A Study on Utilization of Crusher Dust in Place of Sand as a Geotechnical Construction Material

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Abstract— Usually, conventional materials like natural soils, broken rock pieces, sand are required for the construction of many Civil Engineering structures like rods, embankments, reclamation of grounds etc.,. Procurement of such materials in huge quantities have been becoming very difficult and presence of plastic fines in the soils causes excess deformations which proves to be costly for the maintenance of structures keeping this in mind for utilization of waste products in bulk quantities has been searched from which crusher dust was selected as an alternate material in place of sand. To evaluate the performance of crusher dust and sand mixes, tests like compaction, strength, seepage etc, were performed to study engineering parameters like density, CBR and angle of shearing resistance etc. From the test results it is identified that crusher dust –sand mixes attained high densities (γd>1.8g/cc), high CBR values (>10%), shear parameters (ϕ >360) and maintained pervious characteristics (k > cm/sec) in addition to non-plastic and incompressibility characteristics. From the test results it is concluded that 30-40% addition of sand to crusher dust yields satisfactory results and can be used as sub-grade and fill materials in various geotechnical construction activities.

Key words: Crusher Dust, Sand

I. Introduction

Areas like sub-grades, filling and cutting areas embankments and low lying areas require good quality of material for their effective functioning with respect to strength and drainage. Crusher dust and sands are such materials obtained from crushing plants and natural river beds respectively can be used in geotechnical applications. A number of researchers have made their contributions for the utilization of above said materials in various geotechnical applications. CBR and shearing resistance values can enhance their potential use as sub-base material in flexible pavements and also as an embankment material. . In the present investigations various percentages of sands such as 10%, 20%, etc., were added to crusher dust particles and the mixes were prepared and tested for compaction and strength to suit as sub-grade and fill materials.

A. *Objectives of Present Study*

- To know the geotechnical Characterization of Crusher Dust and sand.
- To know the Compaction and strength characteristics of Crusher Dust- sand mixes at various percentages of sand.

B. *Scope of Present Study*

In the present study Crusher dust was collected from Crushing stone plants and sand from Srikakulam, Visakhapatnam respectively. These industrial wastes were tested for Geotechnical Characteristics such as Gradation, Plasticity, Compaction, CBR, etc. To study the performance of Crusher Dust- sand mixes various percentage of sand was added to these Crusher dust and studied plasticity and strength characteristics. Based on the results of CBR, angle of shearing resistance and compaction the stabilized materials were checked as sub-grade and fill materials in accordance with MORTH specifications.

II. Review of Literature

Soosan et.al, (2005) studied the effect of Crusher dust on three type of soils (Red earth, kaolinite and Cochin marine clay) to improve geotechnical properties of soils for highway construction. He found that, addition of Crusher dust improved the CBR value of soil and optimum proportion being 40% of Crusher dust to 60% of soil.

Sridharanet.al (2005, 2006) studied Crusher dust in high constructions and also studied shear strength characteristics of soil-Crusher dust mixtures.

Praveen Kumar et.al, (2006) conducted California Bearing ratio CBR and static cyclic tests on flyash, coarse sand, stone dust and River bed material (RBM) for their use in sub base layer of flexible pavement.

Illongovau R, et.al, (2006) studied Crusher dust as fine aggregate in Concrete.

Nagaraj T.S (2006) also studied Crusher dust as fine aggregate in Concrete.

Praveen Kumar et.al, (2006) studied Crusher dust as sub-base material.

Reddy and Reddy (2007) reported an increasing compressive strength by use of rock flour as fine aggregate instead of river sand. Ilangovana et.al, 2008 reported the strength of Crusher dust concrete was comparably 10-12% more than that of the similar mix of conventional concrete. Satyanarayana Reddy C.N.V and M.V.Reddy (2007), "An Experimental Study on Use of Rock Flour and Insulator Ceramic Scrap in Concrete". Thesis submitted by D.JyothiSwaroop on "A study on interaction of rock flour with woven and non-woven Geotextiles”.

Hameed and sekar, (2009)studied the effect of crusher stone dust as fine sand and found the flexural strength increases than the concrete with natural sand but the value decreases as percentage of crusher dust increases.

III. Methodology

A. *Material Used*

1) *The Materials used in this Investigation are*

- Crusher Dust
- Sand

B. Laboratory Testing

C. Properties of Material

The following tests were conducted on the soil. The index and engineering properties of soil were determined.

1) Grain size analysis confirming (IS: 2720-part 4, 1985)
2) Consistency limits or Atterberg's Limits using Uppals method confirming (IS: 2720-part 5, 1985)
3) Compaction test confirming (IS: 2720- Part 8: 1983)
4) California bearing ratio test confirming (IS: 2720- Part 16: 1987)
5) Direct Shear Test (IS: 2720- Part 17, 1986)

Samples of Crusher Dust are taken as oven dried and weighed as per the volume of Direct Shear mould. Now the sample is filled in three layers in the mould and compacted for 25 blows. Before placing the sample in Direct Shear mould, porous Shearing plates are kept perpendicularly facing their grooves at top and bottom of the sample. Entire set up is now kept in the container seating and a proving ring is attached and a surcharge load of 0.5, 1.0, 1.5 and 2.0 kg/cm^2 are kept simultaneously for samples at various water contents. Now a load is applied in the horizontal direction at a strain rate of 1.25mm/min and observed for shearing in the sample. This procedure is repeated for different normal pressures.

