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A Study on Effective Use of Rice Husk Ashes in Geotechnical Applications

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ABSTRACT:
RHA is an agricultural industrial waste which is nearly 100 million tons, requires huge quantities of land for its disposal. To utilize these huge quantities in several civil engineering applications, physical and engineering properties has been identified to study the quality of RHA. In this connection Gradation, Seepage, compaction, strength and chemical composition tests were conducted. Test results shows there are non-plastic, porous, elongated light weight materials and dominated by siliceous materials. These have low dry densities at high moisture contents achieved high values of shear strength ($\varphi > 36^o$) and CBR (>7) can be use as Embankment, structural fill and sub grade material. Pozzolanic nature of Rice Husk Ashes helps to achieve high strengths with chemical addictives exposed to curing

Keywords **–** Compaction, CBR, Rice Husk Ash, SEM

I. INTRODUCTION

Rice Husk Ash is an Agricultural Industrial Waste produced by burning of Rice Husk a residue from milling of paddy. In India 100 million tons of paddy is produced annually out of which 20 million tons as Rice Husk by burning it produces 20% of ash. Bulk production of Rice Husk Ash needs huge quantities of lands for its disposal and threat to environment. Construction activities have been giving opportunities for the bulk utilization of various industrial wastes. In this concern Rice Husk Ash has been studied for its bulk utilization in Geotechnical construction activities.

Researchers contributed its utilization in various fields can be summarized below. Sharma R.S et.al (2008)[7] studied lime, calcium chloride and Rice Husk Ash on engineering properties of expansive soils, Ali M et.al (2004)[3] studied Rice Husk Ash and lime on properties of Bentonite. Sabat A.K et.al (2011)[4] studied the effect of Marble dust on strength and durability of Rice Husk Ash stabilized expansive soils. Bhasin et.al (1988)[2] studied utilization waste materials for the construction of roads. Satyanarayana PVV et.al (2003)[5] studied Use of Rice Husk Ash ,Lime,and Gypsum in strengthening Subgrade vamsi mohan et al (2012)[6] studied Performance of Rice Husk Ash Bricks. Noor et.al (1990)[3] studied Rice Husk Ash and cement combinations with respect to Compaction, Compressive strength, Tensile strength and Durability aspects.

In the present study engineering properties of Rice Husk Ash have been studied with respect to compaction, strength etc for their bulk utilization in embankment material, fill material in road construction and in other civil engineering applications.

II. MATERIALS

To study the physical and engineering properties of Rice husk ashes (RHA) eight sources were identified from coastel districts of Andhra pradesh and are named as Tekkali and Narasannapeta(N.peta), in Srikakulam district, Padal peta(P.Peta), and jammu in Vizianagaram district, Maddi in Vishakapatnam district,and Sesali, Kalla, kallakuru(K.kuru) in Westgodavari districts in Andhra Pradesh. These samples were dried and tested for various physical and engineering properties.

2.1 PHYSICAL PROPERTIES:

Locations → / Property ↓	Tekkali	P Peta	N Peta	Maddi	Sesali	Kalla	K.Kuru	Jammu
Colour	light black	grey	grey	grey	Grey	grey	grey	grey
Texture	coarse	coarse	coarse	coarse	coarse	coarse	coarse	coarse
Specific Gravity(g)	1.83	1.8	1.86	1.9	1.85	1.82	1.83	1.82
Density (γ)g/cc	0.29	0.33	0.31	0.33	0.33	0.29	0.31	0.33
Volume(cc) For 10g	35	30	32	30	30	34	32	30

Table-1physical properties of Rice husk ash

From the physical identification, majority of the Rice husk ashes appear in grey colour where as Tekkali Rice husk ash in light black colour. The colour of Rice husk ash is mainly depends on the type of Rice husk, burning temperature and type and time of burning etc., These rice husk ashes have coarse texture. These Rice husk ashes occupied volume in the range of 30-35cc for a mass of 10g and exhibited density in free pouring condition are in the range of 0.29-0.33g/cc. Based on these properties these can be identified as high volume ashes It is also identified that the Rice husk ashes have obtained specific gravities are in the range of 1.8-1.9. Low specific gravities are due to presence of silica and absence of heavy metal minerals.

Hence from the observations of physical properties, Rice husk ashes can be identified as light weight, high volume, siliceous, porous with coarse texture and honeycombing arrangement of particles

2.2 ENGINEERING PROPERTIES:

To know the behavior of Rice husk ashes and to predict their engineering behavior tests like gradation, consistency, compaction, permeability, strength and compression were performed as per IS 2720 and results are shown below.

