EXPERIMENTAL INVESTIGATION OF CONCRETE BY USING BAGASSE ASH AND ADDING STEEL FIBRE

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ABSTRACT

The high strength concrete is a concrete mixture which passes high durability and strength compared to conventional but it has a very low tensile strength, limited and the litted resistance to cracking. Internal micro crack are inherently present in the concrete and its poor tensile is due to the propagation of such micro cracks, eventually leading to brittle fracture of the concrete .so fiber are added to the concrete the inherent tensile strength of concrete itself. In this study, bagasse ash concrete was design with the use of steel fiber .Hooked end steel fibre with 60mm length and 0.75 mm diameter were used.That will produced an advantage of reducing dead weight of the structure and to obtain a more economical structure of bagasse ash power as a partial replacement of steel fibre. Six mixes were produced with the cement content of 465 Kg/m^3 and Water cement ratio 0.40. More over the group had proportion of 0%, 5%, 10%, 15%, 20%, and 25% as replacement. Furthermore, it was observed that the addition of 2% steel fibre significantly enhanced the were cast and tested for compressive strength, Split tensile strength, & Flexural strength after curing period of 7 & 28 days. Sulphuric acid test, Sulphate attack test and Durability test were tested for the concrete specimens The main scope of our project is to learn and gather knowledge of strength, and density. It may help us to get clear idea about the bagasse ash concrete and adding hooked end steel fibres.

***(Keywords:** Bagasse ash concrete, Hooked steel fiber, Compression Strength, Split Tensile Strength, Flexural strength, Durability Test)*

1.INTRODUCTION

Concrete is a composite material containing hydraulic cement, water, coarse aggregate and fine aggregate. The resulting material is a stone like structure which is formed by the chemical reaction of the cement and water. This stone like material is a brittle material which is strong in compression but very weak in tension. This weakness in the concrete makes it to crack under small loads, at the tensile end. These cracks gradually propagate to the compression end of the member and finally, the member breaks. The formation of cracks in the concrete may also occur due to the drying shrinkage. These cracks are basically micro cracks. These cracks increase in size and magnitude as the time elapses and the finally makes the concrete to fail. The formation of cracks is the main reason for the failure of the concrete. To increase the tensile strength of concrete many attempts have been made. One of the successful and most commonly used method is providing steel reinforcement. Steel bars, however, reinforce concrete against local tension only. Cracks in reinforced concrete members extend freely until encountering are bar. Thus need for multidirectional and closely spaced steel reinforcement arises. That cannot be practically possible. Fibre reinforcement gives the solution for this problem. So to increase the tensile strength of concrete a technique of introduction of fibres in concrete is being used. These fibres act as crack arrestors and prevent the propagation of the cracks. These fibres are uniformly distributed and randomly arranged. This concrete is named as fibre reinforced concrete. The main reasons for adding fibres to concrete matrix is to improve the post cracking response of the concrete, i.e., to improve its energy absorption capacity and apparent ductility, and to provide crack resistance and crack control. Also, it helps to maintain structural integrity and cohesiveness in the material. The initial researches combined with the large volume of follow up research have led to the development of a wide variety of material formulations that fit the definition of Fibre Reinforced Concrete.

2. LITERATURE REVIEW

Nuntachai Chusilp et al., [2011] investigated the physical properties of concrete containing ground bagasse ash including compressive strength, water permeability, and heat evolution. Bagasse ash from a sugar factory was ground using a ball mill until the particles retained on a No. 325 sieve were less than 5% by weight. They were then used as a replacement for Type I Portland cement at 10, 20, and 30% by weight of binder. The water to binder (W/B) ratio and binder content of the concrete were held constant at 0.50 and 350 kg/m^3, respectively. The results showed that, at the age of 28 days, the concrete samples containing 10–30% ground bagasse ash by weight of binder had greater compressive strengths than the control concrete, while the water permeability was lower than the control concrete. Concrete containing 20% ground bagasse ash had the highest compressive strength at 113% of the control concrete. The results indicate that ground bagasse ash can be used as a pozzolanic material in concrete with an acceptable strength, lower heat evolution, and reduced water permeability with respect to the control concrete.

