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Study on Strength Properties of F.R.C with Incorporation of Wood Ash

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ABSTRACT

Cementations materials have been utilized by humankind for development from days of yore. The each rising practical prerequisite of the structures and the ability to oppose forceful components has required growing new cementations materials and solid composites to meet the better and strength rules. The ecological factors and weight of using waste materials from industry have additionally been the major contributory components in new advancements in the field of solid innovation.

With the headway of innovation and expanded field of uses of cement and mortars, the quality functionality, strength and different characters of the standard solid need changes to make it more appropriate for a by circumstances. Added to this is the need to battle the expanding cost and shortage of concrete. Under these conditions the utilization of admixtures is discovered to be a significant elective arrangement.

Subsequently an endeavor has been made in the current examination to assess the functionality, compressive quality, part elasticity and flexure quality on expansion of wood squander debris (0 – 50%) alongside creased steel strands (0-2%) in concrete. Wood debris is an admixture: a pozzolana. Wood debris is created as a side-effect of ignition in wood-terminated force plants, paper factories, and other wood consuming businesses.

The extent of present examination is

- To study the usefulness regarding compaction factor of wood squander debris basedfiber strengthened cement
- To study the quality attributes regarding compressive, split tensile and flexure qualities of wood squander debris basedfiber fortified cement

Standard shapes of 150 X 150 X 150 mm have been projected and tried for getting 7 days and 28 days compressive Strength.

Standard chambers of 150mm width and 300 mm tallness were projected and tried for Split rigidity.

Keywords: Ecological Factors, Debris Based Fiber, Wood Ash

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I. INTRODUCTION

India is the second biggest maker of concrete on the globe after China. Altogether, India makes 251.2 Million Tons of concrete for every year. The concrete business in India has gotten an extraordinary force from various framework ventures taken up by the Government of India like street organizations and lodging offices. While the Indian concrete industry appreciates a sensational period of development, specialists uncover that it is ready towards an exceptionally prosperous future over the ongoing years. The yearly interest for concrete in India is reliably developing at 8-10%. NCAER has assessed after a broad investigation that the interest for concrete in the nation is relied upon to increment to 244.82 million tons by 2012. Simultaneously, the interest will be at 311.37 million tones if the projections of the street and lodging portions are met truly

Concrete is the world's most burned-through man-made material. To deliver 1 ton of Portland concrete, 1.5 huge amounts of crude materials are required. These materials incorporate great quality limestone and dirt. Along these lines, to produce 1.5 billion tons of concrete every year, in any event 2.3 billion tons of crude materials are required. More than 5-million BTU of energy is expected to deliver one tone of concrete. In the year 1914, India Cement Company Ltd began concrete creation in Porbandar with a yield of 10,000 tons and a creation of 1000 introduced limit. At the hour of autonomy 1947, the introduced limit of concrete plants in India was roughly 4.5 million tons and genuine creation around 3.2 million tons for every year. The fractional profound control in 1982 provoked different mechanical houses to set an arrangement new concrete plants in the nation, limit was almost 30 million tons, which has now, increment to almost 120 million tons during a time of 20 years. The full decontrol on concrete industry in 1988 further gave energy to the development.

The creation of unrivaled nature of Ordinary Portland Cement (OPC) in the nation was basically answerable for presenting the reviewing framework in OPC by Bureau of Indian Standard (BIS) during 1986-87. Different assortments of auxiliary concretes, for example, sulfate opposing Portland concrete, Pozzolana concrete and impact heater slag concrete discovered their way in the improve nature of incited the basic architects and significant shoppers to embrace higher levels of cements in the development work. This has been stamped distinction in the nature of cement during this period principally because of the accessibility of predominant nature of concretes in the market. The pattern is proceeding with an ever increasing number of assortments of concretes are going to the business sectors which help to the purchasers to make appropriated level nature of cement to meet the particular development prerequisite. The superior fiber fortified, polymer solid composites and prepared blended cement have been logically presented for explicit applications.

Concrete and steel are accessible in the unregulated economy and the sturdiness of cement was ensured and was obvious. The strengthened cement has become a typical structure material on account of its natural qualities, for example,

- High quality and sturdiness
- Easy plan strategies to suit any kind of forceful ecological conditions.
- Modularity to required size and shape
- Resistance to fire.
- Flexibility to expand or lessen without genuine endeavors and results.
- Cracking and harm control. Simple upkeep.

With the progression of innovation and expanded field of utilizations of cement and mortars, the quality usefulness, strength and different characters of the customary solid need changes to make it more appropriate by circumstances. Added to this is the need to battle the expanding cost and shortage of concrete. Under these conditions the utilization of admixtures is discovered to be a significant elective arrangement.

