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# Stabilization of Sub Base Soil using Crusher Dust

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**Abstract:**
The performance of Flexible Pavement depends on the functions of the component layers especially Sub-base layers. Generally Sub-base layers are made up of natural soils like Gravels. Frequently gravel soils composed of high amount of fines which causes plasticity characteristics with adsorption of moisture under heavy loads and repeated traffic excess deformation leading several failure which require huge investment of money for their repairs. To reduce the excess deformation of the Gravel soils and to increase the life period (Durability) of the pavement there is a need to arrest their plastic characteristics and stabilization is one such techniques to improve the gravel soils by addition of industrial wastes. In this connection Crusher Dust has been selected as a Stabilizer to improve their qualities. Various percentage of Crusher Dust was added to gravel soil and tests like Plasticity, Compaction and Strengths were conducted. By the addition of Crusher Dust Plasticity Characteristics were reduced and CBR values were improved. Addition of 20-30% of Crusher Dust make the mixes low-plastic and 15-20% of Crusher Dust make the mixes non-plastic, where high CBR values attained. 10-20% of Crusher Dust. Hence from the test results it is identified that addition of 20% of Crusher Dust make the gravel soils meet the specification of MORTH as a sub-base material.

## I.INTRODUCTION

Gravelly soils frequently used as Sub-Base layers in road networking and as a fill material in Embankments and low-lying areas of the several projects. By the nature of the composition of the soil particles varying in the range from 56 mm to 2 μm. Presence of these under range of particles make the Gravel soils Dense/Compacted are achieved higher strength under shearing. Sometimes the presence of plastic fines like clay particles and plastic silts take excess moisture and make these gravel soils subjected for high plastic deformations under shearing. The excess plastic deformations make these soils to lose their strengths under saturated condition. To arrest these plastic deformations by reducing the excess intake of moisture by these fines (Slits and Clays). Stabilization techniques can be proposed. In this an attempt is made to stabilize the plastic fines by reducing the plasticity and expansion characteristics. Crusher dust has been selected as a stabilizer. Various percentages of Crusher dust were added to Gravel soils of various degrees of plasticity characteristics. Crusher dust can be advantageously used in reinforced earth retaining walls, reinforced soil beds and reinforced flexible pavements as a fill material due to its stability, free draining nature and good frictional characteristics with synthetic reinforcement. Moorthy N.V.R.etal (2002)have studied the interaction of usage of rock flour with Geotextiles and reported the potential areas of application. Soosan et.al (2001) identified that crusher dust exhibits high shear strength and is beneficial for its use as a geotechnical material. Sridharan et,al. (2005) studied the effect of quarry Dust in highway construction that CBR and angle of shearing resistance values are steadily increased with increase the percentage of Quarry Dust. Praveen Kumar et.al(2006) conducted CBR and tri-axial tests on fly ash, coarse sand, stone dust and river bed materials for their use in the sub base materials of the flexible pavements. In this an attempt is made to study the effect of Crusher Dust and Crushed Stone Mixes in studying there, plasticity Compaction Characteristics and strength characteristics.

## II.OBJECTIVES OF PRESENT STUDY

The main objective of the present study is stabilization of Gravel soils with Crusher dust material and their mixes can be used as sub-base material in road construction.

- To know the geotechnical Characterization of Gravel soils from North Coastal districts of Andhra Pradesh.
- To know the plasticity characteristics of Gravel-Crusher Dust mixes at various percentages of Crusher Dust.
- To know the Compaction and strength characteristics of Gravel-Crusher Dust mixes at various percentages of Crusher Dust.
- Suitability of the stabilized Gravel soils as Sub-base material in accordance with MORTH specifications.

## III.METHODOLOGY:

Experimental procedures adopted in this investigation and the methodology adopted during the course of the study are briefly presented.

### 3.1Material Used:

The materials used in this investigation are:

- Gravel
- Crusher Dust

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 (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)

## IV.RESULTS AND DISCUSSIONS

### 4.1Soil Sampling:

Four Gravel samples were collected from various sources of North coastal districts of Andhra Pradesh i.e., Anakapalli, Vishakhapatnam, Vizianagaram and Srikakulam. The collected Gravel soil samples from the sources can be designated Anakapalli as AG, Visakhapatnam VG Vizianagaram as VZG & Srikakulam as SG. These samples were subjected for Geotechnical Characterization such as Gradation, Compaction and Strength as per IS: 2720 and the results are listed below in the tables and figures.

