International Journal For Technological Research In Engineering
Volume 5, Issue 9, May-2018 ISSN (Online): 2347 - 4718

EXPERIMENTAL INVESTIGATION ON EFFECT OF TIMBER WASTE ASH ON FRC

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Abstract: Fiber reinforced concrete (FRC) plays a major role in the modern construction. Concrete has unlimited opportunities for innovative applications, design and construction techniques. Its great versatility and relative economy in filling wide range of needs has made it very competitive building material. The ever raising functional requirements of the structures and the capacity to resist aggressive elements have necessitated developing new cementations materials and concrete composites to meet the higher performance and durability criteria. The environmental factors and pressure of utilizing waste materials from industry have also been the major contributory factors in new developments in the field of concrete technology. In this direction, an attempt has been made in the present investigation to evaluate the workability, compressive strength, split tensile strength and flexure strength on addition of timber waste ash (0 – 30%) along with crimped steel fibers (0-1%) in concrete. Standard cubes of 150 X 150 X 150 mm has been cast and tested for obtaining 28 days and 60-day compressive strength. Standard cylinders of 150mm diameter and 300 mm height were cast and tested for Split tensile strength. Standard Beams of 500mmx100mmx100mm were cast and tested for Flexural strength. Results shows that addition of timber waste ash is found to give optimum results at 20% timber waste ash when fiber content is 0.75%. The results were analysed and discussed.
Key Words: FRC, Timber Waste Ash, Admixture, Concrete, Strength, Durability

I. INTRODUCTION

The strength workability, durability and other characters of the ordinary concrete need modifications to make it more suitable for increased applications of concrete and mortars, in variety of situations. Added to this is the necessity to combat the increasing cost and scarcity of cement. Under these circumstances the use of admixtures is found to be an important alternative solution. The production of superior quality of Ordinary Portland Cement (OPC) in the country was primarily responsible for introducing the grading system in OPC by Bureau of Indian Standard (BIS) during 1986-87. The other varieties of structural cements, such as sulphate resisting Portland cement, Pozzolana cement and blast furnace slag cement found their way in the improve quality of prompted the structural engineers and major consumers to adopt higher grades of concretes in the construction work. This has been marked difference in the quality of concrete during this period primarily due to the availability of superior quality of cements in the market. The trend is continuing more and more varieties of cements are coming to the markets which help to the consumers to make appropriated grade quality of concrete to meet the specific construction requirement. The high performance fiber reinforced, polymer concrete composites and ready mixed concrete have been progressively introduced for specific applications. Because of extensive use of cement, for widely varying conditions, the types of cement that could be made only by varying the relative proportions of the oxide compositions were not found to be sufficient. Recourses have been taken to add one or two more new materials, known as additives, to the clinker at the time of grinding, or to the use of entirely different basic raw materials in the manufacture of cement. The use of additives, changing chemical composition, and use of different raw materials have resulted in the availability of many types of cements to cater to the need of the construction industries for specific purposes. The most important Pozzolana materials are fly ash, silica fume and Metakaolin whose use in cement and concrete is thus likely to be a significant achievement in the development of concrete technology in the coming few decades. The high Performance fiber reinforced, polymer concrete composites and ready mixed concrete have been progressively introduced for specific applications. Little research is focused on use of timber waste ash in FRC. As already mentioned, Timber ash is an admixture: a pozzolana as it is generated as a by-product of combustion in timber-fired power plants, paper mills, and other timber burning factories. Thus this new admixture has lot of potential for use in concrete. Hence, there is need to study the strength and workability characteristics of TWA-FRC(Timber waste ash based FRC).

