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Application of Two Industrial Wastes Rice Husk Ash and Crusher Dust as Embankment and Sub-Grade Materials

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Abstract-Crusher dust and Rice Husk Ash are the two prominent industrial wastes, which are producing in huge quantities. In the recent times application of these two industrial wastes, have been gaining importance. In the present study various percentages of crusher dust were added to Rice Husk Ash and tests like compaction, strength tests were performed. From the test results, it is identified that increasing percentage of crusher dust increases strength values. 30% replacement of Rice Husk Ash with crusher dust gives an angle of shearing resistance as 38^0 and CBR as 10. Hence 30% replacement of Rice Husk Ash by crusher dust can be used as geotechnical construction material.

***Index Terms*—CBR, Compaction, Crusher Dust, Rice Husk Ash.**

I. INTRODUCTION

Increasing road networks demands huge quantities of roads. Construction of pavements require large quantities of natural soils as there construction material in embankments, fill and Sub-grade material. Soils having plastic fines gets deformed and overstressed with high wheel stresses under saturated condition due to this behavior soil structures experiencing various modes of failures in the form of excess settlement as increases the maintenance cost. In recent times alternative materials like industrial wastes have been searching to reduce impact on the functioning of structures. RHA and CD are two industrial wastes, RHA obtained from burning of Rice Husk as CD obtained from crushing stone industry these two industrial wastes have inherent advantages for the partial replacement of RHA by Crusher dust , various percentages of CD such as 10,20,30…50 were added and studied engineering behavior. Arun Kumar .U et.al (2016)[2] studied on Impact of Industrial Wastes Utilization as Granular Sub Base (GSB) Material in Flexible Pavement Construction .Ramadas and kumar et.al (2010)[7] repeated that the combination of fly ash and stone dust found to be suitable for reducing swelling characteristics and improve the strength of expansive soils.

II. MATERIALS

To study the performance of Rice husk ash in partial replacement with crusher dust as geotechnical material in the construction of roads, the following test program has done.

A. CRUSHER DUST

Crusher Dust was obtained from local stone crushing plants near Visakhapatnam, Andhra Pradesh and subjected to various geotechnical characteristics and results are shown in table-1 and figure-1(a) &1(b)

Table -1: Geotechnical properties of Crusher dust

Property	**Values**
Gravel (%)	4
Sand (%)	92
Fines (%)	4
a. Silt (%)	4
b. Clay (%)	0
Liquid Limit (%)	NP
Plastic Limit (%)	NP
I.S Classification	SW
Specific gravity	2.66
Optimum moisture content (OMC) (%)	11
Maximum dry density (MDD) (g/cc)	2.02
Angle of shearing resistance(º)	38
California bearing ratio CBR (%) (Soaked)	12
Coefficient of uniformity (Cu)	10.83
Coefficient of curvature (Cc)	1.02
Coefficient of Permeability(k) (cm/s)	$3.4*10^{-3}$

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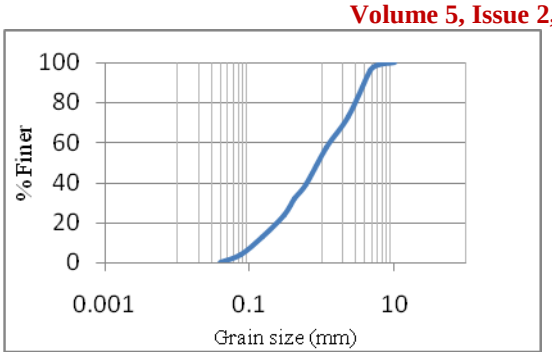

