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Behaviour of Steel Fibre Reinforced Concrete Beam using Bagasse Ash

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Abstract: ***The study involves understanding the behaviour of fibre reinforced concrete with partial replacement of cement with Bagasse ash. The partial replacement is done with 15% of the total cement content. The fibre reinforcement is done with hooked steel fibres.***
The steel fibre content used is taken as 2% by volume of concrete after analysing with 0.5%, 1%, 1.5%, 2% , 2.5% and 3% of fibre contents. Three beams with steel fibres and three others without fibres are experimented for flexural load under a two point loading.
The load- deflection graph is plotted from the results obtained from the flexural test. An increase is found out in the load carrying capacity of the beam with steel fibres compared to that without them.
Keywords: Concrete beams, steel fibres ,bagasse ash, load-deflection graph, flexural strength, tensile strength.

I. INTRODUCTION

The conventional concrete is having good compressive strength whereas its weakness against tensile forces is known. This property of concrete is compensated by addition of supplementary reinforcement.A prominent such reinforcement is through the addition of fibres- natural as well as synthetic fibres. Various fibres such as Steel, Polypropylene, Coconut fibres, Sisal fibres, Hemp fibres etc are used for this purpose.[2]
The ability of concrete reinforced with steel fiber to resist cracks and its propagation is a very prominent property. Fiber reinforcement results in increased tensile strength, both at first crack and at ultimate by the help of the fibers holding together the matrix and also results in increased flexural strength.
Thus the ductile nature of fiber composite beams would increase its energy absorption characteristics and its ability to withstand dynamic and shock loads.
It also gives considerable increase in the overall strength and flexural capacity of the structures.The replacement of cement partially with other desirable materials lets the user to control the environmental pollution in a great manner.Various materials such as flyash, Sugarcane Bagasse ash, husk ash etc. Here we have adopted the partial replacement of cement with Bagasse ash at 15%.[1] [7][8].
After the crushing of sugarcane in sugar mills and extraction of juice from processed cane by milling, the discarded fibrous matter is called bagasse.
Bagasse is used as fuel in cogeneration boilers[9]. The residue after burning, namely bagasse ash, is collected using a baghouse filter. Sugarcane bagasse ash (SCBA) is obtained as a by-product in abundant quantities in India (Bahurudeen and Santhanam 2016[1]) [9][10]as well as other major sugarproducing countries in the world and is currently disposed as a waste material, which causes severe environmental problems..
Fibre reinforced concrete beam is partially replaced with bagasse ash to undergo flexural test and the load-deflection analysis is done both at 28 days and 56 days to check ageing.[3]

II. EXPERIMENTAL PROGRAM

A. Preliminary Tests

The preliminary tests were undertaken on the materials and the data received were used to design the M25 concrete mix based on the Indian Standard Code-10262(2009). The table below gives the details of the concrete mix [4]. Ordinary Portland cement of 53 Grade is used in this experiment. 15% cement was replaced with Bagasse ash.[1]). Steel fibers (Hooked end) of volume fractions 0.5%, 1%, 1.5%, 2% , 2.5% and 3% were mixed with concrete along with 0.5% of super plasticizer (Adva 960) [5] as a result to get the optimum percentage as 2%. [6] .Fe 415 grade steel was used for the bars and stirrups.The steel fibre used inside are of length 37mm.

TABLE 1

Grade of Concrete	M25	M25
Bagasse Ash Replacement %	0	40
Water- Cement ratio	0.49	0.49
Cement (kg/m3)	331	281.35
Bagasse ash (kg/m3)	0	49.65
Fine Aggregate (kg/ m3)	769	769
Coarse Aggregate (kg/ m3)	1201.09	1201.09
Super plasticizer (l/ m3)	1.98	1.98
Water (kg/ m3)	162.19	162.19
Mix proportion	1:2.7:3.55	1:2.7:3.55

B. Experimental Investigation

1) Reinforced Concrete Beam: The test specimens were designed and detailed as per IS 456:2000. The beam cast has been cast for a cross section 110mm X 150mm with a length of 1800mm. Beams were cast using M25 grade concrete and Fe 415 steel is used for longitudinal reinforcement and stirrups.. The details of test specimens are shown in the following Table. Bagasse ash has replaced cement with 15% of cement content whereas steel fibre reinforcement is used as 2 % volume of concrete. 2 nos. of 12mm diameter bars at bottom and 2 nos. of 10mm dia. bars at top were used as longitudinal reinforcement. 8mm dia. bars at 120mm c/c spacing were used as Stirrups.[12] The reinforcement details are shown in figure. Ordinary crushed stone with size 20mm and 12.5mm are used as a coarse aggregate in concrete mixes.[13] River sand which is obtained commercially is used in preparing the concrete, conforming to zone II as per IS 383:1970 is used as fine aggregates.[14].Six specimens were cast to study the behaviour of Reinforced Concrete beams with steel fibres and Bagasse ash under flexural loading.[15]