IV. RESULTS & DISCUSSIONS

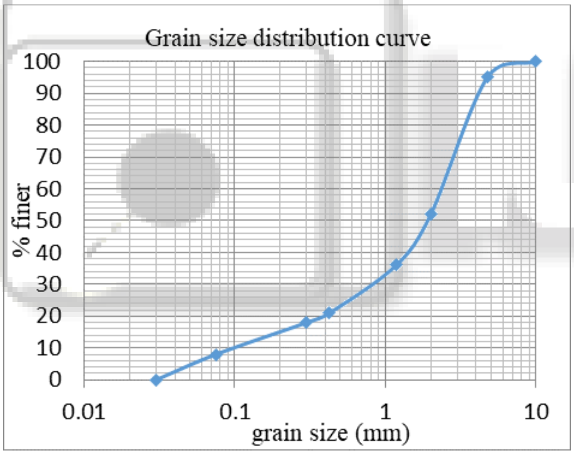

Fig. 4.1: Particle Size Distribution Curve of Crusher Dust

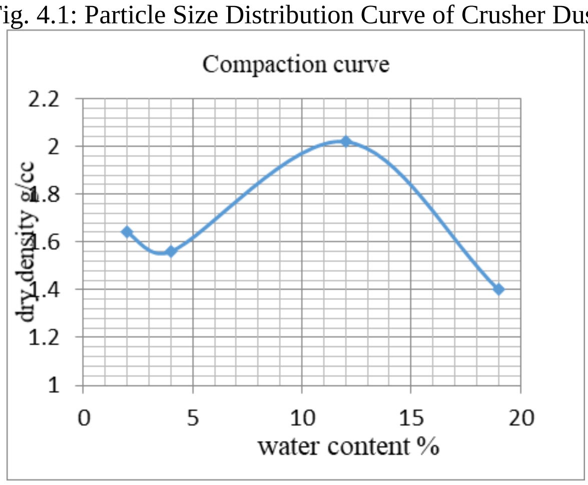

Fig. 4.2: Compaction Curve of Crusher Dust

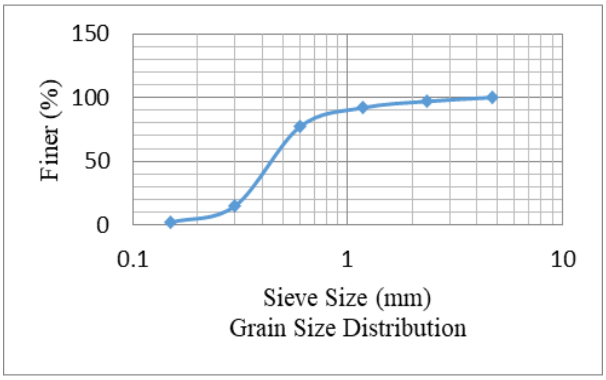

Fig. 4.3: Particle Size Distribution of Sand

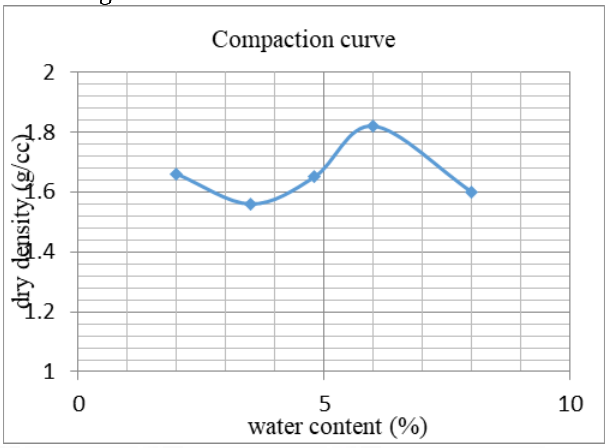

Fig. 4.4: Compaction Curve for Sand

MIXES	Crusher dust (%) +Sand (%)	OMC (%)	MDD (g/cc)
M_1	100+0	12	2.02
M_2	90+10	11.5	2.00
M_3	80+20	10.8	1.97
M_4	70+30	10	1.94
M_5	60+40	9	1.90
M_6	50+50	8.2	1.88
M_7	40+60	7.5	1.86
M_8	30+70	7	1.85
M_9	20+80	6.6	1.84
M_{10}	10+90	6.3	1.83
M_{11}	0+100	6	1.82

