

# International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

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## Partial Replacement of Fine Aggregate in Concrete by Black Cotton Soil

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**ABSTRACT:** In construction there has been a rapid increase in demand of construction materials and fine aggregate or sand used in construction is depleting at a very fast rate. Hence there is need of replacement of fine aggregate so as to reduce the use of sand in construction. Waste products from various industries normally deposited in landfills and dormant materials can be used as alternate construction material. Black Cotton Soil is one such alternative which are available in abundance and very economical. Experimental investigation is carried out to evaluate properties of concrete by replacing fine aggregate by Black Cotton Soil. Further, Workability and Mechanical properties are studied on these mix proportions.

**KEYWORDS:** Concrete, Black Cotton Soil, Fine Aggregates, Workability and Mechanical Properties. ;

### I. INTRODUCTION

Concrete is one of the most extensively used building material, since two billion tons of concrete is used as a construction materials in worldwide. Concrete is made up of materials such as cement, fine aggregates, coarse aggregates and water. But excavation of sand from environment leads to environmental imbalance, so using alternative material for sand results in reducing environmental impact. Because of the river sand mining results in lowering of river-beds, damages the bridge foundation and other structures situated closer to the river and coastal areas. Black Cotton Soil is generally clayey, deep and impermeable. They exhibit high rate of Swelling and Shrinkage when exposed to changes in moisture content. Black Cotton Soil obtained from Chamarajanagara (Karnataka) region which is located in south part of India is the source for present experimental work.

### II. RESEARCH SIGNIFICANCE

The challenge for the civil engineering community in the near future is to realize projects in harmony with the concept of sustainable development and this involves the use of high performance materials and products manufactured at reasonable cost with the lowest possible environmental impact. There are various studies going on to fit materials in place of construction materials without affecting the required strength of concrete. An experimental investigation is carried out to study the properties of concrete by partially replacing fine aggregates with certain percentage of Black Cotton Soil. Further, Workability and Mechanical properties are studied on these mix proportions.

### III. MATERIALS AND PROPERTIES

This paper describes a procedure to achieve concrete mix using Black Cotton Soil as a partial replacing material for cement. In addition, the test results for acceptance characteristics for concrete mix such as Workability characteristics (Slump flow) & Mechanical characteristics (Compressive strength, Split Tensile strength) are presented.

**1. Cement** It is a binder that holds the aggregate (fine & coarse aggregates) together and reacts with mineral materials in hardened mass. In this present work, OPC 53 grade Ultra-Tech Cement conforming to IS: 12269-1987 has been used and tested for their properties; it is presented in Table 1.

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**Table 1:** Properties of Cement

Sl No	Property	Results	IS:12269-1987
1	Standard consistency	33%	$\leq 40\%$
2	Initial setting time	30 min	$\geq 30$ min
3	Final setting time	460 min	$\leq 600$ min
4	Specific gravity	3.12	2.9 - 3.3
5	Fineness	4.5%	$\leq 10\%$

**2. Fine Aggregate** In this investigation fine aggregate used is 4.75 mm down, manufactured sand obtained from the local market in Mysore (Karnataka) and are tested as per IS: 2386, presented in Table 2.

**Table 2:** Properties of Fine Aggregate

Sl No	Property	Result
1	Type	Manufactured
2	Surface Texture	Crystalline
3	Specific gravity	2.57
4	Water absorption	1 %
5	Grading Zone	Zone 2
6	Fineness modulus	3.76

**3. Coarse Aggregate** Coarse aggregate crushed granite of 12.5 mm maximum size and retained on IS 4.75 sieve has been used, obtained from the local market in Mysore (Karnataka), and are tested as per IS: 2386, results is presented in Table 3.

**Table 3:** Properties of Coarse Aggregates

Sl No	Property	Result
1	Surface Texture	Crystalline
2	Specific gravity	2.64
3	Water absorption	1%
4	Bulk density	1524 kg/m <sup>3</sup>
5	Fines Modules	6.90

**4. Black Cotton Soil:** Black Cotton Soil from Chamarajanagara (Karnataka) region was used for replacement for fine aggregates which contributes to the concrete mix. Black Cotton Soil which passes through 4.75mm and retained on 75 micron sieve size is selected. The properties of Black Cotton Soil are tabulated in Table 4.