A.Bahurudeen et al., [2005] investigated the effect of different bagasse ash replacements of cement on the compatibility with superplasticizers in cement paste. Sugarcane bagasse ash based Portland pozzolana cements were produced with three different levels of replacement – 10%, 15%, and 20%. Marsh cone and mini-slump test were used to determine the effect of superplasticizer type and water binder ratio on the saturation dosage. From this study, it was observed that polycarboxylic ether based superplasticizer was more compatible with bagasse ash blended cement than sulphonated naphthalene based superplasticizer.

Dao Van Dong et al., [2008] investigated several key properties of high strength concrete using rice husk ashes. RHAs obtained from two sources: India and Vietnam were used with various contents to partially replace for cement binder in high strength concrete. Key properties of concrete, including: slump, density, compressive strength, water and chloride permeability resistances, were investigated in comparison between samples without using RHA and samples using two types of RHAs. Experimental results showed reasonable improvements in compressive strength, water and chloride permeability resistances of concrete using the RHAs. The results also presented that the improvements of samples composed the India RHA were much better than that of the Vietnam RHA.

Veera Reddy.M [2014] investigated the flexural behaviour of simply supported beams with steel fibre reinforced high strength rice hush ash cement concrete. The variables in the study are volume of steel fibre and longitudinal reinforcement. Twelve rectangular reinforced concrete beams are cast and tested under two-point loading. Moment and curvatures are calculated from the experimental data and the Moment-curvature diagrams are obtained. It is observed that the addition of steel fibres made the RC sections to behave in a ductile manner even if the sections are over reinforced.

Doo-Yeol Yoo, Young-Soo Yoon [2008] investigated ten large ultra-high-performance concrete (UHPC) beams reinforced with steel rebars were fabricated and tested. The experimental parameters included reinforcement ratio and steel fibre type. Two different reinforcement ratios (ρ = 0.94% and 1.50%) and steel fibre types (smooth and twisted steel fibres) were adopted. In addition, three different fibre lengths (L_f = 13, 19.5, and 30 mm) for the smooth steel fibres and one fibre length (L_f = 30 mm) for the twisted steel fibre were considered. Test results indicated that the addition of steel fibres significantly improved the load carrying capacity, post-cracking stiffness, and cracking response, but it decreased the ductility. Specifically, with the inclusion of 2% by volume of steel fibres, approximately 27–54% higher load carrying capacity and 13–73% lower ductility were obtained.

H.Mazaheripouret al., [2009] investigated the impact of polypropylene fibres on Lightweight Self-Compacting Concrete performance at its fresh condition as well as its mechanical properties at the hardened condition. For the mechanical properties of Lightweight Self-Compacting Concrete, the study has been conducted as follows: compressive strength with elapsed age, splitting tensile strength, elastic modulus and flexural strength, all of which were measured after the sample being cured for 28 days. Applying 0.3% volume fractions of polypropylene fibre to the LLSCC resulted in 40% reduction in the slump flow (from 720 mm to 430 mm). Polypropylene fibres did not influence the compressive strength and elastic modulus of LLSCC, however applying these fibres at their maximum percentage volume determined through this study, increased the tensile strength by 14.4% in the splitting tensile strength test, and 10.7% in the flexural strength.

Saeid Kakooei et al., [2013] investigated the effect of polypropylene fibres in reinforced concrete. The compressive strength, permeability and electric resistivity of concrete samples were studied. The concrete samples were made with different fibres amounts from 0 to 2 kg/m^3. Also, the samples fabricated with coral aggregate and siliceous aggregate were examined and compared. The samples with added polypropylene fibres of 1.5 kg/m^3 showed better results in comparison with the others.

