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Strength Characteristics of High Performance Concrete using Bagasse Ash and Slag Sand

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ABSTRACT

Today the high demand in industry is fast construction owning to the properties of strength and high durability. Over the years' concrete has seen progressive development with respect to high performance. High performance concrete (HPC) due to its own property is been largely used for construction of global infrastructure such as bridges, dams, roads etc. The main aspect of the work is to check the durability and strength of HPC. In this study, an investigation is performed to develop high performance concrete using waste materials like Bagasse ash and slag sand - from different industries - with different percentage. Cement is partially replaced by Bagasse ash and M sand by slag sand with varied concentration. Concentration of Bagasse ash replaced in cement are 0%, 8%, 12%, 16%, and 20%, as for Manufactured sand the replaced percentage of slag sand is 0%, 15%, 30%, 45% and 60%. The physical test of constitutes used in HPC has been carried out. The strength characteristics such as compression, tension and flexure are conducted for the curing period of 28 days. The result shows that, including Bagasse ash and slag in concrete increases the compressive strength up to a percentage concentration of 8% Bagasse ash and 15% slag sand, any further increase in the concentration of Bagasse ash and slag sand would decrease the overall strength of concrete.

Key words: Bagasse ash; slag sand; high performance concrete compression; flexure; tension.

1. INTRODUCTION

According to American Concrete Institute, Concrete needs special combination of uniformity and performance requirements that cannot be achieved using regular constituents and traditional mixing, placing, and curing practices. High performance concrete (HPC) is intended to design and perform higher than nominal concrete in terms of its durability and strength [1, 2]. The proportions of High-Performance Concrete (HPC) mixtures are designed and engineered towards providing high strength and durability, although composing of primarily the same materials as conventional concrete mixtures, necessary for the structural and environmental requirements of the project. The approximate compressive strength of High-strength concrete is more than or equal to 55 MPa. This value of 55 MPa is chosen, as it would require special care for production and testing of the concrete and this defined high strength value would require special structural design [3, 4, 5]. Contents of High-performance concrete would include one or more of cementitious materials namely Silica fume, ground granulated blast furnace slag or fly ash & sometimes a superplasticizer. The term 'high performance' is somewhat pretentious because the basic feature of this concrete is that it's constituents and quantities are carefully chosen so as to have specifically appropriate properties that are intended use of structure viz high strength and low penetrability[6,7,8].

Hence, High-performance concrete (HPC) does not behaves differently when compared to nominal concrete as the composition of nominal and HPC are same [9,10, 11]. The workability qualities, strength and durability are enhanced to a very high extent due to the use some admixtures and minerals viz Silica fume and Superplasticizer.

2. CHARACTERIZATION OF MATERIALS

The property of the materials is obtained from the experimental tests carried out according to IS codes for cement, bagasse ash, slag sand, manufactured sand (M-sand), 20mm and 12 mm aggregates.

A. Cement

Birla super 53 grade of OPC is used as referred in the code IS: 12269-1987 the terms of tests as per IS-4031 part 11-1988. The tests are carried out and the properties of the cement are obtained.

3. BAGASSE ASH

Bagasse ash is used as replacement material for the cement. The bagasse ash is procured from the sugar factory in K.M Doddi.

4. FINE AGGREGATE

The fine aggregate used in the concrete is M-sand and slag sand. The results obtained for partially replacement of M-sand and slag sand are depicted.

5. MANUFACTURED SAND

The manufactured sand is obtained from the local quarry. The properties have been studied according to IS: 2386-1963 Part 3 and IS: 383-1970. According to IS: 383-1970, sieve analysis is done and zone II is obtained. According to IS: 2386-1963 Part 3, specific gravity, loose and dense bulk density. These tests are carried out and results as shown in the Table 1.

Table 1: M-Sand Properties

Sl. No.	Properties	Result
1	Specific gravity	2.42g/cc
2	Sieve analysis	Zone II
3	Loose Bulk density	1437.78 kg/m3
4	Dense Bulk density	1716.67 g/m3

6. SLAG SAND

The slag sand is obtained from Bellary in 50 kg bag. The properties have been studied according to IS 2386 1963, Part 3 and IS 383 1970. According to IS 383-1970, sieve analysis is done and zone II is obtained. According to IS 2386-1963, Part 3, specific gravity, loose and dense bulk density. These tests are carried out and results as shown in the Table 2.