### 4.1.1Geotechnical Characteristics of Four Gravels

#### 4.1.1.1.Gradation Characteristics:

**Table.1. (a) Gradation Characteristics of Four Gravels**

| Sieve Sizes | AG | VG | VZG | SG |
|---|---|---|---|---|
| 75 | 100 | 100 | 100 | 100 |
| 53 | 96 | 92 | 94 | 100 |
| 26.5 | 65 | 62 | 68 | 76 |
| 9.5 | 54 | 48 | 54 | 62 |
| 4.75 | 48 | 41 | 46 | 56 |
| 2.36 | 42 | 36 | 40 | 50 |
| 0.425 | 32 | 27 | 28 | 39 |
| 0.075 | 23 | 19 | 18 | 30 |
| 0.002 | 8 | 6 | 6 | 12 |

#### 4.1.1.2. Consistency Characteristics:

**Table.2. (a) Index Properties of Six gravels**

| Consistency Limits | AG | VG | VZG | SG |
|---|---|---|---|---|
| Liquid Limit ($W_L$) % | 26 | 24 | 30 | 36 |
| Plastic Limit ($W_p$) % | 19 | 18 | 19 | 20 |
| Plasticity Index ($I_P$) % | 7 | 6 | 11 | 16 |
| IS Classification | GC | GM-GC | GC | GC |

#### 4.1.1.3. Compaction Characteristics:

**Table.3. (a) Compaction Characteristics of Six Gravels**

| Compaction Characteristics | AG | VG | VZG | SG |
|---|---|---|---|---|
| OMC (%) | 8.5 | 8 | 9 | 11 |
| MDD (g/cc) | 2.08 | 2.10 | 2.04 | 2 |

#### 4.1.1.4. Strength Characteristics:

**Table.4.(a) Strength characteristics of Six Gravels**

| Strength Characteristics | AG | VG | VZG | SG |
|---|---|---|---|---|
| CBR (%) | 28 | 32 | 26 | 20 |

### 4.1.2. Crusher Dust:

Crusher Dust was obtained from local stone crushing plants near Srikakulam district, Andhra Pradesh. The sample subjected to various Geotechnical characterizations. The results are shown in table

**Table.5. (a) Geotechnical Characteristics of Crusher Dust**

| Property | Values |
|---|---|
| **Grain size distribution:** | |
| Gravel (%) | 05 |
| Sand (%) | 90 |
| Fines (%) | 05 |
| Silt(%) | 05 |
| Clay(%) | 0 |
| **Consistency:** | |
| Liquid Limit (%) | NP |
| Plastic Limit (%) | NP |
| I.S Classification | SP |
| Specific gravity | 2.64 |
| **Compaction characteristics:** | |
| Optimum moisture content (OMC) (%) | 13 |
| Maximum dry density (MDD) (g/cc) | 1.9 |
| **Shear parameters:** | |
| Angle of shearing resistance(deg) | 36 |
| California bearing ratio (CBR) (%) (Soaked condition) | 8.0 |

### 4.1.3Gradation Characteristics:

| CRUSHER DUST | |
|---|---|
| **SIEVE SIZES (mm)** | **% Finer** |
| 4.75 | 95 |
| 2.36 | 48 |
| 1.18 | 30 |
| 0.6 | 21 |
| 0.425 | 15 |
| 0.3 | 13 |
| 0.1 | 7 |
| 0.075 | 5 |

**Table.4.1.2(b)**

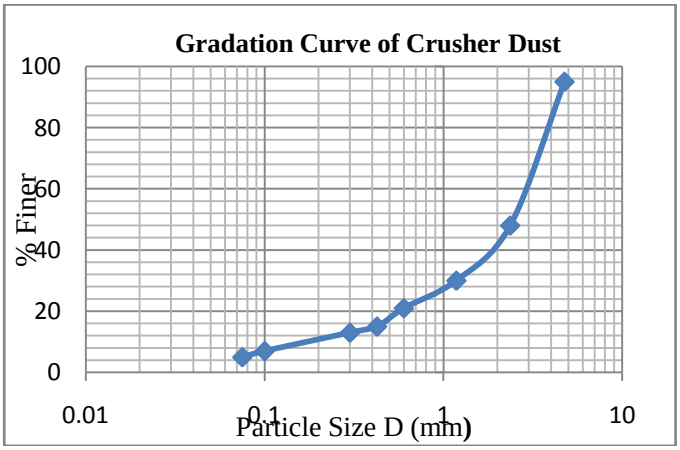



**Figure.4.1.2(a) Particle size distribution curve**

**Compaction Characteristics:**

| Water content (%) | Dry density(g/cc) |
|---|---|
| 2 | 1.65 |
| 4 | 1.54 |
| 6 | 1.6 |
| 8 | 1.7 |
| 10 | 1.79 |
| 12 | 1.88 |
| 13 | 1.9 |
| 16 | 1.82 |
| 18 | 1.72 |
| 19 | 1.6 |