Table 1: Variation of OMC & MDD

MIXES	CD (%) +S (%)	Ø(deg)
M_1	100+0	36
M_2	90+10	36.5
M_3	80+20	37
M_4	70+30	38
M_5	60+40	38
M_6	50+50	37.5
M_7	40+60	37
M_8	30+70	36.5
M_9	20+80	36
M_{10}	10+90	35
M_{11}	0+100	35

Table 2: Angle of Shearing Resistance

MIXES	Crusher dust (%)+sand(%)	CBR (%)
M_1	100+0	10
M_2	90+10	11
M_3	80+20	12

M_4	70+30	13
M_5	60+40	14
M_6	50+50	13.5
M_7	40+60	12
M_8	30+70	11
M_9	20+80	10
M_{10}	10+90	9
M_{11}	0+100	8

Table 3: CBR Test Data

From the experimental data it is observed that as the percentage of sand is increasing, CBR values are increasing (10-14) upto 40%and decreasing (14-8) upto 100% of sand. Maximum values attained (14) at a dosage of 40%and at 30 to 50% of sand, the CBR values are in the range of 13-14. Increase in angle of shearing resistance values are due to development of frictional resistance by filling up of formed voids of crusher dust and sand mixes by the lower sizes of sand and crusher dust particles. Hence a combination of crusher dust and sand particles mobilizes more frictional resistance than individual crusher dust and sand particles against compression. Hence 30-40% dosage of sand to crusher dust attained high CBR values.

A. Discussions

From the test results of crusher dust and sand the following identifications are made specific gravity of crusher dust is 2.64 and that of sand is 2.66. It is identified that crusher dust has more or less the same that of sand.

Based on the grain size compaction crusher dust having coarse sand size 45%. Medium sand sizes 42% and fine sand sizes 8% whereas sand has 6% coarse sand 44% of medium sand and 49% fine sand particles. Compared to sand crusher dust particles has more wide range of particles and occupies well graded condition.

Both crusher dust and sand particles are non-plastic and incompressible. Based on the compaction characteristics crusher dust attained higher dry densities 2.02g/cc whereas sand attained 1.82g/cc and high OMC (12%) with respect to sand of 6%. Compared to sand crusher dust attained high dry density due to availability wide range of particles and high moisture content helps to mobilize particles to occupy very high dense packing.

From the strength characteristics the angle of shearing resistance values attained for crusher dust is 360 and that of sand is 350 whereas CBR of crusher dust is 10 and that of sand is 8. Comparing the results of crusher dust with sand crusher dust attained strength higher values than sand.

From the test results of crusher dust sand mixes it is identified that all these mixes attained higher dry densities (>1.82g/cc) with wide variations in moisture contents. From the strength characteristics these mixes attained high values of angle of shearing resistance as 380 and CBR as 140 for a dosage of 30-40% of sand to crusher dust particles. Compared to undivided sand and crusher dust particles, crusher dust and sand mixes also attained high strength values by maintaining high dry densities at wide range of moisture contents.

V. CONCLUSIONS

To study the use of crusher dust and pond ash mixes as geotechnical material in construction of roads the following conclusions have been drawn based on the experimental results.

1) Based on the grain size distribution crusher dust has dominated by medium to coarse sand size particles whereas sand is also dominated by medium to fine sand size particles.
2) Crusher dust attained high dry densities (2.02 g/cc) by maintaining wider variation moisture contents (12%) with high angle of shearing resistance (36 degrees) and high CBR (10%) values, whereas sand has max dry densities (1.82 g/cc) at 6% moisture content with angle of shearing resistance of 35 degrees and CBR of 8%.
3) As the percentage of sand is increasing in the crusher dust and sand mixes strength values like angle of shearing resistance (ϕ) as 38 degrees and CBR as 14% are increasing. High strength values are attained due to filling up of formed voids in the mixes by lower sizes of sand and crusher dust particles.
4) High values of CBR > 10% and high angle of shearing resistance values ϕ> 36 degrees at high moisture contents and high densities ϒd> 18 KN/m3of these crusher dust-sand mixes can be used as sub-grade, fill and embankment material.
5) 30%- 40% sand can be considered as effective utilization in the crusher dust – sand mixes by maintaining high strength values against shear and compression.

REFERENCES

[1] Ahmed E. Ahmed and Korud A. E., 1989, "Proprties of concrete incorporating natural and crushed sand and very fine sand" American Society for Civil engineers, (ASCE) Material Journal, Vol. 86(4), pp 417-424.
[2] A.K. Mishra (2004) Dinesh k. Khare "An Approach for Material Identification: Success for Rural Road Performance" IGC (2004) Vol-1 Page-485.
[3] IS 2720: Part 4: 1985 Methods of Tests for Soils – Part 4: Grain Size Analysis.
[4] IS 2720: Part 13:1986 Methods of Tests for Soils – Part 13: Direct Shear Test.
[5] IS 2720: Part 16: 1987 Methods of Test for Soils – Part 16: Laboratory Determination of CBR.
[6] IS 2720: Part 17: 1986 Methods of Tests for Soils – Part 17: Laboratory Determination of Permeability.