Vahid Afroughsabet and Togay Ozbakkaloglu [2015] investigated the effect of the addition of steel and polypropylene fibres on the mechanical and some durability properties of high-strength concrete. Hooked-end steel fibres with a 60-mm length were used at four different fibre volume fractions of 0.25%, 0.50%, 0.75%, and 1.0%. Polypropylene fibres with a 12-mm length were used at the content of 0.15%, 0.30%, and 0.45%. Some mixtures were produced with the combination of steel and polypropylene fibres at a total fibre volume fraction of 1.0% by volume of concrete, in order to study the effect of fibre hybridization. All the fibre-reinforced concretes contained 10% silica fume as a cement replacement. The compressive strength, splitting tensile strength, flexural strength, electrical resistivity, and water absorption of the concrete mixes were examined. Results of the experimental study indicate that addition of silica fume improves both mechanical and durability properties of plain concrete. The results also indicate that incorporation of steel and polypropylene fibres improved the mechanical properties of HSC at each volume fraction considered in this study. Furthermore, it was observed that the addition of 1% steel fibre significantly enhanced the splitting tensile strength and flexural strength of concrete. Among different combinations of steel and polypropylene fibres investigated, the best performance was attained by a mixture that contained 0.85% steel and 0.15% polypropylene fibre. Finally, the results show that introducing fibres to concrete resulted in a decrease in water absorption and, depending on the type of fibres, significant or slight reduction in the electrical resistivity of concrete compared to those of the companion plain concrete.

Halit Cenan Mertol et al., [2006] investigated the flexural behavior of lightly and heavily reinforced steel fiber concrete beams. The test series consisted of 20 singly reinforced beams having $180 \times 250 \times 3500$ mm dimensions. The main parameters in the testing program were the type of concrete and the amount of longitudinal reinforcement. Ten different longitudinal reinforcement ratios (with a minimum of 0.2% and a maximum of 2.5%) covering the range from under-reinforced to over-reinforced beam behavior were used in the testing program. Two specimens were cast for each longitudinal reinforcement ratio, one specimen using conventional concrete and another specimen using steel fiber reinforced concrete. Load–deflection behaviors were obtained and evaluated in terms of ultimate load, ultimate deflection, service stiffness, post-peak stiffness, and flexural toughness. The results indicate that the use of steel fiber reinforced concrete increases the ultimate load and service stiffness of the beams slightly compared to that of conventional concrete specimens. As reinforcement ratio increases, the ultimate deflection of steel fiber reinforced concrete specimens becomes significantly greater than that of conventional concrete specimens. For over-reinforced sections, the post-peak stiffness of the steel fiber reinforced concrete specimens is observed to be significantly lower than that of conventional concrete specimens. The flexural toughness of steel fiber reinforced concrete specimens is greater than that of conventional concrete specimens with the difference being significantly larger for over-reinforced sections.

3. Expermental Result and Discussion

Selection of material

Collection of data

Identification of property+material

Fresh concrete

Mix design calculation

Finding optimum % of replacement

Preparation of concrete

Test on concrete

Comparative study

Result & conculsion

3.1 PRELIMINARY TEST

S. No	Material Properties	Cement	F.A	C.A
1.	Specific gravity	3.15	2.7	2.78

3.2 FRESH CONCRETE

Following test were conducted on fresh concrete.

- Slump Test
- Compaction Factor Test

Table 3.2.1 Slump Value

S.No.	Water cement ratio	Slump value (mm)
1	0.30	Nil
2	0.35	34
3	0.40	100

Fig 3.2.1 Concrete Filling in Cone

Fig 3.2.2 Slump Value

3.3 COMPACTION FACTOR TEST

Compaction factor value for control concrete is 0.92

3.4 HARDENED CONCRETE

Test which are conducted on hardened concrete are as follows,

- Compression test
- Splitting tensile test
- Flexural strength test

The test which conducted on hardened concrete are given below.

