (W) gm	5890.5	6055	6099	6033	6015
Weight of container (W_1) gm	10.5	11.5	10.0	11.5	12.5
Weight of container + Wet soil (W_2) gm	65.5	65.0	93.5	78.5	68.0
Weight of container + Dry soil (W_3) gm	62.5	60.0	84.5	70.5	60.5
Wet Density (ρ_d) gm/cc	1.935	2.109	2.156	2.086	2.067
Moisture content (w)%	5.769	10.309	12.081	13.559	15.630
Dry density (ρ_d) gm/cc	1.829	1.912	1.923	1.837	1.787

TABLE 4. OMC of Sand

Weight of mould (W_m) gm	4064	4064	4064	4064	4064
Volume of mould (V_m)	944	944	944	944	944
Weight of mould + Compacted soil (W) gm	5462.0	5523.5	5602.5	5634.5	5667.5
Weight of container (W_1) gm	11.5	12.5	10.0	10.5	9.0
Weight of container + Wet soil (W_2) gm	54.0	63.5	61.5	65.5	65.0
Weight of container + Dry soil (W_3) gm	52.75	61.5	58.75	62.0	60.0
Wet Density (ρ_d) gm/cc	1.48	1.55	1.63	1.66	1.70
Moisture content (w)%	3.03	4.08	5.64	6.80	9.80
Dry density (ρ_d) gm/cc	1.437	1.485	1.543	1.558	1.547

TABLE 5. Maximum Dry Density and OMC

S.No.	**Type of soil**	**rd gm/cc**	**OMC %**
1.	Rice Husk ash	0.862	35.71
2.	Clay	1.911	15.89
3.	Silt	1.923	12.08
4.	Sand	1.558	6.80

TABLE 6. CBR values for different types of Soils

CLAY	SILT	SAND	RHA
2.11	2.54	3.81	4.86

TABLE 7. CBR values for different types of Soils + RHA

	85% + 15%	70% + 30%	55% + 45%
CLAY + RHA	1.06	0.63	1.90
SILT + RHA	2.11	1.90	4.23
SAND + RHA	4.12	4.44	3.38

TABLE 8. CBR values of different soils with addition of lime

Penetration (mm)	Lime (%age)	RHA + Lime	Clay + Lime	Silt + Lime	Sand + Lime
2.5	2	11.10	13.32	7.93	3.17
	4	11.42	17.13	18.71	5.93
	6	14.91	20.30	22.20	4.44
	8	17.76	20.93	22.84	2.85
5	2	12.69	10.99	8.46	2.54
	4	13.53	21.57	22.41	4.23
	6	15.22	26.01	25.37	4.02
	8	17.76	27.49	27.91	2.75

Table 9. CBR values for different types of Soils + RHA + lime

Proportion (%)	81% + 15% + 4%	66% + 15% + 4%	51% + 45% + 4%
CLAY + RHA + LIME	13.53	13.32	14.17
SILT + RHA + LIME	17.55	10.15	14.38
SAND + RHA + LIME	7.61	7.19	5.17

6. CONCLUSIONS

The California bearing ratios for different soil are as under-

FOR SAND- if rice husk is added to sand then it tends to increase the CBR value of soil marginally from 3.81 – 4.44, but if lime is used with RHA, CBR value increases from 3.81- 7.61.

FOR SILT- if rice husk is added to silt then CBR value of soil increases from 2.54- 4.23, but if lime is added with RHA, CBR value increase from 2.54- 14.38.

FOR CLAY- if rice husk is added to clay then CBR value of soil remains unaltered i.e. 2.11, but if lime is used with RHA then there is a substantial increase in CBR value from 2.11- 14.17.

FOR RHA- it can be used as a filling material or in embankment with a suitable soil cover.

7. REFERENCES

1. Khanna S.K & Justo C.E.G., "Highway Engineering", Nem Chand & Bros, Roorkee, 1998
2. Khanna S.K & Justo C.E.G., "Highway Material Testing Manual", Nem Chand & Bros, Roorkee, 1998
3. Head K.H., "Manual of Soil Laboratory Testing", Vol.1, Engineering Laboratory Equipment Ltd., London 1964.
4. Head K.H., "Manual of Soil Laboratory Testing", Vol.2, Engineering Laboratory Equipment Ltd., London 1964.
5. Laboratory Equipment Ltd., London 1964.
6. I.R.C., 37-1970; Guidelines for the Design of Flexible Pavements", New Delhi
7. I.R.C., 51-1922; Use of Soil of Lime Mix in Roads".
8. Slvaraj & Srinivasan , "Rice Husk Ash In Concrete: An Overview", New Building Material & Construction World; July 2002; pp. 50-56.
9. Datta R.K., Kalyan Dass & Gupta P.C, " Some Alternate Binders Based On Rice Husk & Other Cheap/ Waste Materials", National Seminar On Building Materials & Their Science & Technology, Institution of Engineers (India), CBRI, Roorkee; 15-16 April, 1982