GRADED CRUSHER STONE – CRUSHER DUST SOILS USED AS AN ALTERNATIVE IN PAVEMENT CONSTRUCTION

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Abstract:

Use of large quantities of crusher dust in civil engineering projects has been gaining importance in recent times. To reduce thrust on natural soils crusher dust has been chosen an alternative material. In the present work crusher stone – crusher dust mixes are verified with respect to sand mixes and also for gravel soils. The experimental work shows that crusher stone – crusher dust mixes exhibited high CBR values by maintaining high dry densities to suit as sub – base and base course layers. In place of gravel, sand and their allied mixes.

Keywords: *We would like to encourage you to list your keywords in this section*

1. INTRODUCTION

Durability of pavement depends on quality and Performance of the pavement layers. There are numerous examples about the functional failures of pavement component layers in which they are failed in fulfilling their specifications such as use of appropriate gradations plasticity and other characteristics of natural soils laid by standard codes and gradation requirements.

Presence of non- plastic fines in natural soils will reduce deformations in the pavement component layers under repeated application of traffic loads. So, it is necessary that road engineers need to concentrate on the quantities of fines in either partial or full replacement. Several researches have attempted in partial modification of natural soils with crusher dust and crushed stone.

A number of researchers have made their contributions for the utilization of above said materials in various geotechnical applications. Sridharan A et.al (2005, 2006) reported that high CBR and shearing resistance values can enhance their potential use as sub-base material in flexible pavements and also as an embankment material. Praveen Kumar et.al (2006) conducted CBR tests on stone dust as a sub-base material. Collins RJ et al (1994)' studied quarry dust in highway constructions. Arun Kumar. U et al (2016) studied the effect of crusher dust, crushed stone and tire waste in different layers of flexible pavement component for increased strength characteristics, Satyanarayana P.V.V. et.al (2013) observed improved soil characteristics with addition of crusher dust, Lewis chandra K. et al (2013) Studied utilization of Crusher Dust in Geotechnical Applications. Ashok Kumar Studied etal(2013) Performance of Crusher Dust in High Plastic Gravel

Soils as Road Construction Material. In this an attempt is made to study the interaction between crushed stone crushed dust particle gradations as flexible pavement materials were exposed to compaction strength characteristics.

In the present investigation crusher dust, crushed stone are considered as road construction materials in place of sand and gravel soils as an alternative material in road construction. Tests like gradation compaction, CBR were identified to study their grain size distribution, compaction and strength behavior and finally suitability as sub base & base course materials and the utilization of crusher dust, crushed stone and tire waste in bulk quantities to reduce their impact on environment and in turn to reduce the maintenance cost and to increase the durability of the road pavement.

2.0 MATERIALS:

Gravel soils are collected from local quarries of Visakhapatnam, crushed stone and crushed dust are collected from stone crushing plants of Visakhapatnam.

2.1 MIXES OF GRADED GRAVEL SOILS:

In the present study gravel soils are collected from different locations of Visakhapatnam regions. These collected gravel soils are dried and individualized using wet and dry sieve analysis and these individual gravel soil particles are grouped into 8 grades. These Graded Gravel soil are prepared by choosing particles ranging from 75.0mm to less than 0.002mm. and designated as G_1,…….G_8 by varying gravel particles (75-4.75mm) as 85-15% and finer particles (4.75mm less than 0.002mm) as 15-85% , which are shown in the table 1

TABLE1: GRADES OF GRAVEL SOILS

Grades	G_1	G_2	G_3	G_4	G_5	G_6	G_7	G_8
75-4.75mm	85	75	60	50	35	25	15	0
<4.75mm	15	25	40	50	65	75	85	100

2.2 Geotechnical properties of graded gravel soils:

The above mentioned graded gravel soils are subjected to grain size distribution and their corresponding percentage finer and gradation characteristics are shown in table 2 and fig 1.