II. MATERIALS AND METHODS

The objective of present investigation is to study and evaluate the effect of addition of timber waste ash (0, 10, 20 & 30%) and Crimped Steel Fibers (0, 0.5, 0.75 & 1%) in concrete. Cubes of standard size 150mmx150mmx150mm were cast and tested for 28 and 60 days compressive strength. Standard cylinders of size 150mm x 300mm were cast and tested for 28days and 60days split tensile strength. Also standard beams of size 500mm x100mm x 100mm were cast and were tested for 28 days and 60 days flexural strength

Cement: - OPC Cement of 53-grade was used. Coarse Aggregate: - Crushed granite metal with 50% passing 20mm and retained on 12.5mm sieve and 50% passing 12.5mm and retained on 10mm sieve was used. Specific gravity of coarse aggregate was 2.75.

Fine aggregate: - River sand from local sources was used as fine aggregate. The specific gravity of sand is 2.68. Water: - Potable fresh water, which is free from concentration of acid and organic substances was used for mixing the concrete. Fiber: Steel Fibers is supplied by "STEWOLS INDIA (P) LTD, An ISO 9001: 2008 Company" at Nagpur. The most important parameter describing a fiber is its Aspect ratio. "Aspect ratio" is the length of fiber divided by an equivalent diameter of the fiber, where equivalent diameter is the diameter of the circle with an area equal to the cross sectional area of fiber. The properties of FRC are very much affected by the type of fiber. Different types of fibers which have been tried to reinforce concrete are steel, carbon, asbestos, vegetable matter, polypropylene and glass. In the present investigation crimped round fibers used, Aspect ratio of 50.

Timber waste ash: - Timber waste ash is generated as a by-product of combustion in timber-fired power plants, paper mills, and other timber burning factories. In the present research the timber waste ash used, is detained from 300 microns. To evaluate the strength characteristics in terms of compressive, split tensile and flexural strengths, a total of 16 mixes were tried with different percentages of timber waste ash (0,10,20 & 30%) and different percentages of crimped steel fibers (0,0.5,0.75 & 1%). In all mixes the same type of aggregate i.e. crushed granite aggregate; river sand and the same proportion of fine aggregate to total aggregate are used. The relative proportions of cement, coarse aggregate, sand and water are obtained by IS - Code method. M30 is considered as the reference mix.

III. RESULTS AND DISCUSSION

In this section the results obtained from the experimental procedures were tabulated and presented below. The variations of parameters with respect to the percentage of admixtures are also shown in graphs below.

Effect of addition of timber waste ash on workability

The workability of TWA-FRC (Timber Waste ash fibre reinforced concrete) mixes has been measured by conducting Compaction factor test. From Figure 3.1(A) it can be observed that the compaction factor of TWA-FRC mixes decrease with the increase with the addition of timber waste ash content indicating a decrease in the workability. This is due to the absorption of water from the mix by the timber waste ash.

Table 3.1: Workability in terms of Compaction Factor

S.No	% of fiber	Compaction Factor			
		0% TWA	10% TWA	20% TWA	30% TWA
1	0.00% CSF	0.931	0.864	0.822	0.782
2	0.50% CSF	0.863	0.842	0.821	0.786
3	0.75% CSF	0.861	0.844	0.804	0.752
4	1.00% CSF	0.834	0.787	0.761	0.731

Table 3.2 : 28 days Compressive Strength values in N/mm^2

S.No	% of fibre	Compressive Strength (Mpa)			
		0% TWA	10% TWA	20% TWA	30% TWA
1	0.00% CSF	39.2	42.2	43.6	32.9
2	0.50% CSF	41.3	43.8	45.7	34.7
3	0.75% CSF	43.2	45.6	47.8	35.8
4	1.00% CSF	42.8	44.9	47.2	35.2

Table 3.3 : 60 days Compressive Strength values in N/mm^2

S.No	% of fibre	Compressive Strength (Mpa)			
		0% TWA	10% TWA	20% TWA	30% TWA
1	0.00% CSF	42.5	44.9	46.4	33.6
2	0.50% CSF	43.1	45.9	49.4	35.8
3	0.75% CSF	46.2	49.31	52.2	38.3
4	1.00% CSF	44.9	47.9	49.1	36.2

