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A Study on the Performance of Pond Ash In Place of Sand and Red Soil as A Subgrade and Fill Material

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Abstract: ***Industrial wastes have been gaining importance as a geotechnical material in the present days. Due to specific advantages, materials like flyash, pond ash have been considered as a replacement to natural soils. In this an attempt is made to study pond ash as a geotechnical material. To study pond ash as a geotechnical material for sub-grade and fill material, tests like gradation, compaction, CBR, strength and seepage parameters etc., have been conducted on the sample and compared with sand particles. From the test results it is identified that pond ash can withstand high strength by varying moisture contents, good drainage characteristics and incompressible nature like sand particles***

Key words: ***Crusher dust, Sand, Red soil, Angle of shearing resistance, CBR.***

I. INTRODUCTION

Several hundred kilometers of roads have been running through North coastal districts of Andhra Pradesh. These roads have been lying on soils like Red soils. These soils are used as sub-grades which have lost their strength on wetting resulting failure of pavements. To improve the sub-grade and fill material on wet conditions pond ash has been selected in place of natural soils. Pond ash is a waste product obtained from burning of coal. It requires thousands of hectares of land for disposal. Annually more than 100 million tonnes is generated from power plants. Some of the earlier studies on pond ash as a geotechnical material have been mentioned below. Bera A.K et.al (2007), Raju Sarkar et.al (2009) have studied the compaction and strength characteristics of pond ash. Amalendu Ghosh et.al (2005), Venkatappa Rao. G et.al (2011) have studied the bearing capacity of geo-synthetic reinforced pond ash. Kumar. R et.al (2007), Temel Yetimoglu et.al (2005) have studied the behaviour of pond ash reinforced with randomly distributed fibres. Kolay P.K et.al (2011) used pond ash as a stabilizer of peaty soil. Sridharan et.al (1996, 1999) studied geotechnical characteristics of pond ash as a structural fill. The results showed that the use of pond ash increase the peak friction angle, peak compressive strength, CBR value. In this study pond ash has been subjected for geotechnical characteristics such as gradation, compaction, CBR, permeability and strength parameters by varying their moisture contents and compared with sand characteristics.

II. STUDY AREA

North coastal districts of Andhra Pradesh have many pockets of Red soil deposits.

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Most of the deposits contain fine sand silt particles with little amount of clay particles. Small amount of clay and silt particles make these Red soils hard at dry conditions and collapse on wet (saturated) conditions. Roads constructed on these deposits using these soils as sub-grade material have been subjected to number of failures. In the present investigation Red soil obtained from Visakhapatnam is subjected for gradation, compaction and strength characteristics. The results are shown in table -1 and figure 1&2.

Geo technical properties of red soils:

Property	Values
Grain size distribution	
Gravel (%)	0
Sand (%)	74
Fines (%)	26
a. Silt(%)	21
b. Clay(%)	5
Consistency:	
Liquid Limit (%)	24
Plastic Limit (%)	18
I.S Classification	SM-SC
Plasicity index	6
Specific gravity	2.67
Compaction characteristics	
Optimum moisture content (OMC) (%)	8.5
Maximum dry density (MDD) (g/cc)	1.9
California bearing ratio (CBR) (%) (unsoaked)	10.0
California bearing ratio (CBR) (%) (soaked)	3.0
Apparent Cohesion(C)	1.0
Angle of internal friction (Ø)	29
Coefficient of permeability(k, cm/s)	$3.4x10^{-5}$