Table 2: Slag Sand Properties

Sl. No.	Properties	Result
1	Specific gravity	2.54g/cc
2	Sieve analysis	Zone II

7. COARSE AGGREGATE

Coarse Aggregates passing 20mm and 12mm retaining conforming to IS 383- 1970 are obtained from the nearby quarry are used in the manufacture of concrete. The properties have studied according to IS 2386 Part 3-1963. The results are obtained as shown Table 3.

Table 3: Coarse Aggregate Properties

Sl. No.	Properties	Result
1	Specific gravity	2.74g/cc
2	Sieve analysis	Zone II
3	Loose Bulk density	1489 kg/m3
4	Dense Bulk density	1617 m3

8. ADMIXTURE

To attain the workability and required slump super plasticizer Conplast-420 is used according to IS 9103-1979, manifested by FOSROC chemicals.

9. MIX PROPORTIONING

The mix design is done as per IS 10262-2009. Design of mix is done for high performance of concrete using Bagasse ash and slag sand which are partially replaced for different percentage which depicted in the Table 4.

Table 4: Mix Design for HFC

Sl. No	Water-cement ratio	% of Fly ash	% of slag sand
1	0.34	0	0
2	0.34	8	15
3	0.34	12	30
4	0.34	16	45
5	0.34	20	60

10. EXPERIMENTAL PROGRAMME

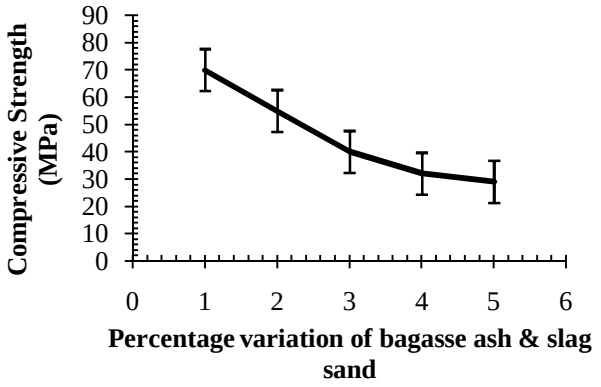
The study on developing high performance concrete is done using Bagasse ash and slag sand partially replaced with cement and manufactured sand according to IS 10262-2009. Conplast- 420 superplasticizer 1% by weigh of cement is used for better workability.

The strength properties for the concrete mixes are compression strength, flexural strength and tensile strength are tested for 28days. The desired values were obtained by testing specimens of cubes of size 150 x 150 x 150 mm^3 to measure compressive strength, each combination six in number, cylindrical specimen of size 150 mm diameter and height 300 mm were cast six in number of each combination to determine the split tensile strength and beam prism of 150 x 150 x 1000 mm^3 was cast of each six number in combination to study the flexural behavior of Bagasse ash and slag sand under pure bending test (Two point loading).

11. RESULTS AND DISCUSSION

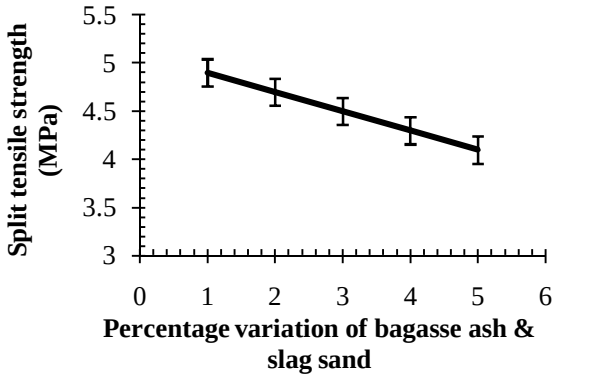
Compression test: The result shows the compression strength of the concrete for partial replacement of Bagasse ash and slag sand. From the evaluation of results bagasse ash with 8% and slag sand by 15% shows high strength is 58.93 MPa. The weight of the mixes reduces as the replacement increases. As replacement increases strength decreases. Figure 1 shows a gradual decrease of compressive strength increased combination of bagasse ash and slag sand.