**(Table 4.1.2(c)) Compaction Characteristics of Crusher Dust**

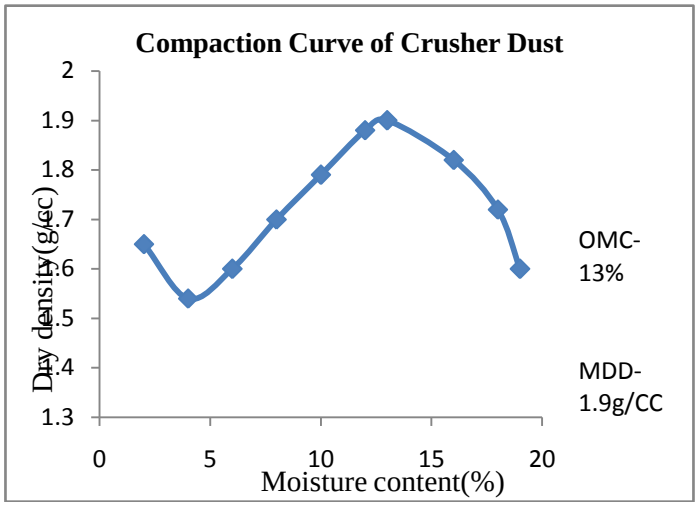



**Figure.4.1.2(a) Compaction curve of Crusher Dust**

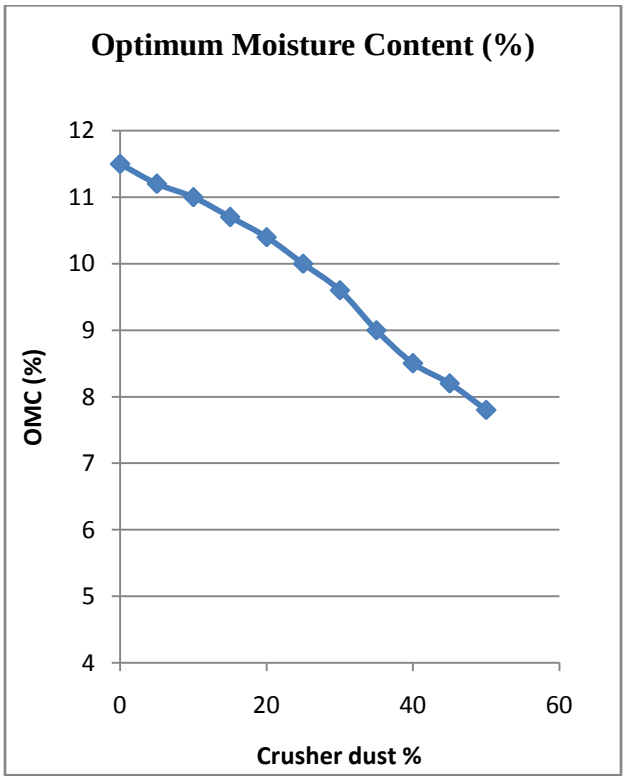
From the physical characteristics it is observed that crusher dust is a grey color fine aggregate consisting of medium to fine sand size particles and of angular shape with rough surface texture. From the consistency data it is non-plastic and very low compressive (incompressible) in nature. From the compaction curve it can be seen that crusher dust attains higher densities with wider variation in moisture content and also increase in workability at higher moisture contents.

**4.1.3.Compaction Characteristics:**

Various percentages of Crusher dust was added to Gravel soils at their dry weights and IS heavy compaction test was performed as per (IS: 2720- Part 8: 1983) and the results are listed below in table

**4.1.3.(a)Compaction Characteristics of Gravel Crusher Dust mixes**

| Crusher Dust (%) | OMC (%) | MDD (g/cc) |
|---|---|---|
| 0 | 11.5 | 1.98 |
| 5 | 11.2 | 2 |
| 10 | 11 | 2.02 |
| 15 | 10.7 | 2.05 |
| 20 | 10.4 | 2.07 |
| 25 | 10 | 2.09 |
| 30 | 9.6 | 2.12 |
| 35 | 9 | 2.13 |
| 40 | 8.5 | 2.11 |
| 45 | 8.2 | 2.09 |
| 50 | 7.8 | 2.06 |