The utilization of Pozzolana materials in concrete cement cleared an answer for

1. Modifying the properties of the solid
2. Controlling the solid creation cost
3. To defeat the shortage of concrete
4. The monetary points of interest removal of modern squanders

The most significant Pozzolana materials are fly debris, silica smoke and Metakaolin whose utilization in concrete and cement is consequently liable to be a critical accomplishment in the improvement of solid innovation in the coming hardly any many years.

Information, item quality and promoting administrations to the purchasers. The pattern is proceeding and an ever increasing number of assortments of concretes are going to the market which assists with devouring to make proper level and nature of cement to meet the particular development necessity. There has been a noteworthy development in the field of solid innovation moreover. The superior fiber fortified, polymer solid composites and prepared blended cement have been dynamically presented for explicit applications.

The word 'pozzolana' was gotten from pozzolana, a town in Italy, a couple of miles from Naples and mount vacuous. The materials are of volcanic area containing different sections of pumice, obsidian, feldspars, and quartz and so forth the name 'Pozzolana' was first applied only to this material. In any case, the term has been stretched out later to diatomaceous earth, exceptionally siliceous rocks and other fake items. Consequently, the pozzolanic materials are regular or counterfeit having almost similar organization as that of volcanic tuffs or debris found at pozzolana.

NEED FOR PRESENT INVESTIGATION:

Though a lot of research is focused in the last decade on use of various admixtures in producing concrete, very little information is available on wood waste ash fiber reinforced concrete. As already mentioned, Wood ash is an admixture: a pozzolana as it is generated as a by-product of combustion in wood-fired power plants, paper mills, and other wood 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 WWAFRC(Wood waste ash based fiber reinforced concrete).

II. LITERATURE

2.1 WOOD WASTE ASH

Wood Waste Ash (WWA) is the buildup created because of burning of wood and wood items (chips, saw dust, bark, and so forth) It is the inorganic and natural buildup staying after the ignition of wood or unbleached wood fiber. The physical and synthetic properties of wood debris shift fundamentally relying upon numerous elements. The physical and substance of wood debris, which deciding its valuable uses, are reliant upon the types of the wood debris the burning techniques that incorporate ignition temperature, effectiveness of the kettle, and strengthening fills utilized.

Ordinarily, wood debris contains carbon in the scope of 5-30% (Campbell, 2009). The significant components of wood debris incorporate calcium (7-30%), potassium (3-4%), magnesium (1-2%), manganese (0.3-1.3%), phosphorus (0.3-1.4%) and sodium, (0.2-0.5%). Thickness of wood debris diminishes with expanding carbon content. The synthetic and physical properties rely on the kind of wood, ignition temperature, and so on

Ordinarily wood consumed for fuel at mash and paper factories and wood items businesses may comprise of saw dust, wood chips, bark and saw plant scraps, hard chips dismissed from pulping, overabundance screenings, for example, stacks and essential residuals without blended auxiliary residuals. Physical and compound properties of wood debris are significant in deciding their useful employments. These properties are impacted by types of tree, tree developing areas and conditions, technique and way of burning including temperature, other fuel utilized with wood fuel, and strategy for wood debris assortment. Further quality variety in the wood debris properties happen when wood is co-terminated with other advantageous powers, for example, coal, coke, gas and the general amount of wood versus such different powers

2.2 Physical Properties:

Naik TR (2011) decided the physical and compound properties of wood remains got from various plants. Filtering Electron Microscopy (SEM) was utilized to decide state of wood debris particles. The SEM micrographs demonstrated wood cinders as a heterogeneous combination of particles of shifting sizes, which were commonly rakish fit as a fiddle. The wood debris comprised of cell particles, which were unburned, or incompletely consumed wood or bark particles. The normal dampness content qualities for the wood debris read were about 13% for wood debris and 22% for base debris. The normal measure of wood debris passing strainer No.200 (75μm) was half. The normal measure of wood debris held on sifter No. 325 (45μm) was about 31% for wood debris. Test results for unit weight or mass thickness (ASTM C 29) displayed normal thickness estimations of 490 kg/m3 for wood debris and 827 kg/m3 for base debris. Wood debris had a normal explicit gravity estimation of 2.48. Explicit gravity for base debris indicated a normal of 1.65. The normal soaked surface dry (SSD) dampness content qualities were 10.3% for wood debris and 7.5% for base debris. The normal concrete action record at 28 years old days for wood debris was about 66% of the control. The normal water prerequisite for wood debris showed an estimation of 116%. Autoclave extension tests for wood debris displayed a low normal development estimation of 0.2%.