Fig-1(a): Grain size distribution curve

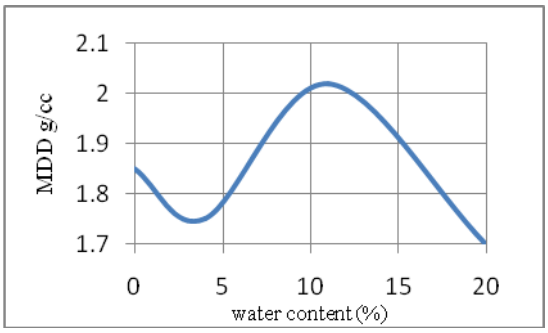

Fig-1(b): Compaction curve for CD

From the test results of crusher dust, the following identifications are made. The grain size distribution of crusher dust shows that it consists of 92% of sand size and 4% of silt size particles. It is equally dominated by particles of coarse, medium and fine sand sizes with rough surface texture. Based on BIS, it is classified as well graded particles with non-plastic fines (SW) with C_u as 10.83 and C_c as 1.02. Compaction characteristics of crusher dust under modified compaction test have an Optimum Moisture Content of 11% and Maximum Dry Density of 2.02 g/cc. From the compaction curve it can also be seen that crusher dust attains higher densities with wider range of moisture contents and increases the workability at high moisture contents. Regarding strength characteristics, it has an angle of shearing resistance (Ø) of 38^0 under undrained condition and CBR of 12% .It has coefficient of permeability of 3.4 $x10^{-3}$cm/sec. Hence it is identified that it has good strength and drainage characteristics.

B. RICE HUSK ASH (RHA)

Rice husk ash (RHA) was collected from Tekkali, Srikakulam, Andhra Pradesh. The collected Rice husk ash was dried and subjected for various geo-technical characterizations such as gradation, compaction, strength, permeability etc. and the test results are shown in table-2 and Fig-2(a) &2(b).

Table-2: Geotechnical properties of RHA

Property	Values
Gravel (%)	0
Sand (%)	84
Fines (%)	16
a. Silt (%)	16
b. Clay (%)	0
Liquid Limit (%)	NP
Plastic Limit (%)	NP
I.S Classification	SM
Specific gravity	1.8
Optimum moisture content (OMC) (%)	38
Maximum dry density (MDD) (g/cc)	0.7
Angle of Shearing Resistance (deg)	36
California bearing ratio (CBR) (%)	8
Coefficient of uniformity (Cu)	9.14
Coefficient of curvature (Cc)	1.75
Coefficient of Permeability(k) (cm/s)	$1.74x10^{-3}$
Volume(cc) of RHA for a mass of 10 g	35

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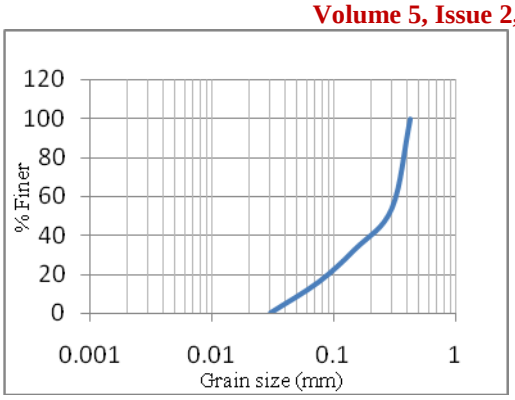

Fig-2(a): Gradation curve for RHA

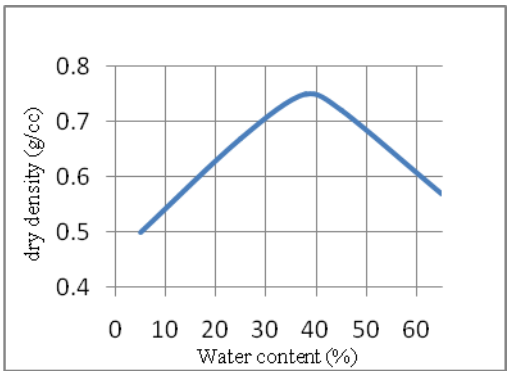

Fig-2(b): Compaction curve for RHA

From the test results of Rice husk ash the following identifications are made. Majority of Rice husk ash particles are under fine sand range and of angular & elongated with rough surface texture. The gradation also shows it comes under zone IV. Based on BIS it is classified as poorly graded silty sand non-plastic and incompressible fines (SM)

Compaction characteristics of Rice husk ash under modified Proctor test have OMC of 38% and MDD of 0.7 g/cc. From the compaction curve it can be seen that Rice husk ash attains lower densities for wider variation in moisture contents. Regarding strength characteristics it has an angle of shearing resistance (Ø) of 36 degrees under un-drained condition and CBR of 8% and has good drainage characteristics with coefficient of permeability as $1.74 * 10^{-3}$ cm/sec. Comparing the above characteristics of crusher dust with Rice husk ash, crusher dust attained high dry densities with less wider variation of moisture contents by maintaining due to nature of particles with low specific gravity, porous and distribution of particles.