These graded gravel soils are tested for compaction characteristics (OMC,MDD) as per IS 2720 part- 8 (1983)and CBR values as per IS 2720 part 16(1986) and the results are shown in table 3 fig 1

TABLE 2 : Grain size distribution of graded gravel soils

Grain Size (mm)	Percentage finer							
	85-15	75-25	60-40	50-50	35-65	25-75	15-85	0-100
75	100	100	100	100	100	100	100	100
50	90	90	95	100	100	100	100	100
26.5	75	75	85	85	90	95	100	100
12.5	50	55	65	70	80	85	95	100
9.5	37	45	52	64	74	82	92	100
4.75	15	25	40	50	65	75	85	100
2.36	11	19	25	42	56	65	74	85
1.18	9	15	22	36	49	56	63	70
0.425	7	13	18	28	35	41	47	53
0.075	5	10	15	20	25	30	35	40
0.002	2	3	5	7	9	10	13	15

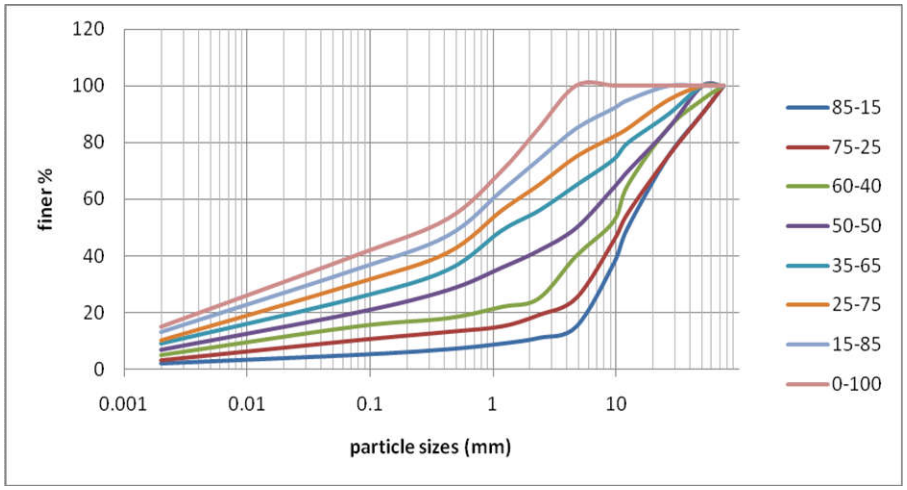

FIG 1: Grain size distribution of graded gravel soils

TABLE 3: COMPACTION AND CBR CHARATERISTICS OF GRADED GRAVEL SOILS

GRADE	COMPOSITION		OMC (%)	MDD (g/cc)	CBR (%)
	75-4.75mm	<4.75mm			
G_1	85	15	8.5	2.13	44
G_2	75	25	8.8	2.15	48
G_3	60	40	9.3	2.12	40
G_4	50	50	10.0	2.10	37
G_5	35	65	10.6	2.07	33
G_6	25	75	11.0	2.05	28
G_7	15	85	11.5	2.03	18
G_8	0	100	12.0	2.00	8

Test results showed that increasing the percentage of gravel particles (> 4.75mm) increases maximum dry density value (MDD) and decreases optimum moisture content (OMC) values, it is vice-versa with respective particles less than 4.75mm. The corresponding range of MDD values is 2.00 g/cc to 2.15 g/cc and the range of OMC values is 8.5 % to 12.5 %. It is also seen that CBR values are also increasing with increase in percentage of gravel particles which is in the range of 18 to 48.

Some of the graded soils have CBR values less than 30 are dominated by finer particles and some more of the graded gravel soil with CBR values greater than 30 are dominated by coarser particles are due to deformation of finer particles under saturated conditions. Gravel soils having CBR values greater than 30 can be used as sub-base course with mechanical modifications.

3.0 CRUSHED STONE AGGREGATE- CRUSHER DUST / SAND MIXES

To compare the above graded gravel soils, gradation mixes of crushing stone with crusher dust/ sand i.e. SC_1/ SS_1 …SC_7/SS7 are prepared from standard materials i.e gravel particles are replaced by crushed stone aggregate and mixed with crusher dust/ sand particles.