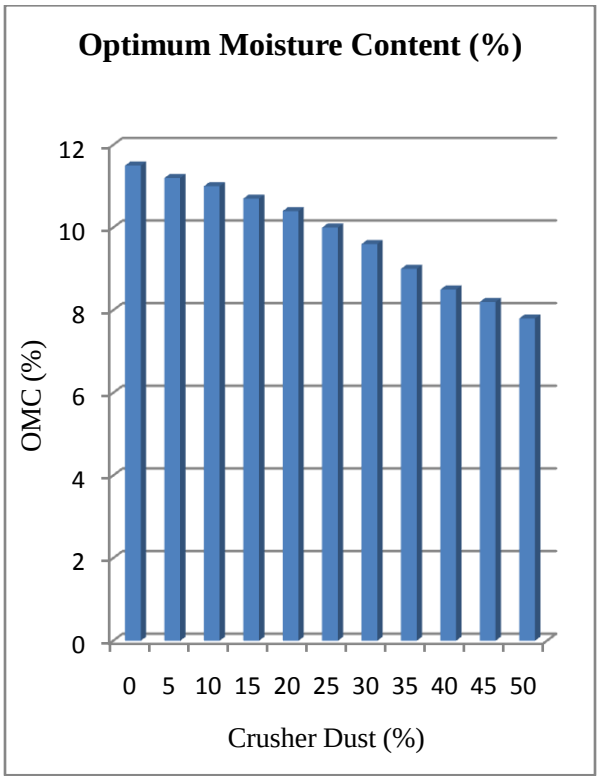



Figure.4.1.3.(a)

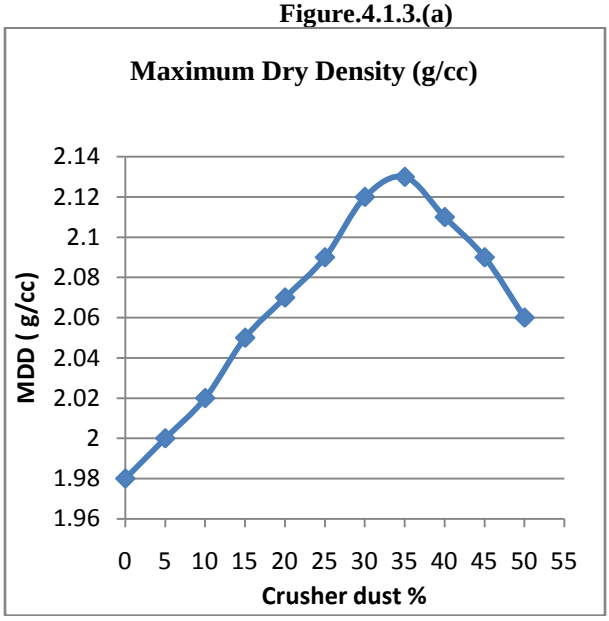



Figure.4.1.3.(b)

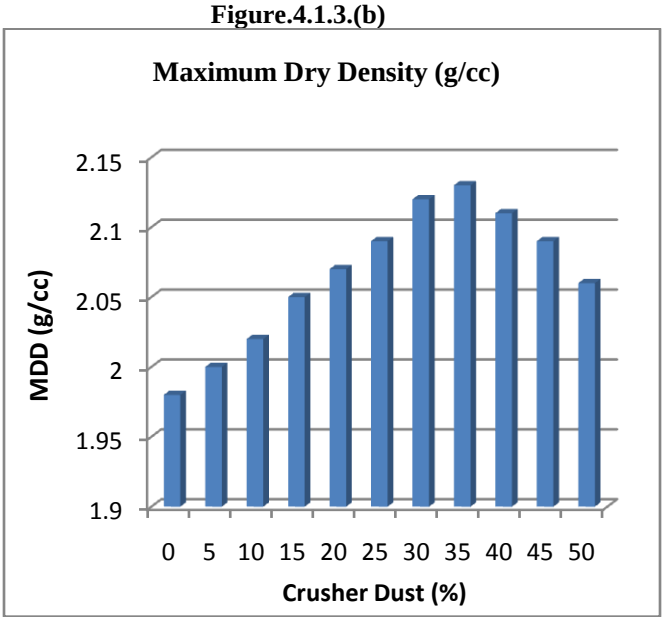



Figure.4.1.3.(c)