Table 4.2 Grain size Characteristics IS: 2720 Part 4, 1985

Size (mm)	% Finer								
	Tekkali	P.Peta	N.peta	Maddi	Sesali	Kalla	K. Kuru	Jammu	Ranges
10	100	100	100	100	100	100	100	100	100
4.75	100	100	100	100	100	100	100	100	100
2.36	100	100	100	100	100	100	100	100	100
1.18	100	100	100	100	100	100	100	100	100
0.6	100	100	100	100	100	100	100	100	100
0.425	100	100	100	100	100	100	100	100	100
0.3	54	51	68	54	58	55	52	56	51-68
0.15	33	35	38	35	30	25	26	28	26-38
0.075	16	18	15	16	19	15	18	17	15-19
0.03	0	2	0	2	1	1	2	0	0-2

D_{10}mm →	0.035	0.04	0.055	0.05	0.046	0.051	0.046	0.05	0.035-0.055
D_{30}	0.14	0.13	0.13	0.14	0.16	0.18	0.18	0.16	0.13-0.18
D_{50}	0.28	0.3	0.2	0.29	0.26	0.28	0.03	0.28	0.03-0.3
D_{60}	0.32	0.33	0.27	0.32	0.31	0.31	0.32	0.31	0.27-0.33
D_{90}	0.4	0.4	0.39	0.4	0.4	0.4	0.4	0.4	0.39-0.4
Cu	9.14	8.25	4.91	6.4	6.74	6.08	6.96	6.2	4.91-9.14
Cc	1.75	1.28	1.14	1.23	1.8	2.05	2.2	1.65	1.14-2.2