Test Procedure and Results:-

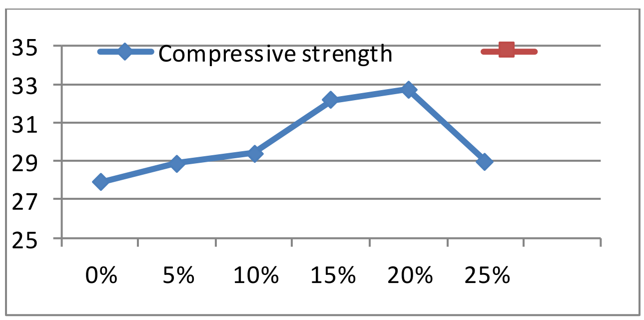
Test specimens of size 150x150x150 mm were prepared for testing the compressive strength concrete. The concrete mixes with varying percentages (0%, 5%, 10%, 15% 20%, and 25%) of bagasse ash as partial replacement of steel fibre were cast into cubes and cylinders for subsequent testing.

Fig 3.4.1 Compression test

3.4.1 COMPRESSIVE STRENGTH OF CONCRETE CUBE SPECIMEN FOR 7 & 28 DAYS

Mix proportion (%)	Compressive strength (N/mm^2)	
	7 Days	28 Days
0	27.99	27.9
5	28.87	28.74
10	29.4	31.5
15	32.15	32.4
20	32.74	33.4
25	29	28.5

Compressive strength for 7and 28 days



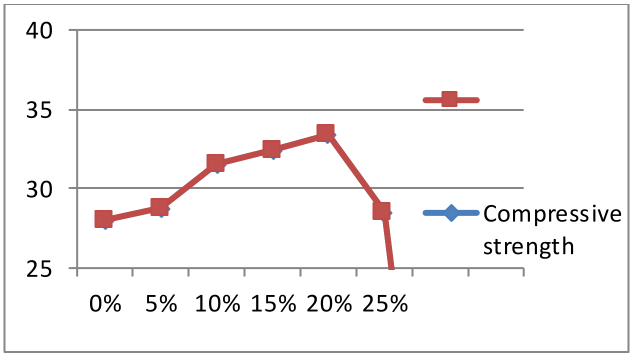


Fig 3.4.1 & 3.4.2

3.5 SPLIT TENSILE STRENGTH TEST

The splitting tensile strength of concrete cylinder was determined based on 516-1959. The load shall be applied nominal rate within the range 1.2 N/ (mm2/min) to 2.4/ (mm2/min). The test was carried out on diameter of 100mm and length of 200mm size cylinder

$$\text{Split Tensile Strength} = \frac{2P}{\pi DL}$$

Where, P = Compressive Load in N

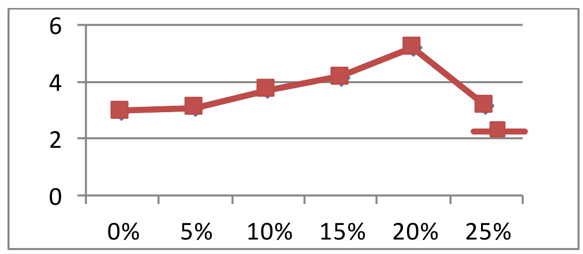
L = Length in mm

D = Diameter in mm

TABLE 3.5 SPLIT TENSILE STRENGTH TEST RESULT FOR BAGASSE ASH AND STEEL FIBRE

3.5.1 Split tensile strength for 7 & 28 days

Mix proportion (%)	Split Tensile Strength (N/mm^2)	
	7 Days	28 Days
0	2.99	4.6
5	3.10	4.96
10	3.72	5.2
15	4.19	5.23
20	5.2	6.06
25	3.16	5.1



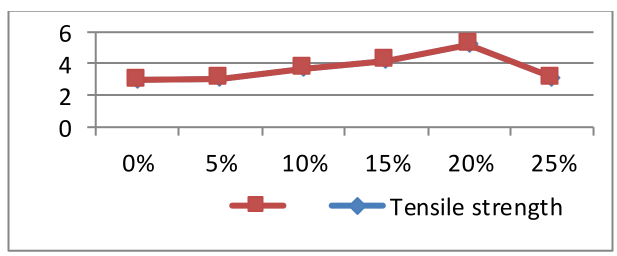


Fig 3.5.1 & 3.5.2

3.6 FLEXURAL STRENGTH TEST

The flexural strength of concrete prism was determined based on IS: 516 –1959. Place the specimen in the machine in such a manner that the load is applied to the upper most surface as cast in the mould along two lines spaced 13.3cm a part. Apply load without shock and increase continuously at a rate of 180 kg/min and it is increased until the sample fails. Measure the distance between the line of fracture and nearest support.