Table 3.4 : 28 days Split Tensile Strength values in N/mm^2

S.No	% of fibre	Split Tensile Strength (Mpa)			
		0% TWA	10% TWA	20% TWA	30% TWA
1	0.00% CSF	4.35	4.52	4.74	3.64
2	0.50% CSF	5.32	5.58	5.81	4.44
3	0.75% CSF	5.64	5.82	6.22	4.67
4	1.00% CSF	5.26	5.65	6.05	4.66

Table 3.5 : 60 days Split Tensile Strength values in N/mm^2

S.No	% of fibre	Split Tensile Strength (Mpa)			
		0% TWA	10% TWA	20% TWA	30% TWA
1	0.00% CSF	4.41	4.58	4.86	3.87
2	0.50% CSF	5.55	5.84	5.98	4.69
3	0.75% CSF	6.21	6.35	6.74	5.14
4	1.00% CSF	5.93	6.19	6.59	4.99

Table 3.6 : 28 days Flexural Strength values in N/mm^2

S.No	% of fibre	Flexural Strength (Mpa)			
		0% TWA	10% TWA	20% TWA	30% TWA
1	0.00% CSF	5.15	5.45	5.61	4.32
2	0.50% CSF	6.23	6.51	6.79	5.17
3	0.75% CSF	6.72	6.99	7.28	5.68
4	1.00% CSF	6.48	6.78	7.09	5.47

Table 3.7: 60 days Flexural Strength values in N/mm^2

S.No	% of fiber	Flexural Strength (Mpa)			
		0% TWA	10% TWA	20% TWA	30% TWA
1	0.00% CSF	5.36	5.59	5.78	4.47
2	0.50% CSF	6.41	6.76	7.07	5.39
3	0.75% CSF	7.26	7.57	7.85	6.12
4	1.00% CSF	6.59	7.38	7.57	5.81