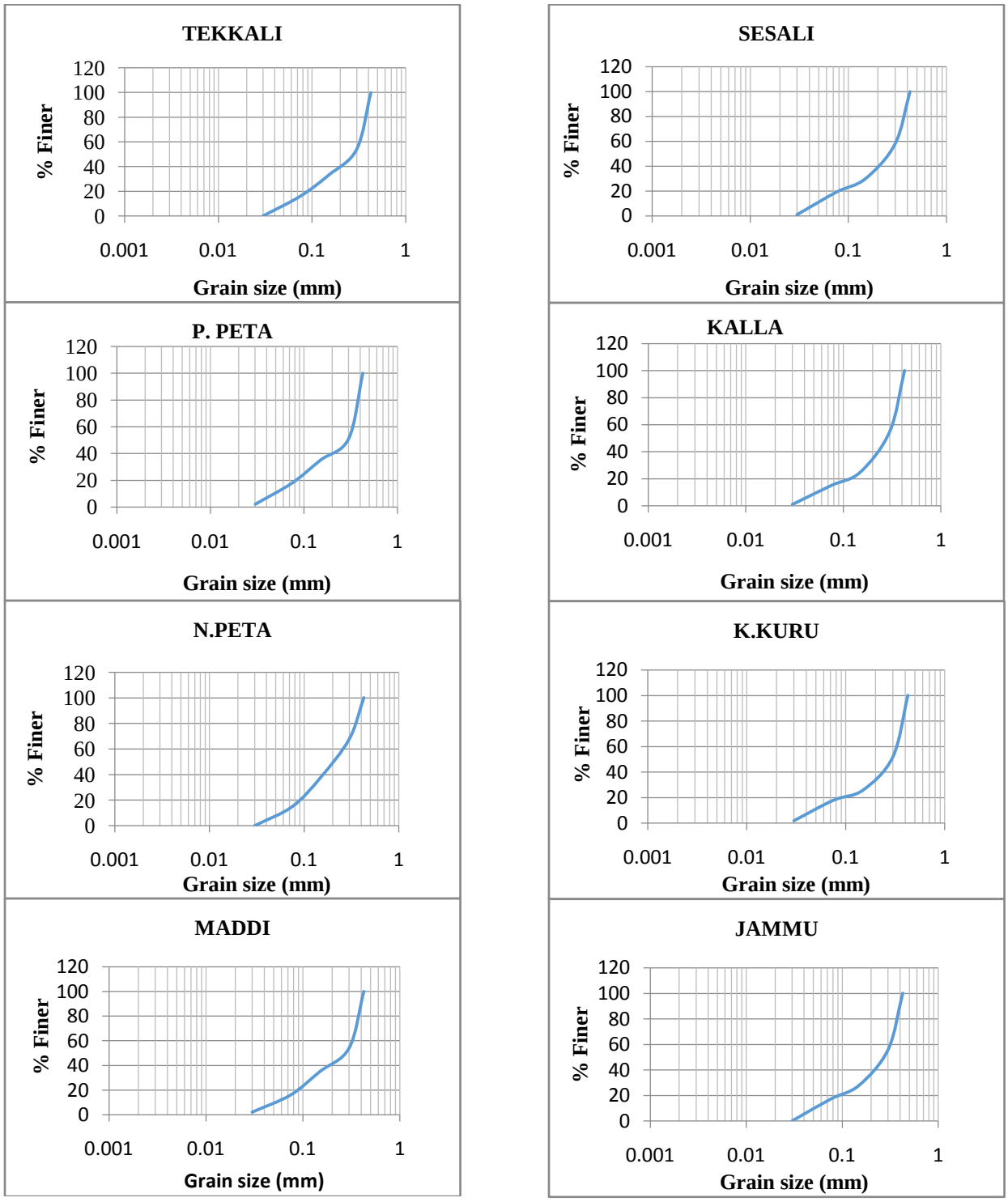

Fig.1-8 Grain size distribution curves

From the test results it is identified that all the RHAs are dominated by fine sand size particles (<425µm) it is also percentages of fines (<75µm) is the range of 15-19% the maximum size particle 425µm. And minimum size of particle is 0.03mm based on IS1498-1970.These are classified as silty sand with non-plastic nature

Table.2.Engineering Properties of Rice Husk Ashes

Property	Tekkali	P.Peta	N.Peta	Maddi	Sesali	Kalla	K.Kuru	Jammu
Optimum moisture content (%)	38	37	35	34	34.5	35.5	34	34
Max dry density(g/cc)	0.7	0.72	0.73	0.78	0.74	0.73	0.75	0.76
California bearing ratio (%)	8	8	8	8.5	7.5	7	7.5	8
Coefficient of permeability(k) cm/sec,10^{-3}	5.29	6.8	7.3	7.0	6.3	5.6	4.8	7.2
Angle of shearing resistance (Ø) 1)UU	36	37	35	37	36	35	36	37
2)CD	38	38	37	39	37	37	39	40
Loose Condition (g/cc)	0.21	0.21	0.22	0.23	0.20	0.20	0.21	0.22
Vibrator Condition(g/cc)	0.32	0.325	0.30	0.32	0.30	0.31	0.33	0.32

