International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 4 Issue 12, December-2015

Potential of Wood Waste Ash as an Additive in Fibre Reinforced Concrete

Rapeti Muralidhar
M.Tech Student
Civil Engineering Department
Pydah College of Engineering & Technology,
Gambeeram, Visakhapatnam

E. T. Chakripani M.Tech
Professor
Civil Engineering Department
Pydah College of Engineering& Technology,
Gambeeram, Visakhapatnam

***Abstract*—This paper presents the experimental investigation to evaluate the workability, compressive strength and split tensile strength on addition of wood waste ash (0 – 30%) along with crimped steel fibers (0-1%) in concrete. From the experimental results, the optimum percentage recommended is 0.75% steel fiber volume with 20% addition of in wood waste ash achieving maximum benefits in compressive strengths and split tensile strengths at any age for the characteristics of wood waste ash fibre reinforced concrete. A Considerable amount of increase in strength was observed in strength behavior.**

Keywords—Wood waste ash, steel fibres, Compressive strength, Split tensile strength

I. INTRODUCTION

Cementations materials have been used by mankind for construction from time immemorial. The every rising functional requirement of the structures and the capacity to resist aggressive elements has necessitated developing new cementations materials and concrete composites to meet the highest 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.

Concrete is an artificial material in which the aggregates both fine and coarse are bonded together by the cement when mixed with water. The concrete has become so popular and indispensable because of its inherent in concrete brought a revolution in applications of concrete. Concrete has unlimited opportunities for innovative applications, design and construction techniques. Its great versatility and relative economy in filling a wide range of needs has made it a very competitive building material.

With the advancement of technology and increased field of applications of concrete and mortars, the strength workability, durability and other characters of the ordinary concrete need modifications to make it more suitable for a by situation. 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.

Approximately 70% of the wood ash generated is land filled; an additional 20% is applied on land as a soil supplement. The remaining 10% has been used for miscellaneous applications (Campbell, 1990; Etiegni, 1990; Etiegni and Campbell, 1991; NCASI, 1993) including construction materials, metal recovery, and pollution control. In Europe, wood ash is used as a feedstock for cement production and road base material (Greene, 1988). Due to these reasons, many attempts are being made to develop high-volume use technologies for wood ash, especially for use in construction materials (Meyers and Kopecky, 1998).

Not much work has been reported relating to the applications of wood ash as a construction material, particularly in cement-based materials. Due to high carbon content in wood ash, its use is limited to low- and medium-strength concrete materials. In Europe, wood ash has also been used as a feedstock in the manufacture of Portland cement (Etiegni, 1990).

Shieh (1998) study was to determine the production and characteristics of wood ash generated by burning "clean wood", i.e., tree debris and/or non-treated wood waste, using air curtain incinerator (ACI) in Florida.

Singh and Singh (2005) deals with an experimental study on the properties of concrete containing Wood Ash and fibers. Wood Ash content used was 3%, 6%, 9% and 12% of mass basis, and fiber volume fraction was 0%, 0.75%, 1%, 1.25% and 1.50% of volume basis. . Although Wood Ash replacement reduces strength properties, it improves workability, reduces drying shrinkage and increases freeze–thaw resistance of fiber reinforced concrete.

Hence an attempt has been made in the present investigation to evaluate the compressive strength and split tensile strength on addition of wood waste ash (0 – 30%) along with crimped steel fibers (0-1%) in concrete. Wood ash is an admixture: a pozzolana. Wood ash is generated as a by-product of combustion in wood-fired power plants, paper mills, and other wood burning industries.

II. MATERIALS AND METHODS

A. Cement

Cemen OPC Cement of 53 grade was used. The specific gravity of cements 3.1 and normal consistency is 33%.

B. 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.

C. Fine aggregate

River sand from local sources was used as fine aggregate. The specific gravity of sand is 2.68.

D. Water

Potable fresh water, which is free from concentration of acid and organic substances was used for mixing the concrete.

E. 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 fiber reinforced concrete 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. In this paper, Crimped Steel fibers were used, as shown in Plate No: 4.1.

F. Wood waste ash

Wood waste ash is generated as a by-product of combustion in wood-fired power plants, paper mills, and other wood burning factories. In the present research the wood waste ash used, is detained from 300 microns.

G. Cube compressive strength test

Cube compressive strength test was evaluated as per the test procedure given in Indian Standards IS 516.

H. Split tensile strength

Split tensile strength was evaluated as per the test procedure given in Indian Standards IS 5816.

III. Results and Discussions

A. Compressive Strength

The variation of 28 days cube compressive strength of WWAFRC mixes are presented in Figure 1.