Naik TR, Kraus RN (2012) assessed the wood cinders from five distinct hotspots for conceivable use in making controlled low-quality materials (CLSM). They utilized wood cinders from five distinct sources in Wisconsin (USA) and were assigned as W1, W2, W3, W4, and W5. ASTM norms don't exist for wood debris. Each wellspring of wood debris displayed distinctive physical properties. Fineness of the wood debris (% held on 45μm sifter) fluctuated from 23 to 90%. SourceW1 andW5 met the ASTM necessity for fineness (34% most extreme), while sourcesW2, W3 andW4 surpassed as far as possible. The quality movement file of the wood debris is a correlation of the compressive quality advancement of 50mm mortar shapes that have 20% (by mass) supplanting of concrete with wood debris, with compressive quality of standard concrete mortar. Wood cinders W1 and W3 met the quality movement list prerequisite of ASTM (75% least at either 7 or 28 days), while wood remains W2, W4 and W5 didn't meet the necessity. In any case, sources W1 and W3 fulfilled the prerequisite for normal Pozzolana. The higher water prerequisite showed that for cement and CLSM containing wood debris, more water would be needed to create same droop or stream as contrasted and the control combination. Unit weight estimations of the wood remains W1, W2, W4, and W5 were 545, 412, 509, and 162 kg/m3, individually. These unit loads are essentially not exactly the unit weight of a run of the mill ASTM Class C or Class F wood debris (roughly 100 to 1300 kg/m3). SourceW3 had a unit weight of 1376 kg/m3. Explicit gravity of wood debris sources went from 2.26 to 2.60. Explicit gravity of wood debris source W1 and W5 was lower than that of a commonplace coal wood debris (around 2.40–2.60).

Udoeyo FF, Inyang H, Young DT, Oparadu, EE (2013) detailed the physical properties of waste wood debris (WWA), utilized as added substance in concrete. They utilized wood squander gathered from a dump site at the lumber market in Uyo, Akwa Ibom State of Nigeria. The waste was exposed to a temperature of 1000◦C in a broiler to burn it into debris before it was utilized as an added substance in concrete. The WWA had a particular gravity of 2.43, a dampness substance of 1.81%, and a pH estimation of 10.48. The normal misfortune on start of the debris was discovered to be 10.46.

Abdullahi (2014) decided the properties of wood debris to be utilized as incomplete substitution of concrete. The wood debris utilized was fine, formless strong, sourced locally, from a bread kitchen. The wood debris was gone through BS strainer 0.075mm size. The particular gravity of wood debris was discovered to be 2.13. The mass thickness of wood debris was discovered to be 760 kg/m3.

2.3 Chemical properties

Naik TR, Kraus RN (2007) studied the chemical composition of wood ashes from five different sources for their possible use in making Controlled Low-Strength Materials (CLSM). ASTM standards do not exist for wood ash. The nearest ASTM standard (ASTM C 618, 1994) available is for coal ash and volcanic ash, was used for analysis of its properties. All wood ashes did not meet all the chemical requirements of ASTM C 618, particularly for the amount of carbon as shown by LOI test results. The LOI obtained for the wood ashes ranged from 6.7 to 58.1%. These high LOI ashes probably will present some difficulties when developing air-entrained concrete mixtures. The high carbon content tends to reduce the amount of air entrained in the concrete mixture and thus requires higher dosages of air-entraining admixtures. However, the higher carbon contents of the wood ashes should not affect the performance of these ashes in CLSM. Wood ash W-2 showed a very low value of SiO_2 + Al_2O_3 + Fe_2O_3 (23.4% most likely due to its high LOI).

Udoeyo FF, Inyang H, Young DT, Oparadu, EE (2008) reported the chemical composition of waste wood ash (WWA). The results of the oxide concentrations of the ash, measured using an X-ray diffraction (XRD) test, showed that its major oxide components are: CaO, SiO_2, Al_2O_3, K_2O, Fe_2O_3, MgO, SO_3, TiO_2, and P_2O_5. Other substances, such as Na_2O, ZnO, Cl, MnO, SrO, Cr_2O_3, CuO, ZrO_2, and Rb_2O, were found in trace amounts. The chemical analysis showed that the ash has silicon dioxide (SiO_2), aluminum oxide (Al_2O_3), and iron oxide (Fe_2O_3) values of 20.8, 11.6, and 5.37, respectively. A combination of the percentage masses of these three oxides gives a total of 37.8%, which is less than the 70% limit specified for Pozzolana in ASTM C 618 (1994).