Figure.4.1.3.(d)

From the test results it is identified that as the percentage of crusher dust is increasing the optimum moisture content values are continuously decreasing. Whereas the Maximum Dry Density values are continuously increasing upto 35% and then decreasing. A steady increase was observed at early dosagesi.e, 0 to 10% and a rapid increase in between 10-30% of dosages. The decrease in optimum Moisture Contents are due to replacement of Silt and Clay particles by Crusher Dust particles which reduces the intake of Moisture compared to Crusher Dust particles and increase in dry densities are due to occupation of more solids with respect to interaction of Crusher Dust and fines of gravel particles upto 25%. Further occupation of majority of the fines by the Crusher Dust particles accepting the behavior of Crusher Dust.

**4.1.4.California Bearing Ratio (CBR):**

Various percentages of Crusher dust was added to Gravel soils at their dry weights and California Bearing test was performed on soaked samples for four days soaking period compacted at their maximum dry densities as per (IS: 2720- Part 16: 1987) and the results are listed below in table

**Table.4.1.4**.(a) **CBR for Gravel Crusher Dust Mixes**

| Crusher Dust(%) | CBR (%) |
|---|---|
| 0 | 16 |
| 5 | 18 |
| 10 | 20 |
| 15 | 23 |
| 20 | 26 |
| 25 | 30 |
| 30 | 35 |
| 35 | 38 |
| 40 | 34 |
| 45 | 30 |
| 50 | 25 |

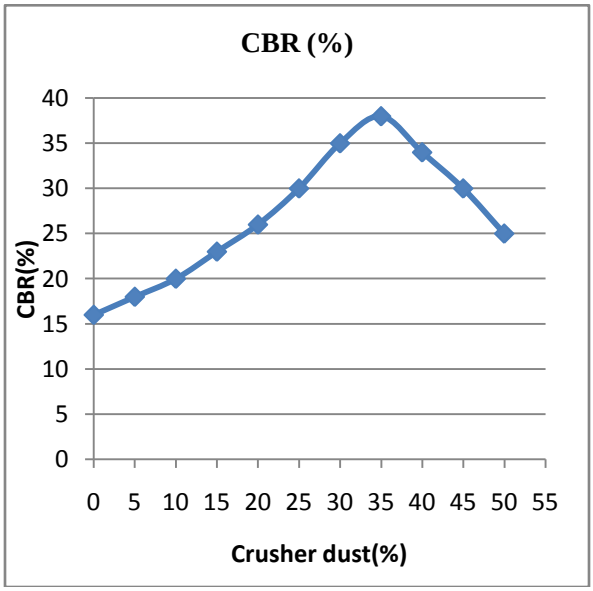



Figure.4.1.4(a)

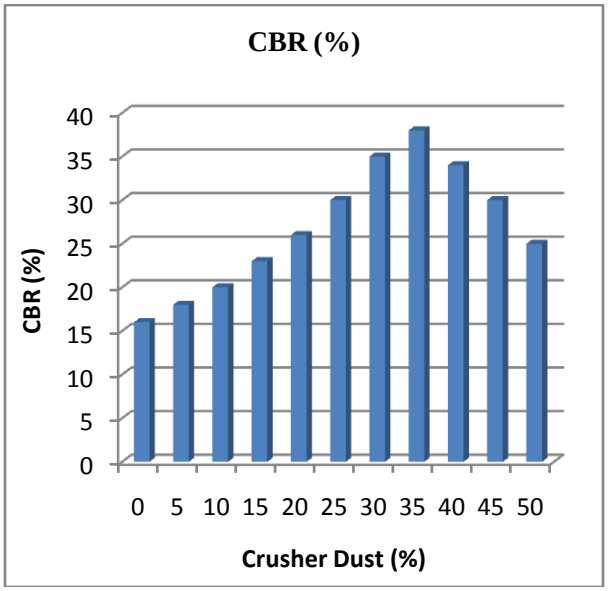



Figure. 4.1.4(b)

As the percentage of Crusher dust increases CBR values are increasing upto 35% and then decreasing. A steady increase in CBR values were observed up to 15% and rapid increase in between 15-35% and beyond 35% a rapid decrease in CBR values were observed. Attainment of maximum values at 30-40% doses are due to more solids occupied in the given volume due to the effective interaction between the Crusher Dust particles and fine and coarser particles of Gravel soil which offer more shearing resistance against compression. Same tests were repeated for different type of gravels with different percentages of crusher dust and result analysis was done and concluded.

