International Journal of Innovative Technology and Exploring Engineering (IJITEE)
ISSN: 2278-3075 (Online), Volume-9 Issue-4, February 2020

Optimizing the Strength of RCC Beam using Bagasse Ash and Copper Slag

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Abstract: The increasing demand and consumption of construction materials create a bottle neck shortage of construction materials this make the researcher and engineer to focus on new material and method for waste reduction and this is for the cost-effective, green and scientific reasons. Sugarcane bagasse ash (SCBA) which is obtained as a secondary product from sugar industry has relatively high silica content has the capacity to react with cement, contribute in increasing the strength of concrete. Copper slag (CS) the secondary manufactured goods from the process of being making copper, it is absolutely lifeless substance that their characteristics are exactly matching with usual sand which is used in construction and may be replaced in concrete.

The effect of earthed Sugarcane bagasse ash (SCBA) and copper slag (CS) on the strength and flexural behavior is studied. A total of 25 % SCBA by mass was replaced in case of Portland cement and a total of 60 % by mass of CS was used as a fine aggregate replacement. The strength and flexural behavior of concrete samples were studied using compression test and two-point loading tests.

The capacity of the objects framed based on actual concrete and secondary product based concrete were evaluated with standard tests. Five sequence of mixing in concrete proportion were organized by means of SCBA restore cement by 0, 5, 10, 15, 20 and 25% by weight of cement and its 14 & 28 day strength were found out and the other mix with constant SCBA and varying percentage of Copper slag were prepared with 40, 45, 50, 55 and 60 % of copper slag for fine aggregate the 14 & 28 day strength were found. Flexural behavior of SCBA and CS combination were found using RCC beams. It has been engaged that SCBA and CS are better substitute for cement and fine aggregate.

Keywords: Sugarcane Bagasse ash, Copper slag, Compression, Elongation, Fracture strength.

Revised Manuscript Received on February 28, 2020.

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I. INTRODUCTION

Rapid urbanization and industrialization is emerging in the developing countries like India with the support of modern engineering construction practices.

Adoption of reinforced cement concrete (RCC) is existing in market because of its fluid in nature in the initial stage which is subjected to setting and gets hardened after pouring in a specified mould.

The nature of easy compaction without any segregation is the advantage of this concrete which is to be experimented in this work.

The fracture strength of naturally compressed concrete was studied, meanwhile compared with conventional vibrated concrete in beams mid span, where a strong and ductile life of beam is observed compared with CVC (vivek et al 2017) [8].

The aim of this work is to utilize inexpensive, higher available amount of industrial wastes as an alternative to existing commercial construction materials.

The industrial byproducts when subjected to dumping on land cause environmental pollution are identified and a solution for minimal of hazard is to be focused.

As a result attention was focused towards utilizing the secondary product emitted from the industry into replacing them in a ratio in cement proportion for concrete mix, which also observed to be yielded a reasonable outcome with slag, fly ash, silica and inert materials [7].

In this study the waste materials identified are sugarcane bagasses ash (SCBA) which has relatively high silica content and copper slag (CS) which has a good mechanical property to be used as fine aggregate.

These secondary products may increase the strength of concrete by means of converting calcium hydroxide into calcium silicate at the time of hydrating in the reaction phase, where the bagasse ash has cementitious value in respect of cement paste [6].

The experimentation focuses on identifying the skeletal adaptation of sustainable concrete that has been analyzed with compression, elongation and fracture strength.

II. MATERIALS AND METHODS

The proposed methodology for the current study is given in figure 1. The Sugarcane bagasses ash for the current research is collected from sugar factory and copper slag is collected form Copper Industries.