2.4 Steel fibers

Steel fibers have been used in concrete since the early 1900s. The early fibers were round and smooth and the wire was cut or chopped to the required lengths. The use of straight, smooth fibers has largely disappeared and modern fibers have either rough surfaces, hooked ends or are crimped or undulated through their length. Modern commercially available steel fibers are manufactured from drawn steel wire, from slit sheet steel or by the melt-extraction process which produces fibers that have a crescent-shaped cross section. Typically steel fibers have equivalent diameters (based on cross sectional area) of from 0.15 mm to 2 mm and lengths from 7 to 75 mm. Aspect ratios generally range from 20 to 100. (Aspect ratio is defined as the ratio between fiber length and its equivalent diameter, which is the diameter of a circle with an area equal to the cross-sectional area of the fiber).

Some fibers are collated into bundles using water-soluble glue to facilitate handling and mixing. Steel fibers have high tensile strength (0,5 – 2GPa) and modulus of elasticity (200GPa), a ductile/plastic stress-strain characteristic and low creep.

2.1.1 Application of FRC:

The uses of FRC over the past thirty years have been so varied and so widespread, that it is difficult to categorize them. The most common applications are pavements, tunnel linings, pavements and slabs, shotcrete and now shotcrete also containing silica fume, airport pavements, bridge deck slab repairs, and so on. There has also been some recent experimental work on roller-compacted concrete (RCC) reinforced with steel fibres. The list is endless, apparently limited only by the ingenuity of the engineers involved. The fibres themselves are, unfortunately, relatively expensive; a 1% steel fibre addition will approximately double the material costs of the concrete, and this has tended to limit the use of FRC to special applications.

III. SCOPE OF INVESTIGATION

3.1 GENERAL

The scope of present investigation is to study and evaluate the effect of addition of wood waste ash (0, 10, 20 , 30 ,40 & 50%) and Crimped Steel Fibers (0, 0.5, 1.0, 1.5 & 2%) in concrete. Cubes of standard size 150mmx150mmx150mm were cast and tested for 7 and 28 days compressive strength. Standard cylinders of size 150mm x 300mm were cast and tested for 28days and 90days split tensile strength. Also standard beams of size 500mm x100mm x 100mm were cast and were tested for 28 days and 90 days flexural strength

3.2 OBJECTIVES

The specific objectives of the present investigations are as listed below.

- → To conduct feasibility study of producing wood waste ash concrete using Steel Fibers
- → To evaluate the workability characteristics in terms of compaction factor addition of wood waste ash (0-50%) along with steel fibers (0-2%)
- → To evaluate the compressive strengths at 7 and 28 days of WWAFRC
- → To evaluate the split tensile strengths at 7 and 28 days of WWAFRC
- → To evaluate the Flexural strengths at 7 and 28 days of WWAFRC

3.3 TEST PROGRAMME

To evaluate the strength characteristics in terms of compressive, split tensile and flexural strengths, a total of 24 mixes were tried with different percentages of wood waste ash (0, 10, 20 , 30 ,40 & 50%) and different percentages of crimped steel fibers (0, 0.5, 1.0, 1.5 & 2%). 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. M20 is considered as the reference mix.(Appendix-I)

The parameters studies are:

- Percentage of Wood Ash – 0, 10, 20 , 30 ,40 & 50%
- Percentage of Crimped Steel Fiber – 0, 0.5, 1.0, 1.5 & 2%

For each mix, 6 cubes of size 150 x 150 x 150 mm and 6 cylinders of 150 mm diameter & 300 mm height and 6 flexural beams of size 500 x 100 x 100 mm were cast and tested. A sample calculation for determination of weight and volumes is presented in Appendix-II. The test programmed consisted of conducting Compressive tests on Cubes, Split Tensile tests on Cylinders and Flexural strength on beams at 7 and 28 days.

IV. EXPERIMENTAL INVESTIGATION AND TEST RESULTS

A) Compaction factor test:

The contraption for leading compaction factor test. The compaction factor test contraption comprises of two containers, each looking like frustum of a cone and one chamber. The upper container is loaded up with solid this being set tenderly so no work is done on the solid at this stage to create compaction. The subsequent container is more modest than the upper one and is accordingly filled to flooding. The solid is permitted to fall in to the lower container by opening the secret entryway and afterward into the round and hollow shape set at the base. Overabundance concrete over the head of the barrel shaped form is cut and the net load of the solid in chamber is resolved. This gives the heaviness of incompletely compacted concrete. At that point the round and hollow form is loaded up with concrete in layers of 5cm profundity by compacting each layer completely. The completely compacted weight is then decided and compaction factor (C.F).