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**Table 4:** Properties of Black Cotton Soil

Sl No	Properties	Values
1	Specific gravity	2.42
2	Bulk density	1474 kg/m <sup>3</sup>
3	Fineness modulus	3.58
4	Classification zone	Zone 2
5	Moisture Content	18%

## IV. METHODOLOGY

Experimental investigation is carried out to study the properties of concrete by partially replacing fine aggregate with certain percentage of Black Cotton Soil, for mix design for M-20 grade (IS 10262 – 2009). To achieve optimum mix, trial mix is done by varying cement, coarse and fine aggregate and water. Once getting the optimum mix, Black Cotton Soil is added to determine the suitability and adaptability, Black Cotton Soil is added in proportions (0%, 3%, 6%, 9% & 12%) by the weight of fine aggregates in the mix design.

Experimental programme are carried out in two phase.

- In the First Phase, for each mix tests are conducted to assess fresh workability property (Slump flow) of concrete.
- In Second Phase, fresh concrete are cast into cubes and cylinders. Specimens are cured in water till testing (3, 7, 28 days), than are used to determine Mechanical characteristics (Compressive Strength and Split Tensile Strength).

## V. RESULTS AND DISCUSSIONS

### 1. Workability - Slump Cone Test

**Table 5:** Slump value for mix proportions

Sl No	Mix Proportion	Slump ( mm )
1	M20 - 0 %	75
2	M20 - 3%	76
3	M20 - 6%	78
4	M20 - 9%	80
5	M20 - 12%	76

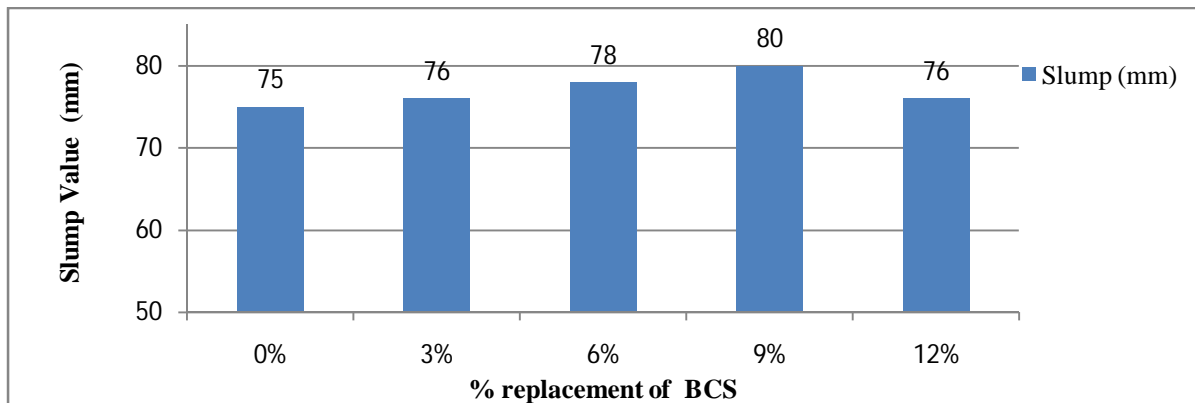
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**Graph 1:** Slump Value for mix proportions