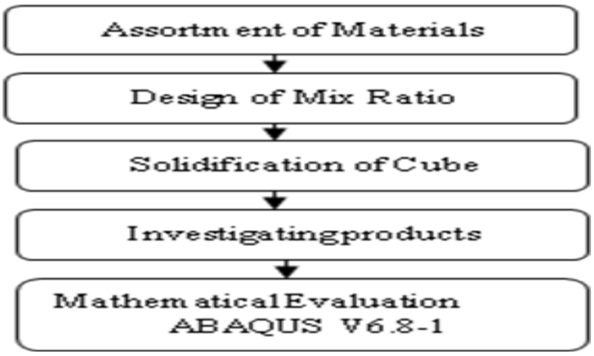

Figure 1: Planned Worksheet

For the project to get the desire result totally of eleven mixes of concrete cubes were casted in 150 x 150 mm cube and tested for compression behavior. In the first set of five mixes to get the optimum percentage of SCBA the cement is replaced with 0, 5, 10, 15, 20 and 25% of SCBA and the specimen were to be casted and tested for 14 and 28 days strength and for the second set of four mixes to get the optimum percentage of CS in the SCBA added concrete for that the sand is replaced in the SCBA added concrete with 40, 45, 50, 55, 60% of CS in the SCBA concrete and the specimen were to be casted and tested. The result we obtain has the optimum percentage of both Sugarcane bagasse ash (SCBA) and Copper slag (CS). Finally the flexural behavior of RCC beam (1m x 0.15m x 0.15m) made with SCBA and CS admixed concrete and also the control beam were casted and tested for two point loading to found out the flexural behavior and this final result is to authenticate with the process of examining mathematical calibration by operating information ABAQUS V6.8-1.

The RCC beam was designed according to the Indian standard code l provisions, the reinforcement and dimensional detail of the RCC beam are size: Length -1.0m x breadth - 0.15m x depth - 0.15m, Top rod 8 mm, Bottom rod 10 mm, Stirrups 6 mm [1].

To combine with all substance the ratio of mix proportion is framed as per M30 and the mix calculation, mix magnitude are shown in table 1 and 2 [2,3].

Table 1: Mix Calculation

S/No	Parameters	Value
1	Volume of concrete	1m^3
2	Volume of cement	0.12 m^3
3	Volume of water	0.192 m^3
4	Volume of aggregate	0.688 m^3
5	Mass of coarse aggregate	1282 Kg
6	Mass of fine aggregate	645 Kg

Table 2: Mix Calculation

Para meters	Cement	Fine Aggregate	Coarse Aggregate	Water
Ratio	1	1.6796	3.3385	0.5
Kg/m^3	384	645	1282	192

Concrete cubes of 150 mm size are casted for each design mix and are shown in table 3 and 4. The concrete is also casted for rcc beam of size 1000mm x 150mm x 150mm with the following specimen detail shown in table 5 [4].

Table 3: Cube specimen detail for first set of mix

Mix Id	Cement		SCBA		F.A sand		C.A	
	kg/ m^3	%	kg/ m^3	%	kg/ m^3	%	kg/ m^3	%
D1	364.8	95	19.2	5	645	100	1282	100
D2	345.6	90	38.4	10	645	100	1282	100
D3	326.4	85	57.6	15	645	100	1282	100
D4	307.2	80	76.8	20	645	100	1282	100
D5	288	75	96	25	645	100	1282	100
CC	384	100	0	0	645	100	1282	100

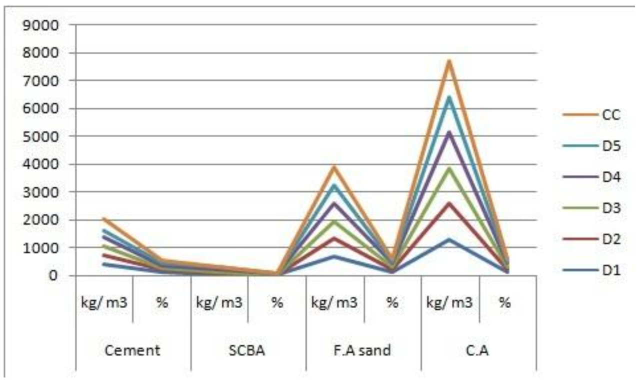

Table 4: Cube specimen detail for second set of mix

Mix Id	SCBA		F.A sand		Copper slag		C.A	
	kg/ m^3	%	kg/ m^3	%	kg/ m^3	%	kg/ m^3	%
C1	38.4	10	387	100	258	40	1282	100
C2	38.4	10	354.75	100	290.25	45	1282	100
C3	38.4	10	322.5	100	322.5	50	1282	100
C4	38.4	10	290.25	100	354.75	55	1282	100
C5	38.4	10	258	100	387	60	1282	100

Table 5: Beam specimen

Beam id	Bagasse ash		Cement		Copper slag		Sand		C.A	
	%	kg/ m^3	%	kg/ m^3	%	kg/ m^3	%	kg/ m^3	%	kg/ m^3
B1	10	38.4	90	345.6	0	0	100	645	1282	100
B2	10	38.4	90	345.6	45	290.25	55	354.75	1282	100
B3	10	38.4	90	345.6	50	322.5	50	322.5	1282	100
B4	10	38.4	90	345.6	55	354.75	45	290.25	1282	100
B5	0	0	100	384	0	0	100	645	1282	100

III. RESULT AND DISCUSSION

Optimization of Sugar cane Bagasse Ash:

From experimentation the power of SCBA composition on the role of compaction without any segregation with relation to water and folder ratio are observed.