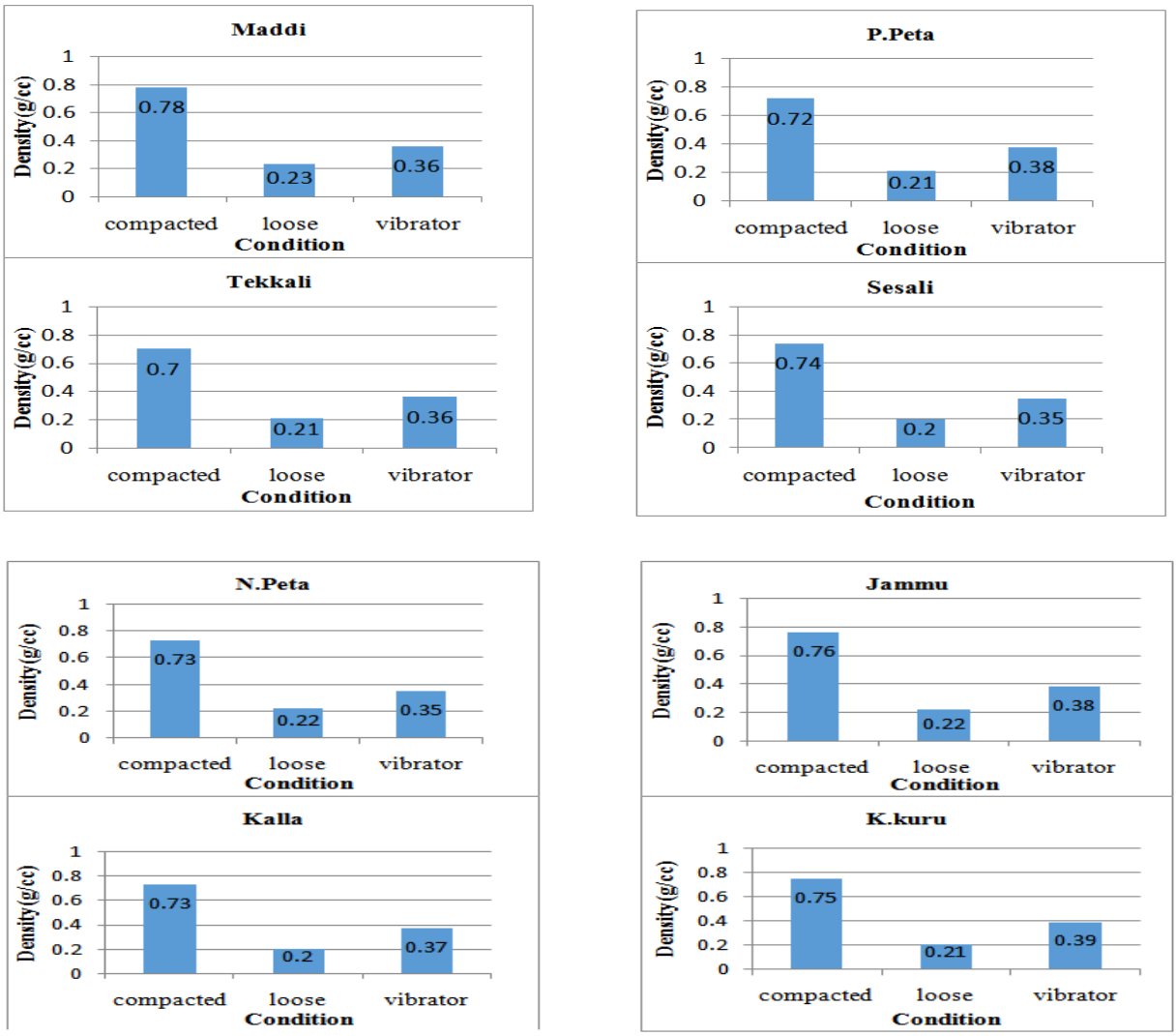

Fig.9-16 Compaction Characteristics Bar Charts

Compaction test data shows these Rice husk ashes are exhibited low dry densities in the range of 0.72-0.76g/cc and high OMC in the range of 34-38, low dry densities are due low specific gravity nature and poor graded of particles. High OMC are due to elongated, porous nature of particles. Where the ashes are in vibrated condition, the maximum density to attain the range of 0.35-0.38g/cc. where in the loose state 0.22-0.23g/cc. From the test results it is seen that RHA are attained high densities in compacted condition than in vibrated condition, this is due to the volume of water makes the RHA particles to roll and attain dense packing.

shear characteristics of Rice husk ashes show, the angle of shear resistance in undrained condition (Φ_{uu}) is in the range of 35-37^o , where as in drained condition it is 37-40^o this shows the shear resistance of rice husk ashes show good strength in drainage condition also CBR values of these rice husk ashes are in the range of 7-8.5. It shows rice husk ashes offer good resistance under compression.

CHEMICAL COMPOSITION:

Table.4.Chemical Compounds

Chemical Composition	Tekkali	P.Peta	N.Peta	Maddi	Sesali	Kalla	K.Kuru	Jammu
SiO_2 (%)	97.69	96.93	96.55	96.83	97.21	97.55	97.25	96.87
Al_2O_3(%)	0	0.67	0.26	0.31	0.46	0.53	0.51	0.58
Fe_2O_3(%)	0.22	0.43	0.22	0.28	0.12	0.15	0.18	0.35
CaO (%)	0.29	0.08	0.59	0.52	0.39	0.30	0.33	0.10
MgO (%)	0	0.30	0.48	0.40	0	0.29	0.15	0.35
Na_2O(%)	0.41	0.40	0	0.38	0	0	0	0.45
K_2O(%)	1.39	1.19	1.89	1.28	2.82	1.18	1.58	1.30