Weight of incompletely compacted concrete

Weight of completely compacted concrete

4.3 TEST SET UP AND TESTING

A) Cube compressive quality test:

The test set ready for directing 3D shape compressive quality test is portrayed. Pressure test on the blocks is led on the 2000 kN AIMIL - make computerized pressure testing machine. The weight check of the machine demonstrating the heap has a least tally of 1 kN. The block was set in the pressure testing machine and the heap on the solid shape is applied at a consistent rate up to the disappointment of the example and a definitive burden is noted. The 3D square compressive quality of the solid blend is then processed. An example estimation for assurance of 3D square compressive quality is introduced in Appendix-III (A). This test has been done on shape examples at 7 days and 28days age.

B) Split Tensile test

This test is directed on 2000 kN AIMIL make computerized pressure testing machine. The chambers arranged for testing are 150 mm in distance across and 300 mm long. Subsequent to taking note of the heaviness of the chamber, polar lines are drawn on the two finishes, with the end goal that they are in a similar hub plane. At that point the chamber is set on the base pressure plate of the testing machine and is adjusted with the end goal that the lines set apart on the finishes of the example are vertical. At that point the top pressure plate is brought into contact at the head of the chamber. The heap is applied at uniform rate, until the chamber comes up short and the heap is recorded. From this heap, the parting rigidity is determined for every example. An example estimation for calculation of split rigidity is introduced in Appendix-III (B). In the current work, this test has been directed on chamber examples following 7 days and 28 days of relieving.

V. RESULTS & DISCUSSION

Workability in terms of Compaction Factor

S.No	% of fiber	Compaction Factor					
		0% WWA	10% WWA	20% WWA	30% WWA	40% WWA	50% WWA
1	0%	0.927	0.856	0.815	0.775	0.784	0.698
2	0.5%	0.916	0.842	0.812	0.765	0.734	0.688
3	1%	0.863	0.844	0.814	0.766	0.766	0.666
	2%	0.842	0.824	0.784	0.732	0.732	0.652

7 days Compressive Strength values in N/mm^2

% of fiber	Compressive Strength (Mpa)					
	0% WWA	10% WWA	20% WWA	30% WWA	40% WWA	50% WWA
0%	28.3	20.6	22.3	11.6	10.4	19.8
0.5%	27.1	29.8	31.6	20.8	19.6	18.4
1%	31.6	33.3	34.4	26.4	24.1	20.3
2%	32.3	32.3	35.6	24.3	21.3	19.6

28 days Compressive Strength values in N/mm^2

% of fiber	Compressive Strength (Mpa)					
	0% WWA	10% WWA	20% WWA	30% WWA	40% WWA	50% WWA
0%	38.3	40.6	42.3	31.6	30.4	29.8
0.5%	37.1	39.8	41.6	30.8	29.6	28.4
1%	41.6	43.3	44.4	36.4	34.1	30.3
2%	42.3	42.3	45.6	34.3	31.3	29.6

Split tensile strength

7 days Split Tensile Strength values in N/mm^2

% of fiber	Split Tensile Strength (Mpa)					
	0% WWA	10% WWA	20% WWA	30% WWA	40% WWA	50% WWA
0%	3.28	3.41	3.56	2.48	2.24	2.16
0.5%	4.28	4.41	4.56	4.48	4.24	4.16
1%	4.31	4.59	4.82	3.49	3.36	3.28
2%	3.67	3.82	5.27	3.77	3.52	3.16

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

% of fiber	Split Tensile Strength (Mpa)					
	0% WWA	10% WWA	20% WWA	30% WWA	40% WWA	50% WWA
0%	4.28	4.41	4.56	3.48	3.24	3.16
0.5%	5.28	5.41	5.56	5.48	5.24	5.16
1%	5.31	5.59	5.82	4.49	4.36	4.28
2%	2.67	2.82	4.27	2.77	2.52	2.16

VI. CONCLUSION

Results were analyzed to derive useful conclusions regarding the strength characteristics of wood waste ash fiber reinforced concrete (WWAFRC). M20 concrete has been used as reference mix.

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

- The workability of concrete measured from compaction factor degree, as the percentage of wood waste ash and steel fibre increases in mix compaction factor decreases. Hence it can be concluded that with the increase in the wood waste ash content and fiber content workability decreases.

- The workability of concrete measured from vee-bee degree, as the percentage of wood waste ash and steel fibre increases in mix the vee bee time increases. Hence it can be concluded that with the increase in the wood waste ash content and fiber content workability decreases.
- From the experimental results, the optimum percentage recommended is 0.5 & 1% steel fiber volume with 20 & 30% 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 30% level when compared to that of plain concrete. Hence for normal concreting works we can go up to 20% addition level of wood wasteash.

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