Table-1

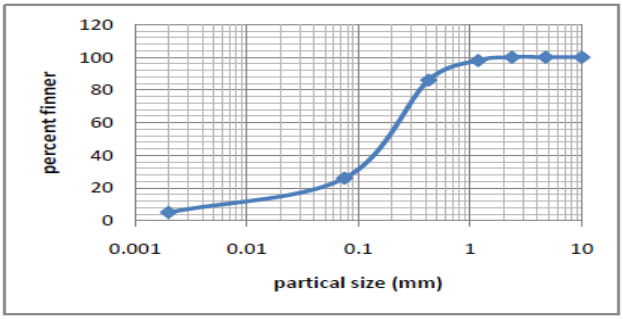

Fig-1 Particle size distribution curve of Red soil

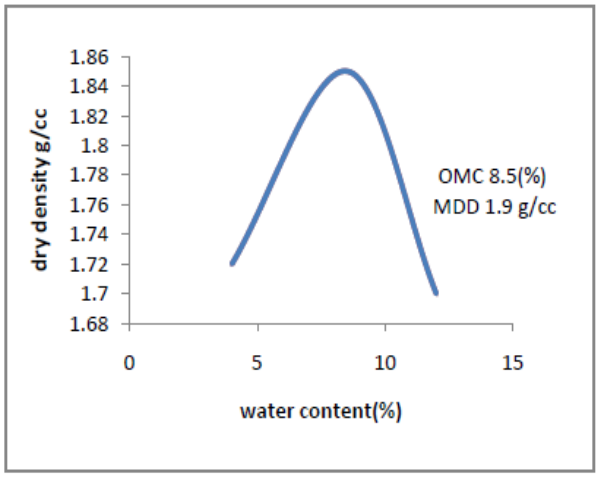

Fig-2 Compaction curve of Red soil

Variation of strength parameters of Red soil:

Water content (%)	8.5	10	12	14
C (t/m^2)	1.0	0.8	0.5	0
Ø (deg.)	29	27	25	22

Table-2

From the test results it is identified that Red soil contains 74% of fine sand 21% of silt and 5% of clay particles and it is having low plasticity characteristics (Ip=6<7). It has exhibited high maximum dry density of 1.9 g/cc and high shear strength parameters (C as 1.0 t/m^2 and Ø as 29 deg). When the soil sample is subjected for strength parameters like C, Ø and CBR on wet conditions, the following identifications are made. When the sample tested at moisture contents is higher than optimum moisture content, the apparent cohesion(C) and angle of shearing resistance (Ø) values get decreased. Moisture content just above OMC (10%) has little decrease where as at 14%, abnormal decrease in shear strength parameters was observed. This is due to loss of cohesion and friction between particles due to excess moisture contents between the particles. In the case of CBR test, it has a maximum value (10%) at unsoaked condition where as at soaked condition it has a CBR value of 3.

To introduce materials like pond ash and to study its behavior, tests like gradation, compaction and strength parameters are used. It is used to suit as sub-grade material and fill material and also to compare the result of pond ash with sand as a replacement to sand in geotechnical constructional activities.

III. MATERIALS

Pond ash was obtained from NTPC power plant, Visakhapatnam, Andhra Pradesh and sand sample was collected from river Nagavali, Srikakulam, Andhra Pradesh

IV. RESULTS

4.1 Pond ash:

Pond ash was collected from NTPC power plant, Parawada, Vishakhapatnam, Andhra Pradesh. The collected pond ash was dried and subjected to various geo-technical characterizations such as gradation, compaction, strength etc. The test results are shown in table-3 and fig 3& 4.

Geotechnical properties of Pond ash

Property	Values
Grain size distribution	
Gravel (%)	0
Sand (%)	95
Fines (%)	05
a. Silt(%)	05
b. Clay(%)	0
Consistency:	
Liquid Limit (%)	NP
Plastic Limit (%)	NP
I.S Classification	SPN
Specific gravity	2.4
Compaction characteristics	
Optimum moisture content (OMC) (%)	14
Maximum dry density (MDD) (g/cc)	1.4
Angle of shearing resistance(deg)	34
California bearing ratio (CBR) (%) (Soaked)	6.0
Coefficient of uniformity (C_u)	5.6
Coefficient of curvature (C_c)	0.86
Coefficient of permeability(k, cm/s)	2.6x10^{-3}