If a > 13.3cm then

3.6.1 FLEXURAL STRENGTH RESULT FOR BAGASSE ASH AND STEEL FIBRE

Mix proportion (%)	Flexural Strength (N/mm^2)	
	7 Days	28 Days
0	2.36	2.85
5	2.95	3.15
10	3.20	4.26
15	3.85	4.95
20	4.55	5.10
25	3.38	4.76

3.7 ACID ATTACK TEST

3.7.1 SULPHURIC ACID TEST

The acid resistivity of concrete was studied by immersing the specimens in acid solution. The test has been conducted for the conventional concrete and concrete specimens replacing bagasse ash and steel fibre. The Specimen size 150 x 150 x 150 mm were casted and cured in water for 28 days. After 28 days of curing the specimens were removed from the curing tank and their surfaces were cleaned with a soft nylon brush to remove weak reaction production and loose material from the specimen. The initial waits where measured and the specimen were immersed in 5% in sulphuric acid solution for next 28 days of acid exposure, specimens were tested for compressive strength and compare with the strength of concrete specimen which were not exposed to acid attack. The result are tabulated

3.7.1 Weight loss and compressive strength loss

Specification (bagasse ash)	Avg. weight of specimen (kg)	Weight of specimens after 60 days (kg)	Loss in weight (%)
0%	8.21	7.72	5.96
5%	8.01	7.53	5.99
10%	8.08	7.61	5.81
15%	8.2	7.80	6.10
20%	7.63	7.33	5.42
25%	7.87	7.49	5.82

3.7.2 SULPHATE ATTACK TEST

The sulphate resistivity of concrete was studied by immersing the specimen in sulphate solution. The test has been conducted using conventional concrete and concrete specimen replacing bagasse ash and Steel fibre. The specimen sizes 150 x 150 x 150 mm were casted and cured in water for 28 days. After 28 days of curing the specimens were removed from the curing tank and their surfaces were cleaned with a soft nylon brush to remove weak reaction products and loose materials from the specimen. The initial weight were measured and the specimens were immersed in 5% sodium sulphate solution for the next 28 days of sulphate exposure, specimen were tested for compressive strength and compared with the strength of concrete specimens which were not exposed to acid environment.

Table : 3.7.2 Weight loss and compressive strength loss

Specification (bagasse ash)	Avg. weight of specimen (kg)	Weight of specimens after 60 days (kg)	Loss in weight (%)
0%	8.26	7.8	5.6
5%	7.87	7.4	6
10%	8.1	7.4	6
15%	8.16	7.56	6.9
20%	7.6	7.38	6.65
25%	7.95	7.45	6.5

4. CONCLUSION

Based on the test results of the experimental investigation using SCBA with addition of steel fibre concrete the following observation can be drawn:

1. Bagasse ash is the by-product material which is used as the cement substitute material. It reduces the level of CO2 emissions by the cement industries and also save a great deal of core materials in cement manufacture

2. As the percentage (%) of partially replacement of bagasse ash in cement increases it normal consistency and its setting time.

3. The percentage of bagasse ash increases the compressive strength of concrete up to certain percentage replaced by weight of cement and then the strength of concrete gets decreased with increasing of bagasse ash. The inclusion of Sugarcane Bagasse Ash (SCBA) is replaced by weight of cement in the various percentages of 0%, 5%, 10%, 15%, 20% and 25% with and without addition of steel fibre. The results for compressive strength of concrete were obtained at 7 and 28 days, respectively.

4. In addition of hooked end steel fiber, the crack formation had been arrested and mechanical and flexural properties of concrete achieve 25% higher than conventional concrete at lower volume fraction of fibre .

5. The high strength fiber reinforced concrete at the volume fraction of 2% enhances compressive strength, split tensile strength and flexural strength 25% by compared to conventional concrete.

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