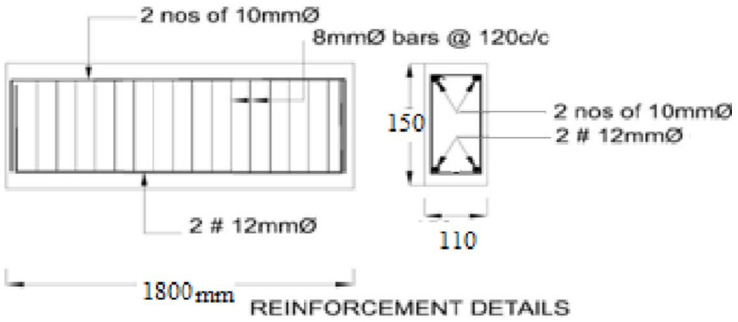


FIG 1

TABLE 2

Sl.no	Specification	% of Bagasse ash	% of steel fibers	No. of days
1	RC 0%-0%-28	0	0	28
2	RCS 0%-2%-28	0	2	28
3	RBC 15%-0%-28	15	0	28
4	RBCS 15%-2%-28	15	2	28
5	RBC 15%-0%-56	15	0	56
6	RBCS 15%-2%-56	15	2	56

2) Test Set-up for Beams: The test setup consists of a vertical loading hydraulic jack of 50kN capacity.[16]This jack is conncected to a load cell which measures the load applied on the beam.The load cell is rested on a spreader beam which distributes the point load to two point loading over the kept beam.The effective length of the beam is 1.5 m.All the six specimens are tested for flexural strength..The deflections at midspan of the beam is measured using Linear Voltage Displacement Transducers (LVDT) connected to the points.At each one-third distances from two ends dial gauges are connected to measure deflection at those points.[17]. A computer capture readings from a data logger connected with LVDT at every load intervals until failure of the specimens. The experimental set-up is shown in Figure.

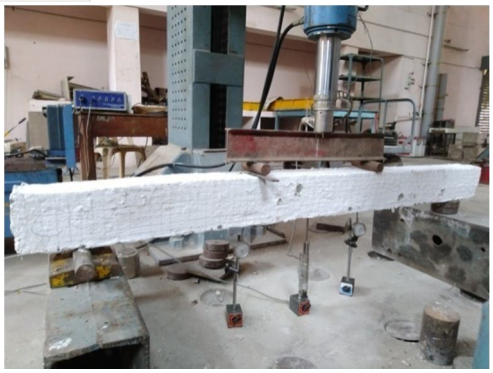
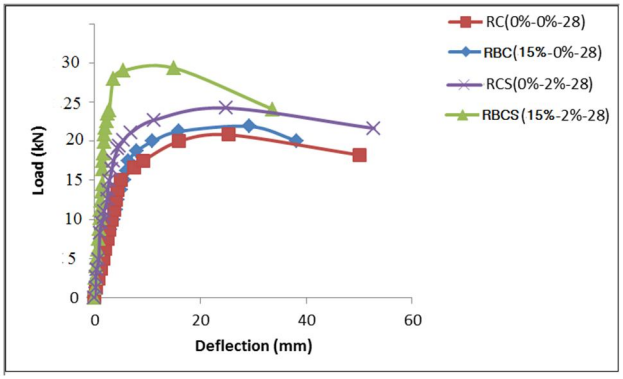


FIG 2 Experimental setup of the beam under two point loading

III. TEST RESULTS AND DISCUSSION

A. Load-Deflection Curves

The ultimate load carrying capacity of the specimens RC(0%-0%-28), RCS(0%-2%-28), RBC(15%-0%-28), RBCS (15%-2%-28) are 19.89kN, 25.01kN, 22.6kN and 29.9kN with a deflection of 29.3mm, 24.8mm, 25.3mm and 16mm respectively when tested at 28th day. The ultimate load carrying capacity of the specimens RBC(15%-0%-56) and RBCS(15%-2%-56) are 23.9kN and 30.4kN with a deflection of 32.4mm and 15.4mm respectively when failed at 56th day.



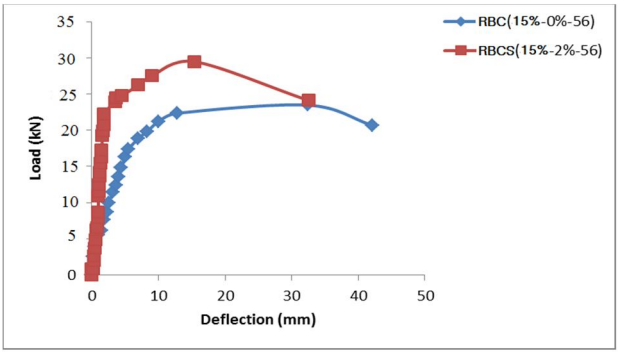


FIG 3 a)Load-deflection graph for Beam specimen at 28 days b)Load deflection curve for Beam specimen at 56 days

IV. CONCLUSIONS

A. The addition of steel fibres to the concrete showed considerable increase in the load carrying capacity of the concrete compared to those without steel fibre inclusion.An increase of 35% is observed in the load carrying capacity of steel fibre reinforced concrete beam(RCS) compared to normal ocncrete beam.(RC).The deflection for steel fibre reinforced concrete has a considerable decrease of 25% compared to RC beam.