Split tensile strength: The result shows the tensile the strength of the concrete for partial replacement of bagasse ash and slag sand. From the evaluation of results bagasse ash with 8% and slag sand by 15% shows high strength. The weight of the mixes reduces as the replacement increases. As replacement increases strength decreases as shown in Figure 2.



1. 0% bagasse ash & 0% slag sand
2. 8% bagasse ash & 15% slag sand
3. 12% bagasse ash & 30% slag sand
4. 16% bagasse ash & 45% slag sand
5. 20% bagasse ash & 60% slag sand

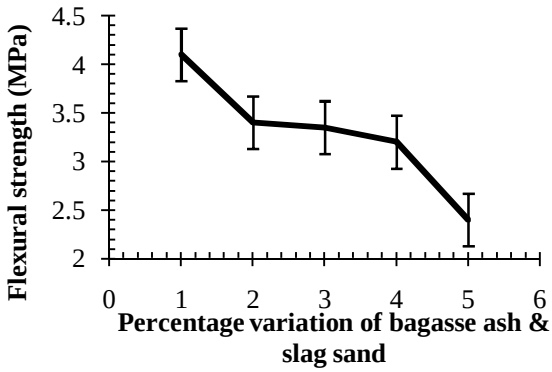
Figure 1 : Compressive Strength for 28 Days for Different Percentage of Partial Replacement



1. 0% bagasse ash & 0% slag sand
2. 8% bagasse ash & 15% slag sand
3. 12% bagasse ash & 30% slag sand
4. 16% bagasse ash & 45% slag sand
5. 20% bagasse ash & 60% slag sand

Figure 2:- Split Tensile Strength for 28 Days for Different Percentage of Partial Replacement

Flexural strength: The result shows the flexural the strength of the concrete for partial replacement of bagasse ash and slag sand. From the evaluation of results bagasse ash with 8% and slag sand by 15% shows high strength that is as the weight of the of the mixes reduces as the replacement increases as shown in Figure 3. As replacement increases strength decreases.



1. 0% bagasse ash & 0% slag sand
2. 8% bagasse ash & 15% slag sand
3. 12% bagasse ash & 30% slag sand
4. 16% bagasse ash & 45% slag sand
5. 20% bagasse ash & 60% slag sand

Figure 3 : Flexural Strength for 28 Days for Different Percentage of Partial Replacement

12. CONCLUSION

In this paper, strength characteristics of concrete is computed by replacing 8%, 12%, 16% & 20% bagasse ash by cement and 15%, 30%, 45% & 60% slag sand with M-sand. Percentage increase in replacements such as bagasse ash and slag sand is directly proportional to decrease in workability of concrete. The following conclusions are drawn:

1. The compressive strength on concrete for 8% bagasse ash and 15% slag sand replacement strength decreases by 19.18%, for 12% bagasse ash and 30% slag sand replacement decrease in strength of 33%, for 16% bagasse ash and 45% slag sand replacement and 20% bagasse ash and 60% slag sand replacement strength decreases between 50 to 60%.
2. The flexural strength of concrete for 8% bagasse ash and 15% slag sand replacement strength decreases by 14.67%, for 12% bagasse ash and 30% slag sand replacement decrease in strength of 15.67%, for 16% bagasse ash and 45% slag sand replacement decrease in strength of 22.88% and 20% bagasse ash and 60% slag sand replacement strength increases by 39.80% than that of 16% bagasse ash and 45% slag sand.
3. Concrete's split tensile strength for 8% bagasse ash and 15% slag sand replacement a slight decrease in strength of 4.10%, for 12% bagasse ash and 30% slag sand replacement decrease in strength of 7.18%, for 16% bagasse ash and 45% slag sand replacement and 20% bagasse ash and 60% slag sand replacement strength decreases between 10 to 20%. As the replacement percentage increases strength of concrete reduces.

4. The high performance characteristics are shown by 8% bagasse ash and 15% slag sand replacement for compressive strength.

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