Table-3

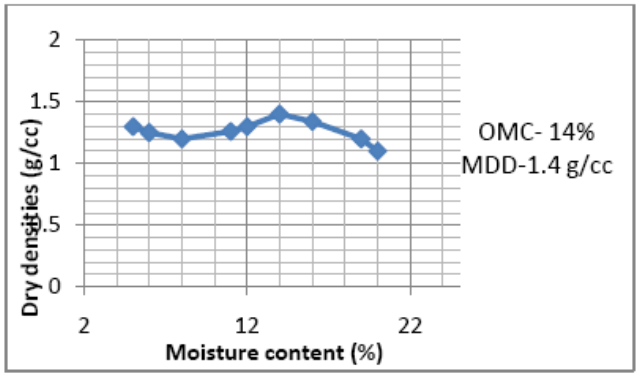

Fig-3 Compaction curve

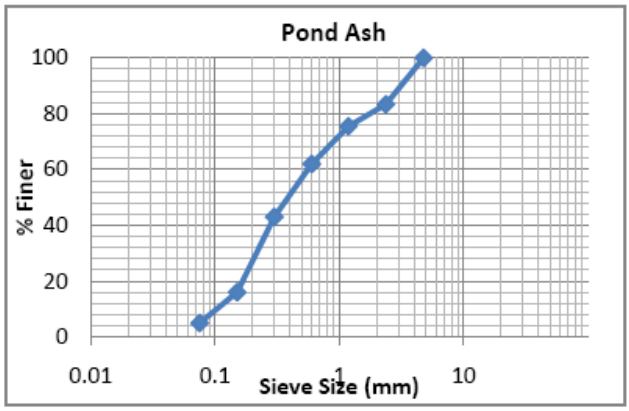

Fig-4 Particle size distribution curve of pond ash

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From the test results of pond ash, the following identifications are made. The grain size distribution of pond ash shows that it consists of 95% of sand size and 5% of silt particles. Majority of Pond ash particles are medium to fine sand ranges with rough surface texture. The gradation also shows that it comes under Zone III as per IS 383-1970. Based on BIS, it is classified as poorly graded with non-plastic fines (SPN) with C_u as 5.6 and C_c as 0.86. From the consistency data, it is identified that it is non plastic and incompressible. Compaction characteristics of pond ash under modified compaction test have an Optimum Moisture Content of 14% and Maximum Dry Density 1.4 g/cc. From the compaction curve, it can be seen that pond ash attains high densities with wider variation in moisture contents. Regarding strength characteristics, it has an angle of shearing resistance (Ø) of 34 degrees under undrained condition and CBR of 5% and coefficient of permeability as 2.6 x 10^{-3} cm/sec.

4.2 Sand:

The sand sample is collected from river Nagavali near Srikakulam district and subjected to various geotechnical characteristics and the results are shown in table -4 and fig 5 and 6

Geotechnical properties of sand:

Property	Values
Grain size distribution:	
Gravel (%)	0
Sand (%)	98
Fines (%)	2
a. Silt(%)	2
b.Clay(%)	0
Consistency:	
Liquid Limit (%)	NP
Plastic Limit (%)	NP
I.S Classification	SP
Specific gravity	2.66
Compaction characteristics:	
Optimum moisture content (OMC) (%)	6
Maximum dry density (MDD) (g/cc)	1.75
Shear parameters:	
Angle of shearing resistance(deg)	34
California bearing ratio (CBR) (%) (Soaked)	8
Coefficient of Uniformity (C_u)	2.07
Coefficient of Curvature (C_c)	1.41

Table-4

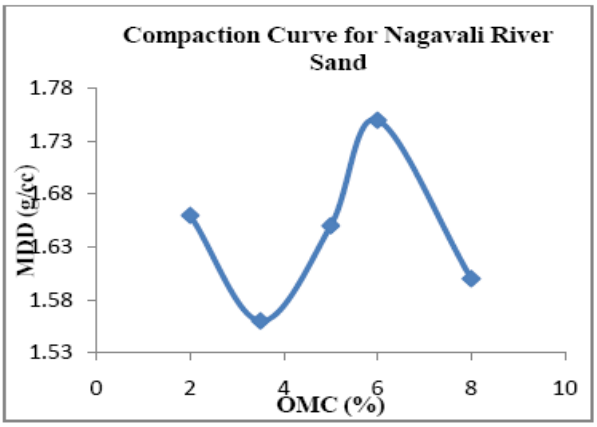

Fig-6

From the test results of Nagavali Sand, the following identifications have been made. Majority of sand particles are under Medium to Fine Sand range. The gradation also shows it comes under zone III. Based on BIS it is classified as poorly graded sand and non-plastic in nature. SP with C_u= 2.07 and C_c= 1.44. Compaction characteristics of Sand under modified Proctor test have OMC of 6% and MDD 1.75 g/cc and it is incompressible in nature. Regarding strength characteristics it has an angle of shearing resistance (Ø) as 34 degrees under undrained condition and CBR of 6%.