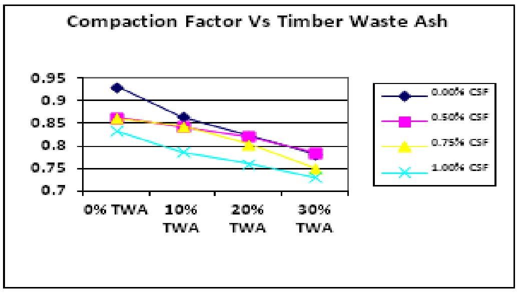

Figure 3.1 (A): Compaction Factor vs. % of Timber Waste Ash

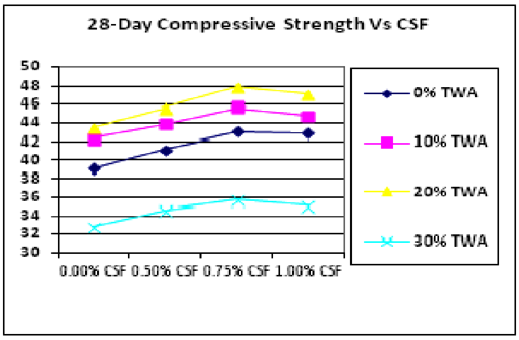

Figure 3.2(A): 28 Days Compressive Strength Vs % of CSF

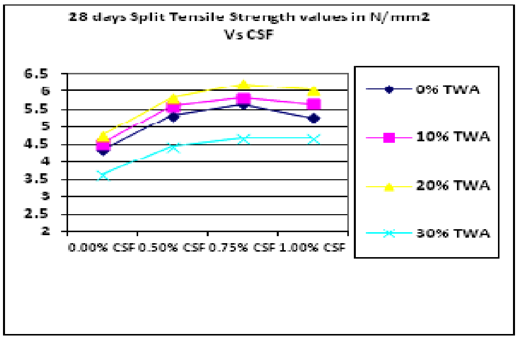

Figure 3.3(A): 28 Days Split Tensile Strength Vs % of CSF

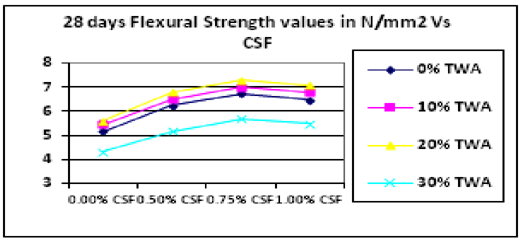

Figure 3.4(A): 28 Days Flexural Strength Vs % of CSF

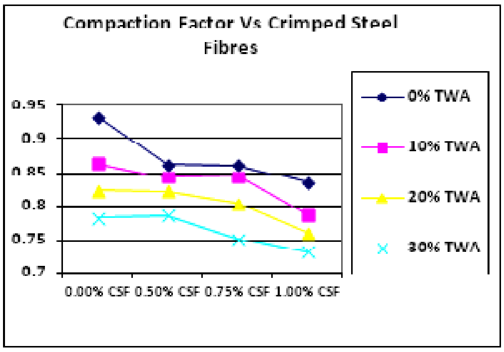

Figure 3.1(B): Compaction Factor Vs % of Crimped Steel Fiber

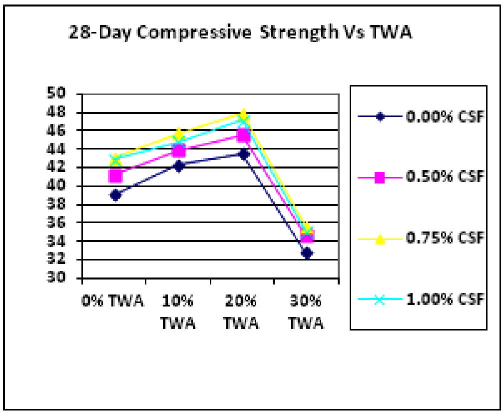

Figure 3.2(B): 28 Days Compressive Strength Vs % of TWA

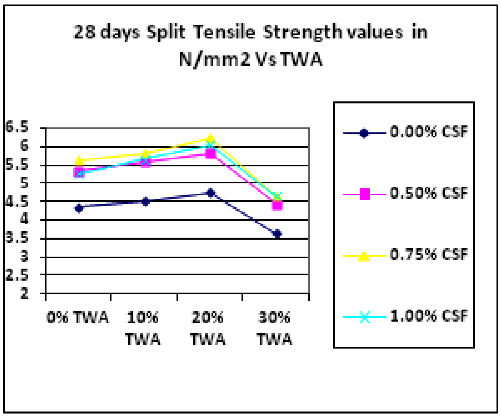

Figure 3.3(B): 28 Days Split Tensile Strength Vs % of TWA

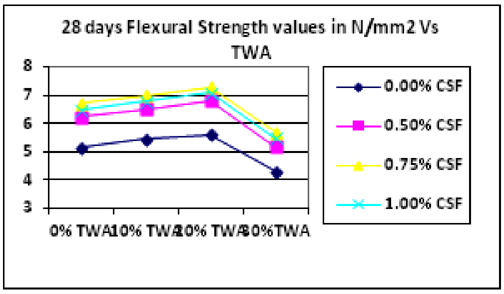

Figure 3.4(B): 28 Days Flexural Strength Vs % of TWA

Effect on workability: It can be observed from the Figure 3.1(B), that the compaction factor decreases with the increase in the percentage of crimped steel fibre. Thus indicating decrease in the workability with the increase in the crimped steel fibre content.

Effect of timber Waste ash on Compressive Strength: From Figure 3.2(A) it can be observed that the 28 days compressive strength increases with the increase in the percentage of timber waste ash up to 20% addition level. On 20% addition of timber waste ash there is increase of cube compressive strength by 11.3% over plain concrete. At 10% level, the compressive strength has increased by 8.18%. But at 30% level, the compressive strength has decreased by 16.1%.