III. RESULTS AND DISCUSSION

Various percentages of Crusher Dust such as 10%,20%,30%.....50% were added to Rice husk ash and the mixes are listed below in table-3 and subjected for geotechnical characteristics like compaction, angle of shearing resistance and CBR tests as per IS 2720.

Table –3: RHA-CRUSHER DUST MIXES

RHA (%)	100	90	80	70	60	50
Crusher dust (%)	0	10	20	30	40	50
Mixes	M_1	M_2	M_3	M_4	M_5	M_6

Performance of crusher dust and RHA mixes

Mixes of crusher dust - Rice husk ash such as M1,M2.....M6 were subjected to heavy compaction by compacting the samples with a rammer of 4.89 kgs, five layers and each layer was subjected to 25 blows and their optimum moisture contents and maximum dry densities were determined as per IS 2720 part 8(1983). To know the shear parameter (φ) these samples were compacted at their maximum dry densities in the shear box apparatus and tested at a strain rate of 1.25 mm/min as per IS 2720-part 13(1986). CBR characteristics were obtained by compacting CD-RHA particles in the CBR mould at their maximum dry densities and soaked for four days and tested at a strain rate of 1.25mm/min as per IS 2720: part 16 (1987) and the results are shown in table-4 and fig-3(a),3(b),3(c),and 3(d).

Table-4: Geotechnical properties of crusher dust and RHA mixes

MIXES	RHA (%)+Crusher dust(%)	OMC (%)	MDD (g/cc)	Ø(deg)	CBR (%)
M_1	100+0	38	0.75	36	8
M_2	90+10	35.5	1	37	9
M_3	80+20	32.5	1.14	37.5	10
M_4	70+30	30.4	1.26	38	11
M_5	60+40	27.8	1.4	38	12
M_6	50+50	25	1.54	38.5	13

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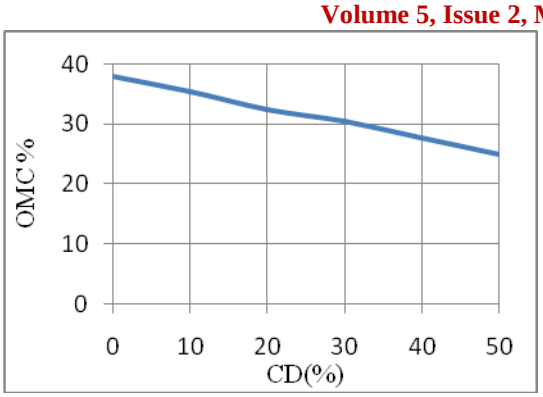