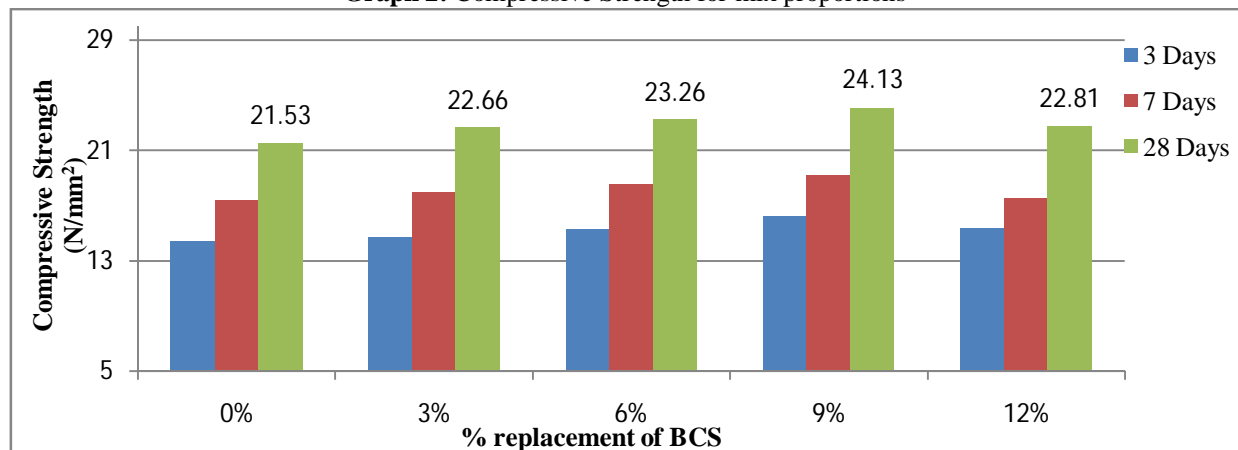
## 2. Mechanical Properties of Concrete

### a. Compressive Strength Tests

**Table 6:** Compressive Strength of Cubes

Sl No	Mix Proportions	Compressive Strength (N/mm <sup>2</sup> )		
		3 Days	7 Days	28 Days
1	M20 - 0 %	14.46	17.43	21.53
2	M20 - 3%	14.75	17.98	22.66
3	M20 - 6%	15.36	18.60	23.26
4	M20 - 9%	16.25	19.22	24.13
5	M20 - 12%	15.41	17.57	22.81

**Graph 2:** Compressive Strength for mix proportions



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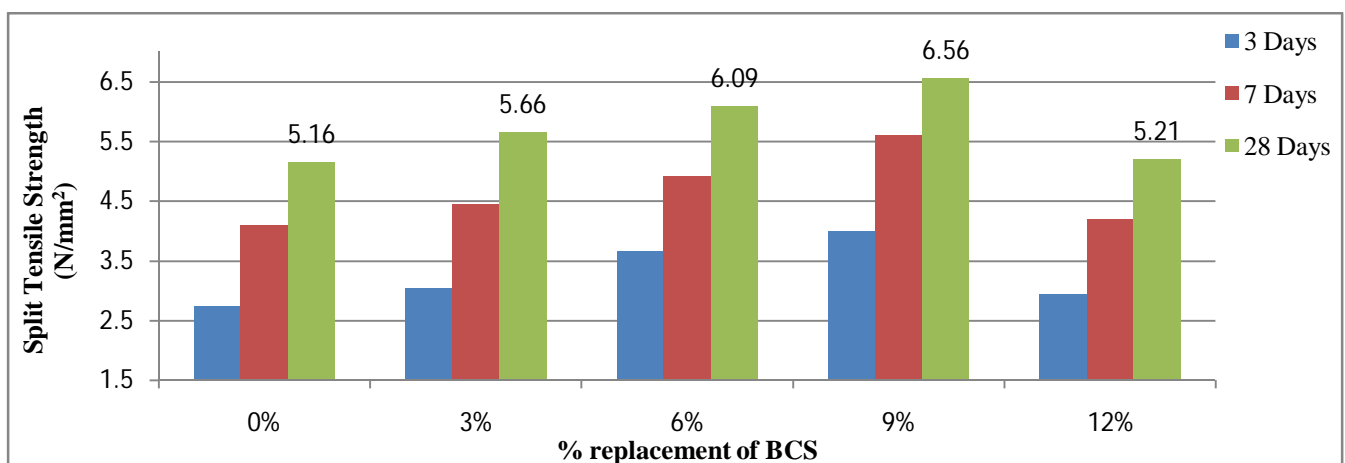
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## b. Split Tensile Strength Test

**Table 7: Split Tensile Strength of Cylinders**

Sl No	Mix Proportions	Split Tensile Strength (N/mm <sup>2</sup> )		
		3 Days	7 Days	28 Days
1	M20 - 0 %	2.75	4.10	5.16
2	M20 - 3%	3.05	4.44	5.66
3	M20 - 6%	3.66	4.92	6.09
4	M20 - 9%	3.99	5.61	6.56
5	M20 - 12%	2.94	4.2	5.21

**Graph 3 Split Tensile Strength for mix proportions**



## VI. CONCLUSIONS

1. Specific gravity of Black Cotton Soil (2.42) is near to the Specific gravity of Manufactured sand (2.57).
2. Black Cotton Soil replaced concrete shows lesser workability when compared to that of normal concrete considered.
3. The slump for standard mix concrete is 75mm and the maximum slump for the concrete with addition of 9% Black Cotton Soil is 80mm
4. Compressive strength after 28 days for Standard mix is 21.53N/mm<sup>2</sup> and Compressive strength is maximum for concrete with addition of 9% BCS the value is 24.13N/mm<sup>2</sup>
5. Split tensile strength after 28 days for Standard mix is 5.165N/mm<sup>2</sup> and Split tensile strength is maximum for concrete with addition of 9% BCS the value is 6.56N/mm<sup>2</sup>

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## **CODE OF PRACTICE**

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- [4] Hand book on concrete mixes SP: 23-1982.