Crusher stone aggregate and stone crusher dust/ sand mixes are prepared by choosing stone aggregate in the range of 75mm to 4.75mm with percentage finer of 85-15% and crusher dust/ sand of sizes from 4.75mm-0.075mm with percentage finer is varying from 15-85%. These gradation mixes are designated as SC_1/SS_1 - SC_7 /SS_7 are shown in the table – 3 and their gradation curves are their corresponding gradation characteristics are shown in the table – 2

TABLE 4: GRADATIONS OF CRUSHED STONE AGGEGRATE - CRUSHER DUST / SAND MIXES

Grades	SC_1/ SS_1	SC_2/ SS_2	SC_3/ SS_3	SC_4 /SS_4	SC_5/SS_5	SC_6/SS_6	SC_7/SS_7
75-4.75mm	85	75	60	50	35	25	15
<4.75mm	15	25	40	50	65	75	85

3.1 COMPACTION CHARACTERISTICS

These gradation are also tested for compaction characteristics as per IS 2720 PART 8 (1983).

TABLE 5 : COMPACTION CHARATERISTICS OF CRUSHED STONE AGGR-CRUSHER DUST/ SAND MIXES

GRADE	COMPOSITION		OMC (%)			MDD (g/cc)		
	75-4.75mm	<4.75mm	G	SC	SS	G	SC	SS
GRADE -1	85	15	8.5	4.5	3.5	2.13	2.28	2.22
GRADE -2	75	25	8.8	5.0	3.8	2.15	2.30	2.24

GRADE- 3	60	40	9.3	5.6	4.2	2.12	2.26	2.20
GRADE -4	50	50	10.0	6.2	4.6	2.10	2.24	2.16
GRADE -5	35	65	10.6	6.7	5.0	2.07	2.20	2.10
GRADE -6	25	75	11.0	7.4	5.3	2.05	2.15	2.04
GRADE -7	15	85	11.5	8.2	5.7	2.03	2.10	1.96

G – Graded gravel soil, SC – crushed stone aggregate + crushed dust, SS – crushed stone aggr + sand