Fig.3 (a) CD (%) Vs OMC

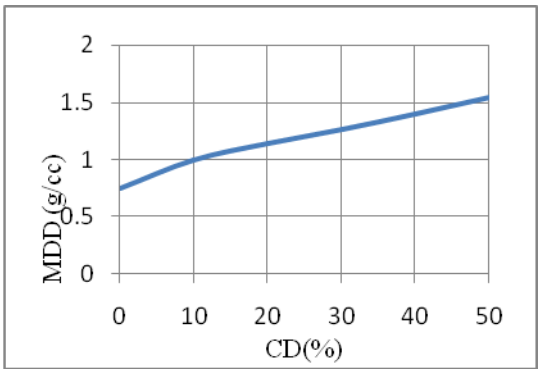

Fig.3 (b) CD (%) Vs MDD

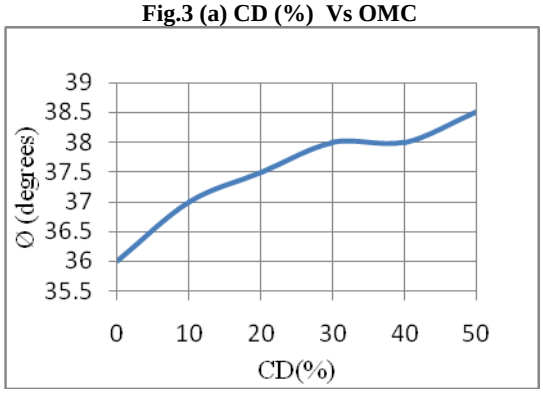

Fig – 3(b) CD (%) Vs Ø

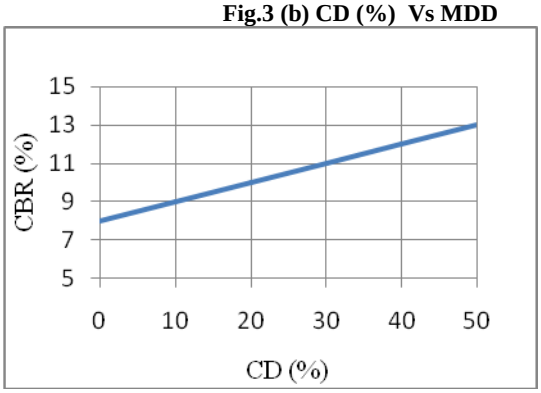

Fig3(c) CD (%) Vs CBR

From the compaction test data it is observed that as the percentage of Crusher Dust is increasing, optimum moisture content values are decreasing and maximum dry density values are increasing. A rapid decrease in OMC and increase in MDD values were observed. At low percentages of crusher dust, the behavior of Rice Husk Ash is dominating, at high percentages of crusher dust the behavior of Crusher dust particles is dominating in the mixes. The Rapid decrease in OMC is due to the shape and nature of Rice husk ash particles, where as rapid decreasing dry densities is due to low specific gravity and replacement of Rice husk ash with crusher dust particles.

From the shear test data it is observed that as the percentage of crusher dust is increasing, the angle of shearing resistance values are increasing. Maximum values were attained at a dosage of 50%.The Increase in angle of shearing resistance values is due to the development of high frictional resistance and attainment of dense condition against shear. Hence a combination of crusher dust and 50% crusher dust particles mobilizes more frictional resistance than individual crusher dust and Rice husk ash particle and achieved maximum angle of shearing resistance value as 38.5^0.though the shearing resistance values are getting to be constant from30-50%dosage.

The percentage of crusher dust is increasing, CBR values are increasing 8-13.Maximum value of 13% was attained at a dosage of 50% of crusher dust. Increase in CBR values are due to development of frictional resistance by filling up of formed voids in Rice husk ash and crusher dust mixes by the lower sizes of Rice husk ash and crusher dust particles. it is also identified that Hence a combination of crusher dust and Rice husk ash particles mobilizes more frictional resistance than individual crusher dust and Rice husk ash particles against compression and shear. Being Rice Husk Ash is high volume ash it is recommended to go with 30% replacement crusher dust which gives an angle of shearing resistance as 38^0 and CBR of 11 can be effectively used as geotechnical construction material.

IV. APPLICATIONS

1. Crusher dust is a coarse grained, non-plastic material with high dry densities (2.02 g/cc) and shear strength values ($\varphi=38^0$) can be used as fill & Embankment material. It is also had the CBR value 12 can be used as Sub-grade material for high traffic intensity roads such as highways and Express ways.

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2. RHA is also a coarse grained, non-plastic material with low dry densities (0.7 g/cc) and high angle of shear resistance 36^o,can also be used as embankment and fill material especially on poor grounds and also be used as Sub-grade material (CBR =8).
3. Crusher dust and Rice Husk Ash combination gives high strength values inters of φ>38.5^o. CBR 13 can be used as Fill and Sub grade material
4. RHA is a high volume ash, to maintain denseness and effective gradation 40-50% can be recommended as partial replacement of Crusher dust.

V. CONCLUSION

Industrial wastes like Crusher Dust and RHA can be effectively used as fill and Sub grade material individually and 40-50% replacement of RHA by CD can also be effectively used as Geotechnical construction material by maintaining dry densities in the range of 1.78-2.02 g/cc angle of shearing resistance in the range of 36-38.5^o where as CBR 8-13%.

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