The control 100% cement shows 70 mm and sample (5% SCBA and 95% cement) 90 mm of slump value at increases with increase in SCBA content and has acceptable binding quality. The outcome is acceptable with regard to supply of all the components in the prescribed ratio which gives a better yield [5].

The compression strength result of cylindrical cube for control at 14 days and 28 days are 25, 35 respectively. SCBA with 5% and 10% replacement shows comparative result of control as 25, 35% and 24%, 35%. Increase in SCBA concentration is observed to decrease the strength, as it possibly carry forward the liberation of excess silica because of enormous availability of lime in its composition. This may naturally make the composition decrease its quality.

Optimization of Copper Slag:

The optimized SCBA 10% is kept constant and increase in copper slag from 40% to 60% is carried out varying each 5%. The slump value is 115 mm and increase with increase in CS. This may be due to poor water absorption potential of CS which is good in sand though workability is more and acceptable.

The compressive strength result of cylindrical cube at 10% constant SCBA and 40% is observed that 28% at 14 days, 39% at 28 days. The accumulations of CS that incorporate SCBA amplify its force under solidity up to 50% of replacement as 31% at 14 days and 40% at 28 days. Addition of CS beyond 50% diminishes the compression potency close to control. Because of excess CS availability which makes the concrete segregates and decrease its strength. [5].

Optimization of RCC Beam:

The optimized SCBA 10% and optimized CS 40, 45, 50 and 55% are used for casting and testing of RCC beams. Control and four set of RCC Beams were tested in a loading frame to get the flexural behavior and was shown in table 6. The shipment hauling competence of the RCC beam is carried out with two point load testing method, it suggests that B3 has the higher load carrying capacity. [6]

Table 6: Optimized admixture in RCC Beams

S/No	Beam id	Maximum load KN	Deflection mm
1	B1	67.45	5.55
2	B2	68.63	5.85
3	B3	69.72	5.40
4	B4	66.87	6.10
5	B5(CC)	67.23	5.20

Finite Element Modeling of Beam:

As per the experimentation the outcome is authenticated using ABAQUS the operating information system. The perception at the rear of FEM is that the skeleton of object is alienated into minor rudiments of limited magnitude and it is connected with an infinite number of concerning points. The model projecting beam created with partition and the model projecting tensile reinforcements are shown in figure 2.

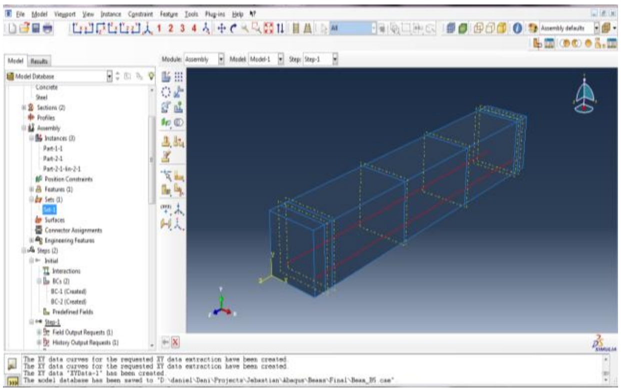

Fig 2: Model Showing Tensile Reinforcements Embedded

The interlocking of the distributed zones strengthens the volume of casted object. The stress distribution is shown in figure 4.

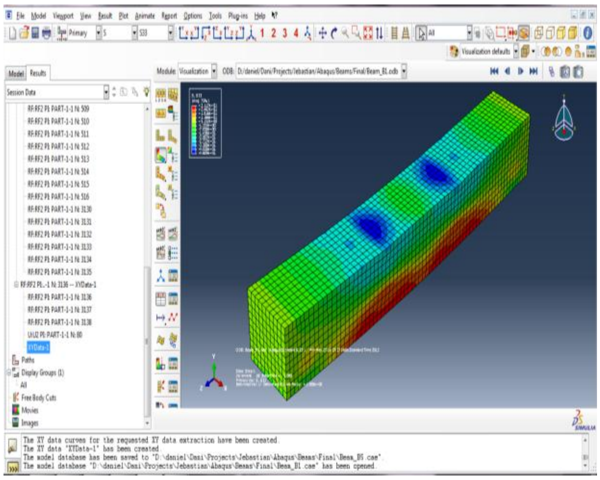

Fig 3: Model Showing stresses distribution in beam

Load deflection for beams (FEA)