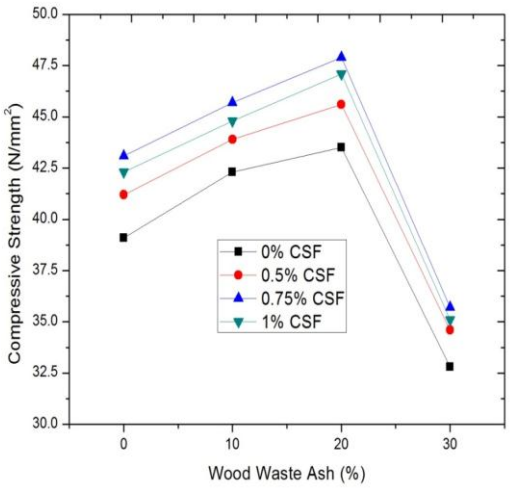

Figure 1. 28 Days Compressive Strength Vs % of Wood Waste Ash

From Figure, it can be observed that the 28 days compressive strength increases with the increase in the percentage of wood waste ash up to 20% addition level. On 20% addition of wood 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%. Similar trends were observed even in case of FRC (Fiber reinforced concrete) mixes on addition of wood waste ash. For example: at 0.75% of fiber volume and on addition of 20% wood waste ash the compressive strength has increased by 11.1% over plain FRC. On 10% addition of wood waste ash there is increase in the compressive strength by 6.03%. But at 30% level, the compressive strength has decreased by 17.2%. Hence 20% addition of wood waste ash is taken as the optimum content. Thus, the effect of addition of wood waste ash is very similar for both plain concrete as well as fiber reinforced concrete.The variation of 28 days and 90days cube compressive strength of wood waste ash fiber reinforced mixes are presented in Figure 2.

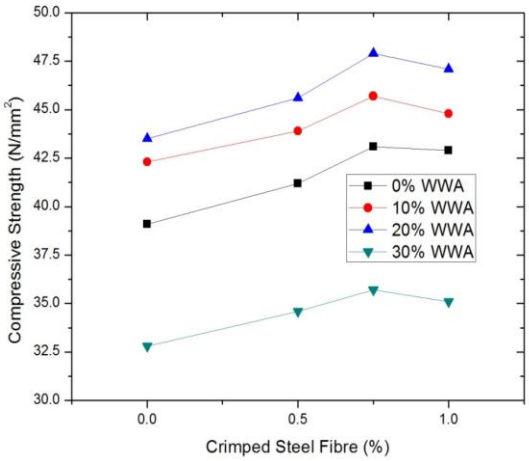

Figure 2. 28 Days Compressive Strength Vs % of Crimped Steel Fiber

From Figure 2, 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. Similar trends were observed even case of WWC mixes on addition of fibers. For example: at 10% wood waste ash level on addition of 0.75% fibers the compressive strength has increased by 8.1%. similarly on addition of 0.5% and 1.00% fibers the compressive strength has increased by 3.78% abd 5.9% respaectively. Hence 0.75% of fiber volume can be considered as the optimum content. Also it can be observed that on 1.00% addition of fiber volume the compressive strength has decreased when compared to that at 0.75% fiber volume. This phenomena is due to the balling effect that takes place due to the increase in the fiber volume. Thus the effect of addition of fibers is very much similar for both plain concrete and wood waste ash concrete.

B. Split tensile strength

The variation of 28 days and 90days Split tensile strength of WWWAFRC mixes are presented in Figure 3.

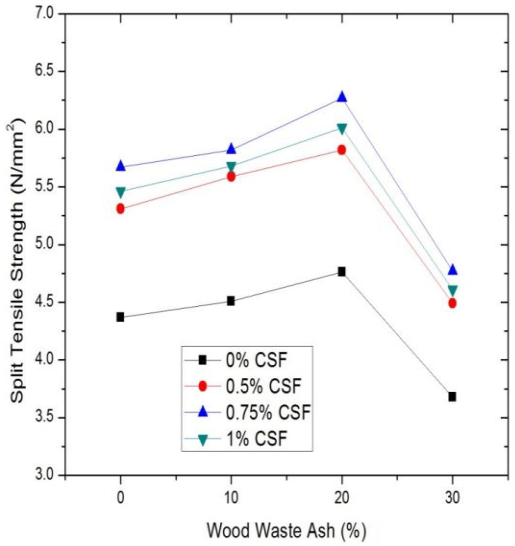

Figure 3. 28 Days Split Tensile Strength Vs % of Wood Waste Ash

From Figure 3, it can be observed that the 28 days split tensile strength increases with the increase in the percentage of wood waste ash up to 20% addition level. On 20% addition of wood 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%. Similar trends were observed even in case of FRC (Fiber reinforced concrete) mixes on addition of wood waste ash. For example: at 0.75% of fiber volume and on addition of 20% wood waste ash the split tensile strength has increased by 10.58% over plain FRC. On 10% addition of wood waste ash there is increase in the split tensile strength by 2.64%. But at 30% level, the split tensile strength has decreased by 15.87%. Hence 20% addition of wood waste ash is taken as the optimum content.