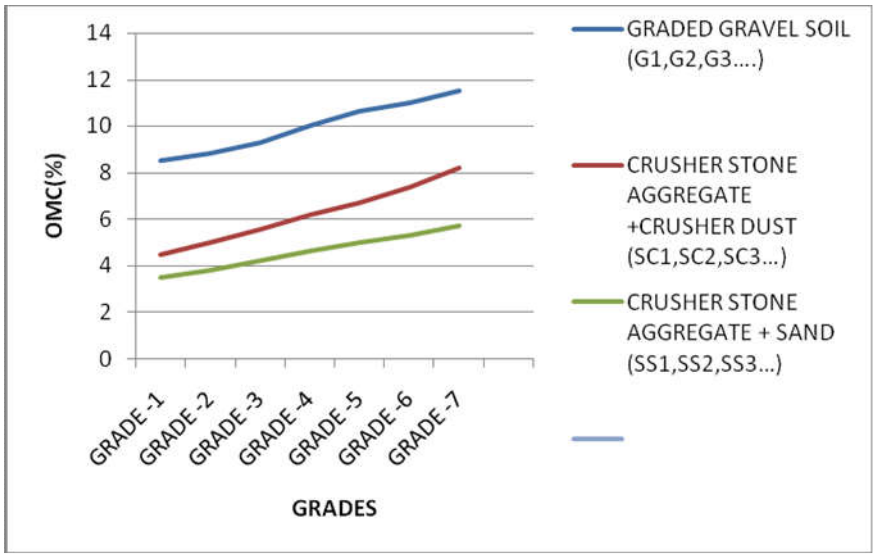

fig: 2. Variation of OMC w.r.t gradation mixes

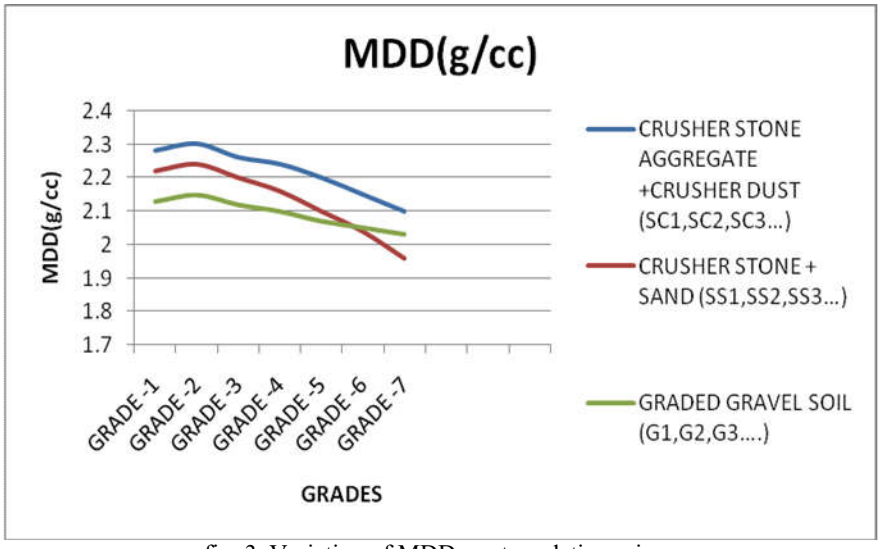

fig: 3. Variation of MDD w.r.t gradation mixes

Test results are showing that OMC values are increasing with increasing crusher dust contents which are from 4.5 to 8.2 %, with sand contents these are increasing from 3.5 to 5.7%. Comparing OMC values of graded gravel these values are very lower.

Test results of MDD values are showing that dry density values of crusher stone – crusher dust and crusher stone – sand values are increasing, which are ranging from 2.12 to 2.30 g/cc, 1.96 to 2.24 g/cc respectively.

3.2 CBR CHARACTERISTICS

To know CBR characteristics of graded gravel soils, crusher stone – crusher dust mixes and crusher stone – sand mixes samples are prepared at their OMC and MDD in CBR moulds and soaked for 4 days. After completion of curing period, these samples are tested as per IS 2720 part 16 (1986)

TABLE - 6 : COMPARSION OF GRADED GRAVEL SOILS, CRUSHER STONE AGGREGATE - CRUSHER DUST MIXES AND CRUSHED STONE AGGREGATE- SAND MIXES

GRADE	COMPOSITION		CBR (%)		
	75-4.75mm	<4.75mm	G	SC	SS
GRADE -1	85	15	44	85	82
GRADE -2	75	25	48	96	88
GRADE- 3	60	40	40	84	80
GRADE -4	50	50	37	73	68
GRADE -5	35	65	33	62	57
GRADE -6	25	75	28	48	43
GRADE -7	15	85	18	36	34

G – Graded gravel soil, SC – crushed stone aggregate + crushed dust, SS – crushed stone aggr + sand