## V.GRAVEL-CRUSHER DUST MIXES (SUMMARY):

The performance of a pavement depends not only on sub-grade, it is also on sub-base and base coarses. If the component layers functioning well, the durability of the pavement can be maintained. The function of sub-base course depends on its composition and geo-technical characterization. Generally sub-base layers are made up of natural materials like Gravels, Morrum and crushed stone. The presence of fines in the gravelly soils causes deformations due to their plastic nature leading to number of failures of the pavements like mapping, cracking, rutting, heaving etc. To reduce the impact of fines in the component layers especially sub-base course and to utilization of waste products like crusher dust, pond ash, flyashetc in the geotechnical applications. In this an attempt is made to utilize the crusher dust in stabilization of gravelly soils as a sub-base material. In this study, gravelly soils were collected from Anakapalli, Visakhapatnam,Vizianagaram and Srikakulam, from the test results these are identified as gravel size dominated soils with 40-60% composition. The presence of fines made these to attain plastic characteristics. Srikakulam soil more plastic fines exhibited intermediate compressibility and high plasticity index ($I_P$>15), are respectively where as Visakhapatnam, Anakapalli and Vizianagaram soils exhibited low compressibility-($W_L$<35%) and intermediate plasticity and low plasticity respectively. MORTH specifications (Table 400) says that a material suited as sub-base material should have $I_P$<6, $W_L$<25% one of the Visakhapatnam soils satisfied the results and the other is at is wedge in meeting the standards of MORTH (Table 400), where as the other soils are away from the specifications. To make these soils fit for sub-base materials with respect to the plasticity characterization crusher dust was added. Srikakulam soil exhibited low plastic characteristics ($I_P$<5), higher densities (2.12g/cc) and high CBR values (36) at a dosage of 25% of crusher dust while meeting standards of MORTH (Table 400) specifications and at 30% of dosage this soil attained non-plastic conditions with highest CBR value of 38. Anakapalli soil exhibited low plastic characteristics ($I_P$<4), higher densities (2.12g/cc) and high CBR values (35) at a dosage of 10% crusher dust while meeting standards of MORTH (Table 400) specifications and at 15% of dosage this soil attained non-plastic conditions with highest CBR value of 38. Vizianagaram soil exhibited low plastic characteristics ($I_P$<5), higher densities (2.14g/cc) and high CBR values (38) at a dosage of 15% crusher dust while meeting standards of MORTH (Table 400) specifications and at 25% of dosage this soil attained non-plastic conditions with highest CBR value of 42. Vishakhapatnam soil exhibited low plastic characteristics ($I_P$<5), higher densities (2.14 g/cc) and high CBR values (38-40) at a dosage of 5-10% crusher dust while meeting standards of MORTH (Table 400) specifications and at 10% of dosage this soil attained non-plastic conditions with highest CBR value of 38-40. Based on the plasticity, compaction and strength (CBR) characterizations, Srikakulam soil requires 25% of crusher dust, Vizianagaram soil requires 15% crusher dust &Anakapalli soil requires 10% crusher dust, whereas Vishakhapatnam soil requires 5-10% Crusher Dust respectively due to the presence of respectively due to their presence of fines and their composition, and Visakhapatnam soils met standards of MORTH (Table 400) specifications. From these, it is concluded that 10%-30% of crusher dust dosage is sufficient for soils varying their compressibility in the range of low to medium and plasticity index medium to high and to make them low plastic to non plastic in accordance with MORTH specifications.

## VI.CONCLUSIONS:

From the study of the performance of Crusher Dust on Gravels soils the following conclusions have drawn.

1. As the percentage of crusher dust is increasing plasticity characteristics, like liquid limit, plastic limit and plasticity index are reducing.
2. As the percentage of Crusher Dust is increasing strength characteristics like CBR values are also increasing.
3. High plastic soils and intermediate compressible soils like Srikakulam require high percentage (30-35%) of Crushed dust to meet the specifications of MORTH as a sub-base material.
4. Medium to low plastic and low compressible soils like Visakhapatnam Gravels (VG) 10%, Anakapalli gravel (AG) and Vizianagaram Gravel (VZG) require 15-25% of Crusher Dust to attain low to non-plastic condition and to meet the specifications of MORTH as a sub-base material.
5. At higher percentages of Crusher Dust these Gravel soils attained the characteristics of Crusher Dust by maintaining high densities and CBR values.

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