The variation of 28 days and 90days cylinder split tensile strength of wood waste ash fiber reinforced mixes are presented in Figure 4.

From Figure 4, 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. Similar trends were observed even case of WWC mixes on addition of fibers. For example: at 10% wood WWAste ash level on addition of 0.75% fibers the split tensile strength has increased by 29.04%. Similarly on addition of 0.5% and 1.00% fibers the split tensile strength has increased by 23.94% and 25.94% respectively. Hence 0.75% of fiber volume can be considered as the optimum content. Also it can be observed that on 1.00% addition of fiber volume the split tensile strength has decreased when compared to that at 0.75% fiber volume. This phenomena is due to the balling effect that takes place due to the increase in the fiber volume. Thus the effect of addition of fibers is very much similar for both plain concrete and wood waste ash concrete.

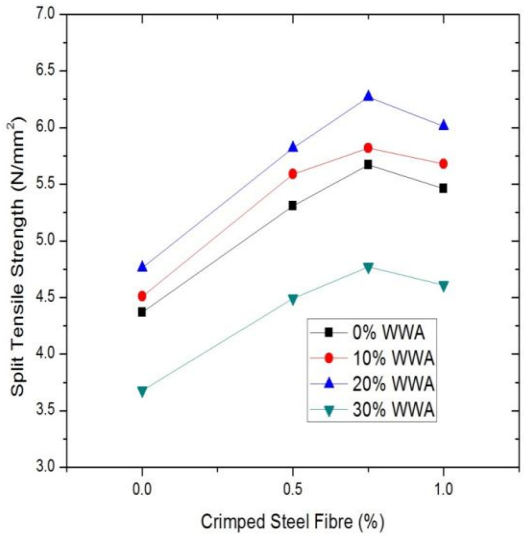

Figure 4. 28 Days Split Tensile Strength Vs % of Crimped Steel Fiber

IV CONCLUSIONS

The following conclusions may be drawn from the study on strength characteristics of wood waste ash fibre reinforced concrete properties.

- From the experimental results, the optimum percentage recommended is 0.75% steel fiber volume with 20% addition of in wood waste ash achieving maximum benefits in compressive strengths, split tensile strengths and flexural strengths at any age for the characteristics of wood waste ash fibre reinforced concrete.
- The compressive strength of WWAFRC mixes at 28 days increased with the addition of wood 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 wood 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 90 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 WWAFRC mixes at 28 days increased with the addition of wood 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 90 days age. The maximum percentage increase over plain concrete is 49% and the percentage increase ranges from 7.54 to 49% over nominal mix.

REFERENCES

[1] A. G. Campbell (1990), "Recycling and Disposing of Wood Ash", Tappi Journal, Pp.141-146.

[2] Etiegni L, Campbell AG (1991), *"Physical and Chemical Characteristics of Wood Ash",* Bio-resource Technology, Elsevier Science Publishers Ltd., Vol.37, No.2, Pp.173–178.

[3] Etiegni (1990), "Mechanical Properties of Steel Fibre Reinforced Rapid-set Materials", ACI Materials Journals, Jul-Aug, Vol.88, No.4, Pp.384-389.

[4] Etiegni and Campbell (1991), "Characterization and Utilization of Wood Ash in the Ceramic Industry", International Ceramic Review, Vol.44, No.1, Pp.31-33.

[5] Greene (1988),"Tests of Wood Ash as a Potential Source for Construction Materials", UWM Centre for By-Products Utilization, Report No.CBU-1999-09, Pp.61.

[6] Meyers and Kopecky (1998), "Use of Wood Ash for Structural Concrete and Flowable,", Solid Waste Management and Research Program, CLSM, Report No. CBU-2000-31, Pp.121.

[7] Singh and Singh (2005), "Fiber Reinforced Cements and Concretes" Advances in Concrete Technology, Gordon and Breach Science publishes, Vol.7, Pp.105-108.

[8] H. Shieh (1998), "Pull-out Mechanisms of Twisted Steel Fibres Embedded in Concrete", Proceedings of International Conference o Applications of Shotcrete, Pp.197-203.