4.3 Angle of shearing resistance:

Pond ash and sand samples were compacted at various moisture contents and tested for shear parameters as per IS 2720 part-13 (1986). The results are shown in table 5&6, fig 7&8

Pond ash:

Water content(%)	0	2	4	6	8	10	12	14	16	18	20
	-14	-12	-10	-8	-6	-4	-2	0	+2	+4	+6
Angle of shearing resistance(degree)	28	28.5	29	30	31	32.5	33	34	33	32	30

Table-5

Sand:

Water content(%)	0	2	4	6	8	10	12	14
	-6	-4	-2	OMC	+2	+4	+6	+8
Angle of shearing resistance(degree)	28	29	32	34	32	30	27	28

Table-6

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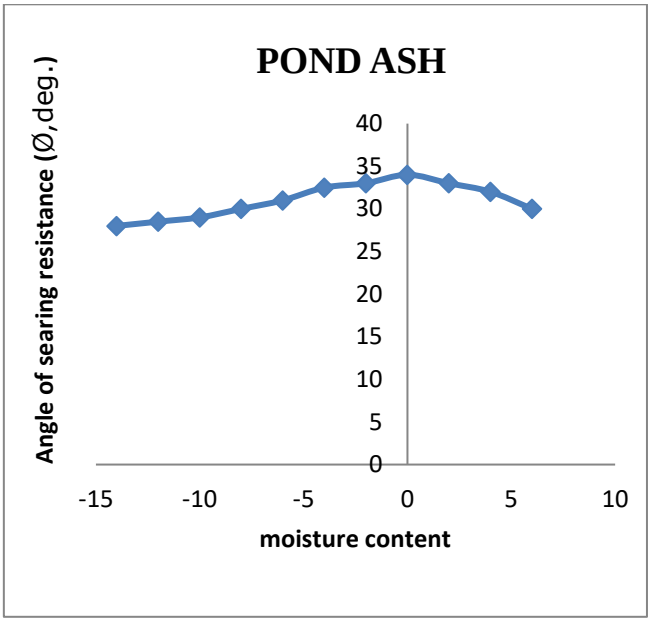

Fig-7

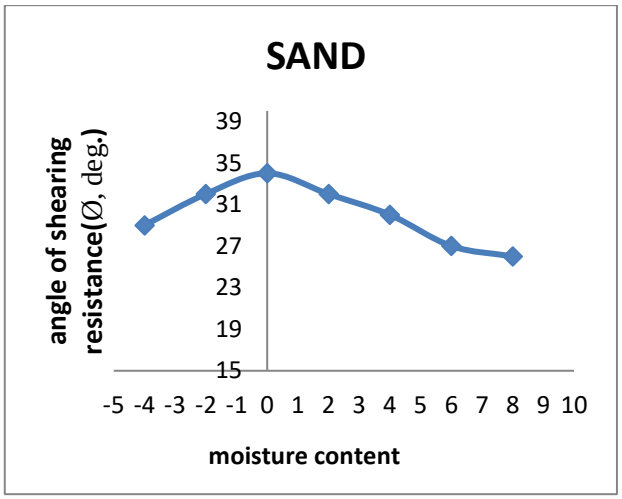

Fig-8

From the test results of pond ash it was identified that at moisture contents less than optimum moisture content (dry side) a sharp decrease in angle of shearing resistance values occurred, whereas at moisture contents higher than optimum moisture content (wet side) a marginal decrease was observed. It was also identified that high angle of shearing resistance values were observed with variation of moisture contents on wet side of optimum moisture content i.e the pond ash particles can withstand high moisture contents by maintaining high shearing resistance under shearing of particles. From the test results of sand it was observed that at higher and lower moisture contents with respect to optimum moisture content, a sharp decrease in angle of shearing resistance values occurred. Compared with the results of pond ash, sand exhibited high loss of shearing resistance for shallow range of moisture contents. Hence pond ash offers more shearing resistance at wide range of moisture contents.