B. Partial replacement of cement with bagasse ash is found to have complemented well as it has given an increase in the load carrying capacity with 15% compared to no replacement cement concrete beam(RC)

C. The steel fibre reinforced concrete with bagasse ash has given very good load carrying capacity and lesser defclection compared to Conventional concrete in a range of 50% and 40% respectively.

D. On 56th day of testing the beams RBC and RBCS showed minute increase in load carrying capacity by 10% each.

E. The optimum percentage of steel fibres was found to be 2% by volume of concrete.

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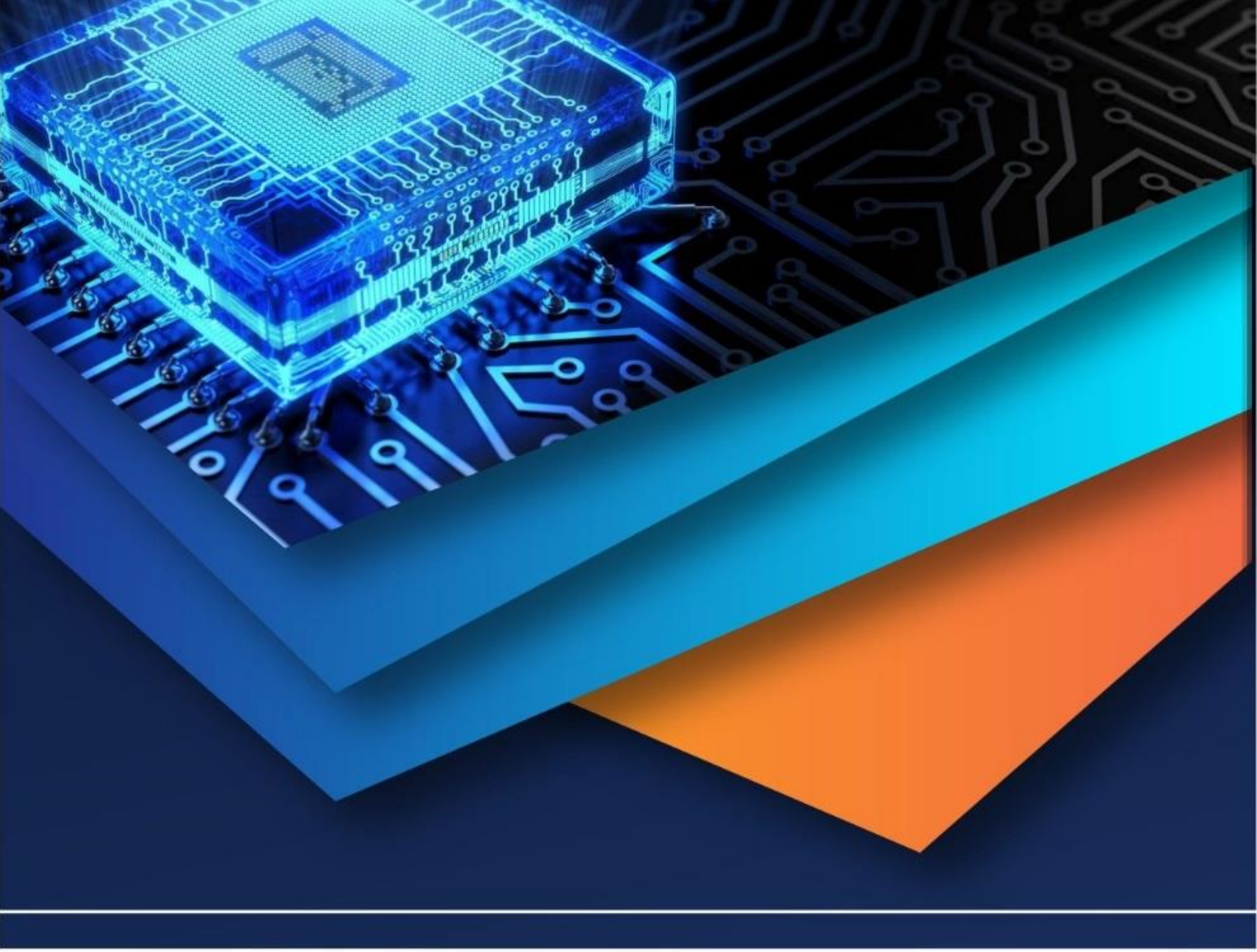

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