

# EXPERIMENTAL STUDY OF IMPROVING THE STRENGTH OF BLACK COTTON SOIL

S Suthandra devi<sup>1</sup>, Y Mercy<sup>2</sup>, M Ranjith Kumar<sup>3</sup>

<sup>1</sup>Assistant professor, Mahendra Institute of Engg and Tech, Namakkal

<sup>2,3</sup>Students, Dept. of Civil Engg, Mahendra Institute of Engg and Tech, Namakkal

**Abstract :** Black cotton soil is one of the major deposits of India. It is expansive soil and hence it loses its strength in the presence of water. Without any warning it causes expansiveness and cracks due to the considerable rate of montmorillonite which is dangerous for construction. Various techniques are available for stabilization of black cotton soil. This investigation is an attempt to study the effectiveness of Eco Sand and Quartz Powder to control swelling properties of black cotton soil along with an impact of its strength characteristics and investigates the possibility of using Eco Sand and Quartz Powder to control the expansion properties. Eco Sand is a waste bi-product of ACC Limited which has a cement factory at Madukkarai. The source is limestone taken from the hills for manufacture of cement. Quartz powder is a colourless mineral often tinted by impurities found in igneous, sedimentary and metamorphic rocks. The various proportions of Eco Sand and Quartz Powder were used i.e. 5%, 10%, 15%. This deals with the complete analysis of the changes in various soil properties such as Atterberg's limits (Liquid limit, plastic limit, shrinkage limit), Unconfined Compressive Strength and California Bearing Ratio were studied.

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**Keywords:** Cotton Soil, Eco Sand, Quartz Powder and Soil Stabilization.

## I. INTRODUCTION

Naturally available material is a soil. In naturally available soil only all the civil engineering structures are supported. In most cases civil engineers must use the rejected site for the construction purpose and geotechnical engineer alters the engineering properties of the soil through a number of in-situ techniques and ground replacement. In India black cotton soil is widely found in central and Deccan

plateau. The properties of black cotton soil differ from the other soil is its high compressibility, low bearing capacity, low shearing strength these are problematic in nature. Attempts were made for the stabilization of black cotton soil by using various admixtures like wood ash silica fumes, quarry dust etc. The present paper investigates the possibility of using Eco Sand and Quartz Powder. A foundation should be strong then only structure will be safe.

## 2.MATERIALS:

- A. **Black Cotton Soil:** Black cotton soil has been collected from a field in Madukkarai, Coimbatore. This soil is collected from an open excavation at a depth of 1m to 1.5m below the natural ground surface. Soil used in this is blackish grey and the sample is sieved through 4.75mm and 425micron sieves. The sieved sample is stored in the container.
- B. **Eco-Sand:** Eco-Sand has been collected from ACC Limited, Coimbatore. It is a waste bi-product of cement factory and it is a very fine silica powder. The sample is sieved through 4.75mm and 425 micron size and sieved sample is stored in container.
- C. **Quartz Powder:** Quartz Powder is a crystalline powder. The average particle size standard grades are 10microns and 3microns sieving and then stored in the container which is ready to use.
- D. **METHODOLOGY-**The following test to be carried out on Black Cotton Soil
  1. Specific gravity test
  2. Grain size analysis
  3. Liquid Limit test
  4. Plastic Limit test
  5. Standard proctor compaction test
  6. California Bearing Ratio test
  7. Unconfined Compressive Strength

### 3. RESULTS

**Table 1: Properties of Black Cotton Soil**

| s.no | Properties                      | Result                    |
|------|---------------------------------|---------------------------|
| 1.   | Specific Gravity                | 2.68                      |
| 2.   | Liquid Limit ( $W_L$ )          | 75%                       |
| 3.   | Plastic Limit ( $W_P$ )         | 28.67%                    |
| 4.   | Plasticity Index ( $I_p$ )      | 46.09%                    |
| 6.   | Optimum Moisture Content        | 19.285%                   |
| 7.   | California Bearing Ratio (CBR)  | 1.55%                     |
| 8.   | Unconfined Compressive Strength | 109.347 KN/m <sup>2</sup> |
| 9.   | Grain Size Distribution         | Sand – 90%                |

#### A. Chemical Properties:

**Table 2: For Eco Sand**

| s.no | Properties                     | %     |
|------|--------------------------------|-------|
| 1.   | SiO <sub>2</sub>               | 58-60 |
| 2.   | Al <sub>2</sub> O <sub>3</sub> | 2-3   |
| 3.   | Fe                             | 1-3   |
| 4.   | MgO                            | 0.4-1 |
| 5.   | CaO                            | 20-25 |

**Table3: For Quartz Powder**

| s.no | Properties | Ppm   |
|------|------------|-------|
| 1.   | Na         | 0.83  |
| 2.   | K          | 0.74  |
| 3.   | Li         | 0.131 |
| 4.   | Ca         | 0.45  |

**Table 4: Physical Properties of BCS+ES**

| Particulars            | BCS   | BCS+5% ES | BCS+10 %ES | BCS+15 %ES |
|------------------------|-------|-----------|------------|------------|
| Liquid Limit Test (%)  | 75    | 77        | 82         | 59         |
| Plastic Limit Test (%) | 28.67 | 46        | 50         | 42         |
| Plasticity Index (%)   | 46.09 | 31        | 32         | 17         |
| Specific Gravity Test  | 2.7   | 2.69      | 2.72       | 2.77       |