Comparing the results of pond ash with Red soil, loss of shear strength in terms of cohesion and friction is high at higher moisture contents (14%), whereas pond ash exhibited highest friction force at the same moisture contents. From the CBR characteristics it was identified that pond ash attained high CBR values at high moisture contents compared to sand and red soils. Hence from the test results pond ash performed better than sand and can be used as alternative material to sands in geotechnical applications such as sub grades and fill materials.

V. CONCLUSION

Pond ash particles are similar to sand particles and offer more shear strength at wider variation of moisture contents and can withstand high strengths in terms of CBR and angle of shearing resistance which can be used as fill and sub grade material in place of Red soil and sand.

REFERENCES

1) Bera A.K., Ghosh A, Ghosh A (2007). “Compaction characteristics of pond ash”. Journal of Materials in Civil Engineering ASCE, 19 (4): 349-357.
2) David croney and Paul croney (1992) “The design and performance of road pavements” Mc Graw Hill International Edition.
3) Ghosh A. et al, (2005) “Bearing capacity of square footing on pond ash reinforced with jute-Geotextile” journal of Geotextiles and Geomembranes Volume 23 Issue 2, April 2005, Pages 144-173.
4) IS 2720 : Part 3 : Sec 2 : 1980 Test for Soils - Part III : Determination of Specific Gravity - Section 2 : Fine, Medium and Coarse Grained Soils
5) IS 2720 : Part 4 : 1985 Methods of Test for Soils - Part 4 : Grain Size Analysis
6) IS 2720 : Part 8 : 1983 Methods of Test for Soils - Part 8 : Determination of Water Content-Dry Density Relation Using Heavy Compaction
7) IS 2720 : Part 13 : 1986 Methods of Test for Soils - Part 13 : Direct Shear Test
8) IS 2720 : Part 16 : 1987 Methods of Test for Soil - Part 16 : Laboratory Determination of CBR
9) IS 2720 : Part 17 : 1986 Methods of Test for Soils - Part 17 : Laboratory Determination of Permeability
10) Kolay, P.K et al (2011), “Tropical peat soil Stabilization using class F pond ash from coal Fired power plant” World Academy of Science, Engineering and Technology pp. 74, 2011.
11) Kumar, R., Kanaujia, V.K. and Chandra, D., 2007, “Engineering Behavior of Fiber-reinforced Pond ash and Silty Sand”, Geosynthesis International, Vol.6, No. 6, pp. 509-518.
12) Ministry of Road and Highways “Pocket book for Highway engineers” published by Indian Road Congress, 2002.
13) Raju Sarkar, “Compaction characteristics of Pond ash” 10th International Symposium on Environmental Geotechnical and Sustainable Development, 2009.
14) Sridharan. A, et.al (1996), N.S. Pandian and C.Rajasekhar, Geotechnical characterization of pond ash, Ash Ponds and Ash Disposal systems (V.S.Raju et.al Eds), Narosa Publishing House, New Delhi, Pp.97-108 (1996).
15) Sridharan. A, et.al (1999), N.S. Pandian and S.Srinivas, Shear Strength Characteristics Of Pond Ash For Use As structural Fills, Fly Ash Disposal and Deposition: Beyond 2000 Ad(V. Dayal et. al., Eds), Narosa Publishing House, New Delhi (1999).
16) Temel Yetimoglu et al, “A study on bearing capacity of randomly distributed fiber reinforced sand fills overlying soft clay” Geotextiles and Geomembranes Volume 23, Issue 2, April 2005, Pages 174-183.
17) Venkatappa Rao. G et.al, (2011) “Behavior of a strip footing on compacted pond ash reinforced with coir Geotextiles” International journal of Advanced technology in Civil engineering, Vol. 1 April (2011).

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