Effect of steel fibres on Compressive Strength: From Figure 3.2(B), it can be observed that with the increase in the percentage of fiber up to 0.75%, the compressive strength has increased by 10.2% over plain concrete. At 0.5% fiber volume the compressive strength has increased by 5.4% and at 1.00% fiber volume the compressive strength has increased by 9.7% respectively. Hence 0.75% of fiber volume can be taken as optimum content.

Effect of timber waste ash on Split Tensile Strength: From Figure 3.3(A) it can be observed that the 28 days split tensile strength increases with the increase in the percentage of timber waste ash up to 20% addition level. On 20% addition of timber waste ash there is increase in split tensile strength by 8.92% over plain concrete. At 10% level, the split tensile strength has increased by 3.20%. But at 30% level, the split tensile strength has decreased by 15.8%.

Effect of steel fibres on Split Tensile Strength: From Figure 3.3(B), it can be observed that with the increase in the percentage of fiber up to 0.75%, the split tensile strength has increased by 29.75% over plain concrete. At 0.5% fiber volume the split tensile strength has increased by 21.51% and at 1.00% fiber volume the split tensile strength has increased by 24.94% respectively. Hence 0.75% of fiber volume can be taken as optimum content.

Effect of timber waste ash on Flexural Strength: From Figure 3.4(A) it can be observed that the 28 days flexural strength increases with the increase in the percentage of timber waste ash up to 20% addition level. On 20% addition of timber waste ash there is increase of flexural strength by 8.93% over plain concrete. At 10% level, the flexural strength has increased by 5.83%. But at 30% level, the split tensile strength has decreased by 16.11%.

Effect of steel fibres on Flexural Strength: From Figure 3.4(B), it can be observed that with the increase in the percentage of fiber up to 0.75%, the flexural strength has increased by 30.48% over plain concrete. At 0.5% fiber volume the flexural strength has increased by 21% and at 1.00% fiber volume the flexural strength has 25.82% respectively.Hence 0.75% of fiber volume can be taken as optimum content.

IV. CONCLUSIONS

Results were analyzed to derive useful conclusions regarding the strength characteristics of timber waste ash FRC (TWA-FRC). M30 concrete has been used as reference mix. The following conclusions may be drawn from the study on strength characteristics of timber waste ash fibre reinforced concrete properties. The workability of concrete measured from compaction factor degree, as the percentage of timber waste ash and steel fibre increases in mix compaction factor decreases. Hence it can be concluded that with the increase in the timber waste ash content and fiber content workability decreases. From the experimental results, the optimum percentage recommended is 0.75% steel fiber volume with 20% addition of in timber waste ash achieving maximum benefits in compressive strengths, split tensile strengths and flexural strengths at any age for the characteristics of timber waste ash fiber reinforced concrete. The compressive strength of TWAFRC mixes at 28 days increased with the addition of timber waste ash up to 20% level when compared to that of plain concrete. Hence for normal concreting works we can go up to 20% addition level of timber waste ash. The maximum percentage increase over plain concrete is 22.50% and the percentage increase ranges from 11.25 to 22.50% over plain mix. Similar trends were observed even at 60 days age. The maximum percentage increase over plain concrete is 26.33% and the percentage increase ranges from 11.83 to 26.33% over plain mix. The split tensile strength of TWA-FRC mixes at 28 days increased with the addition of timber waste ash up to 20% level when compared to that of plain concrete. The maximum percentage increase over plain concrete is 43.47% and the percentage increase ranges from 8.92 to 43.47% over nominal mix. Similar trends were observed even at 60 days age. The maximum percentage increase over plain concrete is 49% and the percentage increase ranges from 7.54 to 49% over nominal mix. The flexural strength of TWA-FRC mixes at 28 days increased with the addition of timber waste ash up to 20% level when compared to that of plain concrete. The maximum percentage increase over plain concrete is 41.36% and the percentage increase ranges from 8.93 to 41.36% over normal mix. Similar trends were observed even at 60 days age. The maximum percentage increase over plain concrete is 46.45% and the percentage increase ranges from 7.83 to 46.45% over normal mix.

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