**Table 5: Physical Properties of BCS+QP**

| Particulars            | BCS   | BCS+5% QP | BCS+10 %QP | BCS+15% QP |
|------------------------|-------|-----------|------------|------------|
| Liquid Limit Test (%)  | 75    | 53        | 63         | 45         |
| Plastic Limit Test (%) | 28.67 | 28        | 36         | 26         |
| Plasticity Index (%)   | 46.09 | 25        | 27         | 19         |
| Specific Gravity Test  | 2.65  | 2.54      | 2.63       | 2.49       |

**Table 6: Compaction Test of BCS+ES**

| Dosage      | OMC (%) | MDD(g/cc) |
|-------------|---------|-----------|
| BCS         | 19.28   | 2.672     |
| BCS + 5% ES | 8       | 2.538     |
| BCS + 10%ES | 12      | 2.795     |
| BCS + 15%ES | 10      | 2.746     |

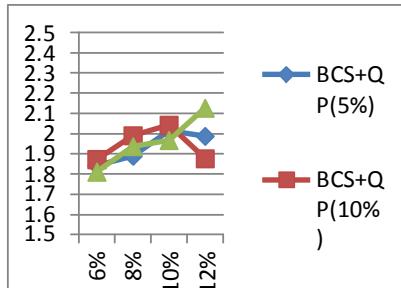
**Table 7: Compaction Test of BCS+QP**

| Dosage      | OMC (%) | MDD(g/cc) |
|-------------|---------|-----------|
| BCS         | 19.28   | 2.672     |
| BCS + 5% ES | 8       | 2.538     |
| BCS + 10%ES | 12      | 2.795     |
| BCS + 15%ES | 10      | 2.746     |

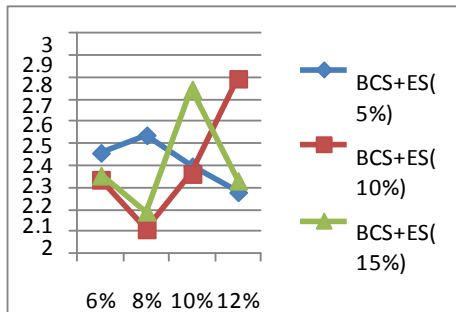
**Table 8: CBR Results of BCS+ES**

| Dosage       | OMC (%) | MDD (g/cc) |
|--------------|---------|------------|
| BCS          | 19.28   | 2.317      |
| BCS + 5% QP  | 8       | 1.976      |
| BCS + 10% QP | 10      | 2.042      |
| BCS + 15% QP | 12      | 2.126      |

**Fig 1: Compaction Test Results for BCS + ES**



**Fig 2: Compaction Test Results for BCS + QP**

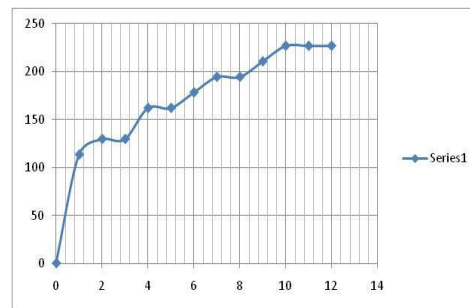


## B.California Bearing Ratio Test Results:

**Table 9: CBR Results of BCS+QP**

| Dosage       | CBR (%) |
|--------------|---------|
| BCS          | 1.48    |
| BCS + 5% QP  | 1.97    |
| BCS + 10% QP | 2.05    |
| BCS + 15% QP | 1.27    |

**Fig 3: California Bearing Ratio Test Results of BCS+ES**



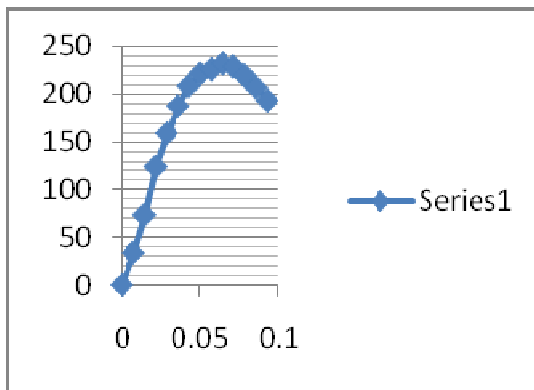
**Table 10 : Unconfined Compressive Strength Results of BCS+ES**

| Soil      | Stress(KN/m <sup>2</sup> ) | Strain     |
|-----------|----------------------------|------------|
| BCS       | 109.965                    | 19.73x10-3 |
| BCS+5% ES | 167.44                     | 52.60x10-3 |
| BCS+10%ES | 230.674                    | 39.78x10-3 |
| BCS+15%ES | 117.082                    | 39.78x10-3 |

**Table 11: Unconfined Compressive Strength Results of BCS+QP**

| Soil      | Stress(KN/M <sup>2</sup> ) | Strain     |
|-----------|----------------------------|------------|
| BCS       | 109.965                    | 19.73x10-3 |
| BCS+5%QP  | 147.3                      | 48.23x10-3 |
| BCS+10%QP | 128.547                    | 22.34x10-3 |
| BCS+15%QP | 107.35                     | 19.63x10-3 |

Fig 4: UCC Test Results of BCS + ES



#### 4. CONCLUSION

The following conclusion are drawn from study

1. Eco sand has the sufficient properties to make the black cotton soil suitable for foundation work.
2. When mixing 10% of Eco sand with black cotton soil the Unconfined Compressive strength result was increased.
3. Compared to Quartz Powder, when Black cotton soil mixed with Eco Sand gives the effective strength value and it was increased at 10% of overall dry weight.

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