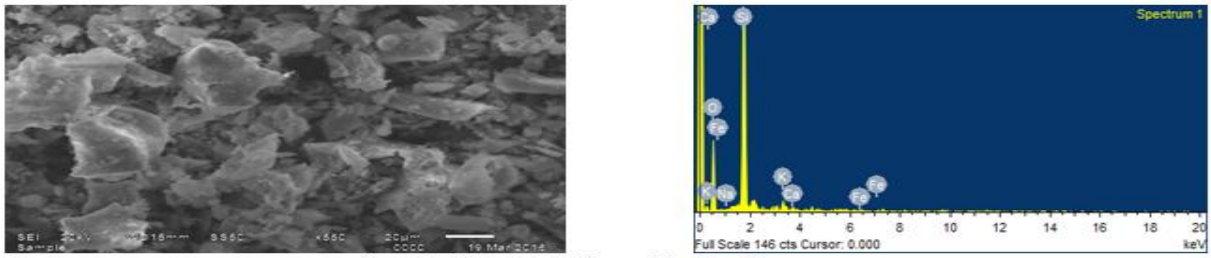

Fig 17.and 18 SEM for Tekkali soil

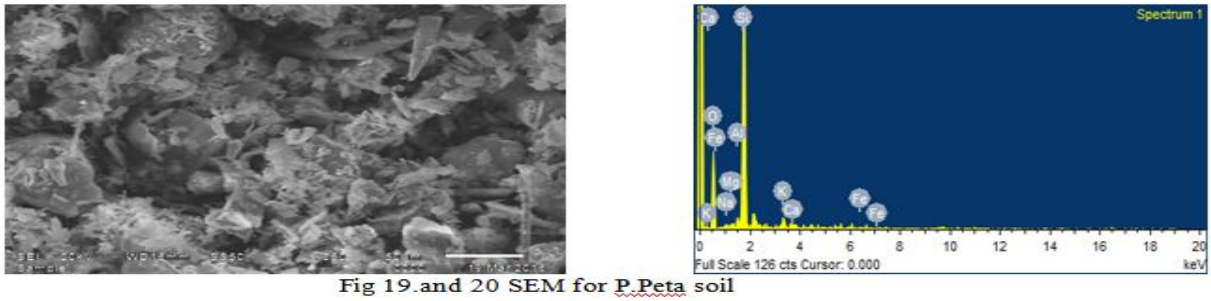

Fig 19.and 20 SEM for P.Peta soil

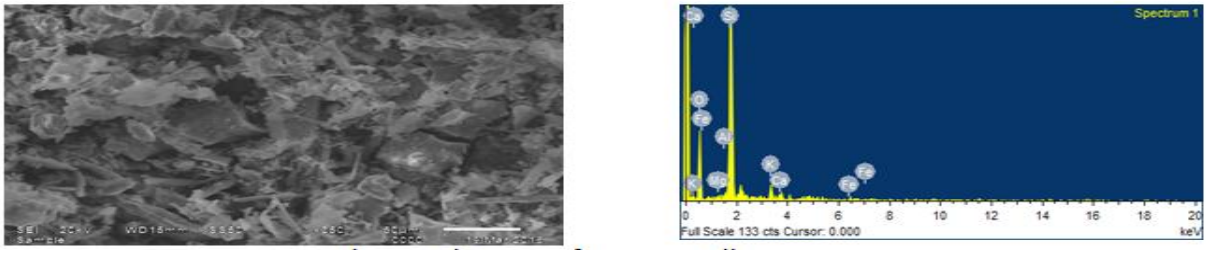

Fig 21.and 22 SEM for N.Peta soil

From the chemical composition of Rice Husk Ashes it is identified that SiO_2 is dominating as its range is 97-98% .These Rice Husk Ashes have very low percentages of CaO which is in the range of 0.08-0.59% (< 1%). Hence these non-self pozzolanic and can be pozzolanic with addictives like Lime, Cement and Sodium silicates etc.

IV. IDENTIFICATIONS AND APPLICATIONS:

1. RHAs are coarse grained, non-plastic, porous, elongated particles.
2. These have low specific gravity and poorly graded particle size distribution which gives low dry densities and High optimum moisture contents
3. Moisture contents in compacted played a big role in achieving dense.
4. Presence of very high quantities of SiO_2 makes RHAs as pozzalonic and can achieve high strength with chemical addictives with curing.
5. High strength characteristics such as high angle shear resistance and high CBR can be useful in Embankments, Fill materials and Sub grade materials in road construction.
6. It can also used in stabilization of fine grained soils Due to its inherent quantities like non-plastic and porous nature

CONCLUSIONS:

RHA'S are porous, non-plastic, low strength and siliceous and high volume material, which exhibited high strength in terms of angle of shearing resistance and CBR, can be used as Fill, Embankment and Sub Research and Applications. ISSN: 2248-9622. Pp: 1906-1910. Grade materials. Due to pozzolanic nature when there inter acted with chemical addictives these gives high strengths with curing time.

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