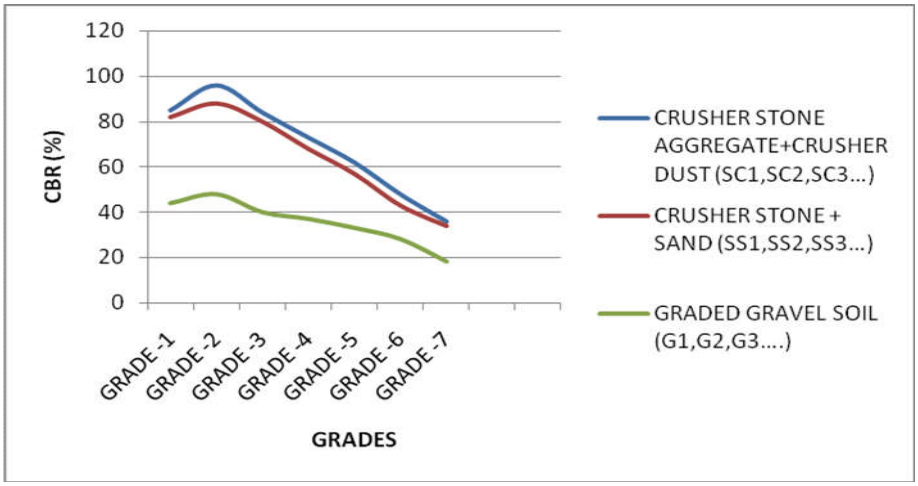

fig: 4. Variation of CBR w.r.t gradation mixes

Test results of CBR values are showing that CBR values of crusher stone – crusher dust and crusher stone – sand values are increasing coarse particles which are ranging from 36 to 96 and 34 to 88 respectively.

Comparing the compaction characteristics of graded gravel (G_1 to G_7) soils with the mixes of crusher stone with crusher dust(SC_1 to SC_7) and the crushed stone aggregate with sand (SS_1 to SS_7) the following identifications are observed

Replacement of gravel particles by crusher stone particles and finer particles (<4.75mm) of gravel soils with crusher dust particles achieved high dry densities similar to mixes of crushed stone particles with sand particles. it is also observed that CBR values are also high similar to that of graded mixes of crushed stone aggregate - sand. High CBR values and dry densities due to filling up of more crusher dust/ sand particles in the voids of crusher stone particles, nature of crusher stone particles with gravel particles and non plastic nature of mixes as a whole w.r.t graded gravel soils.

Gradation mixes SC_1 to SC_5 have exhibited MDD values 2.20 to 2.30g/cc and CBR values are in the range of 62 to 96 can be used as base course materials. Gradation mixes SS_1 to SS_4 have exhibited MDD values 2.16 to 2.24 g/cc and CBR values are in the range of 68 to 88 can be used as base course material

Gradation mixes SC_6 and SC_7 have exhibited MDD values 2.10 to 2.15 g/cc and CBR values are in the range of 36 to 48 can be used as sub- base course materials. Gradation mixes SS_5 to SS_7 have exhibited MDD values 1.96 to 2.10 g/cc and CBR values are in the range of 34 to 57 can be used as sub- base course material

4. 0 CONCLUSION:

Graded gravel soils attained CBR values in the range of 18-48. Mixes of crusher stone aggregate particles with crushed dust / sand particles i.e SC_1 to SC_5 and SS $_1$to SS_4 CBR values in the range of 62 to 96 can be used as base course materials. and mixes of crusher stone aggregate particles with crusher dust / sand particles i.e SC_6 to SC_7 and SS_5 to SS_7 with CBR values in the range of 34 to 57 can be used as sub- base course material. Hence utilization of huge quantities of crusher dust upto 65% can reduce thrust on natural soils

5.0 REFERENCES:

1. Collinns, R.J. and Ciesiski, S.K. (1994) recycling and use of waste materials and by-products in highway construction, synthesis of highway practice 199, national academy press, Washington D.C.
2. Praveen kumar, satish Chandra, and vishal, R. (2006). Comparative study of different sub- base materials. J.mat. in civ, engg. Vol.18 (4), 576-580.
3. Sridharan, A. and soosan, T.G.(2005),"utilization of crusher dust to improve the geotechnical properties of soils in highway construction", Canadian geotechnical journal, vol.28, pp.391-400.
4. Sridharan, A. and Soosan, T.G. and Babu, T.J. (2006),"shear strength studies on soil – crusher dust mixtures", journal of geo technical and geological engineering, vol. 24, pp. 1163 – 1179.

5. Satyanarayana, P. V. V. Raghu P. Ashok Kumar R, Pradeep N (2013),” Performance of Crusher Dust In High plastic gravels as road construction material”. IOSR journal of Mechanical and Civil Engineering (IOSR-JMCE), vol. 10.pp:1-5
6. Satyanarayana, P.V.V, Raghu P, Praveen P (2013), "Utilization of Crusher dust Stabilized Gravel as Sub-base materials". International Journal of Engineering Research and Technology (IJERT) vol 2. issue 11.pp:4034-4016.