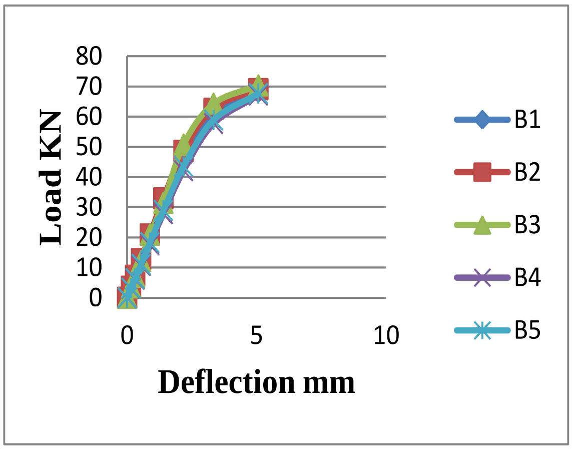

Fig 4: load vs. deflection for FEA beams

Comparative Results:

The final results for both experimental and analytical are shown in the table 8. The model mathematical evaluation assessment are higher than the experimental this may be due to the difference in insertion, compressed, solidification and supplementary substantial complexity in the RCC beam casting and are shown in figure 5 and 6.

Table 8: Experimental and Analytical results

Beam id	Experimental		Analytical	
	KN	mm	KN	mm
B1	67.45	5.55	68.31	5.07
B2	68.63	5.85	69.13	5.06
B3	69.72	5.40	70.37	5.06
B4	66.87	6.10	67.14	5.07
B5(CC)	67.23	5.20	67.69	5.06

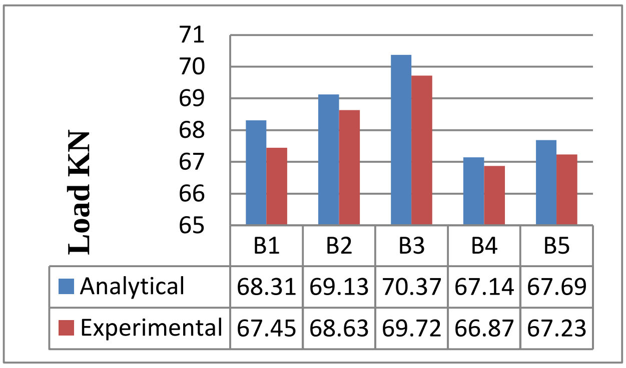

Fig 5: Maximum load for Analytical and Experimental

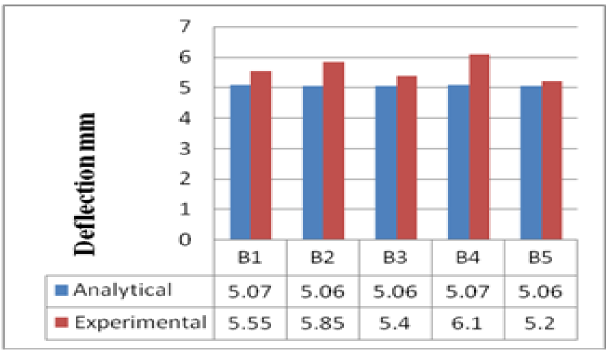

Fig 6: Maximum Deflection For Analytical And Experimental

IV. CONCLUSION

The addition of SCBA and CS has improved the compression strength and fracture strength of concrete. The slump value of SCBA and CS concrete lies between 115 to 170 mm. The fracture potency of beams consequences demonstrate that the final weight hauling ability of the beam amplifies at 10% SCBA and 50% CS. The uses of CS as a partial substitution for sand pass on power up to 50% alternate stage. Elevated intensity substitution may escort to separation and hemorrhage. The load-deflection results obtained from ABAQUS is closer to the load – deflection curve obtained from the experimental study. The ultimate load obtained in ABAQUS is higher than the values obtained from the experimental study. Comparison between the load-deflection results obtained from ABAQUS for control and admixed specimens shows that the ultimate load has increased for the beam with 10% SCBA and 50% CS.

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