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AN EXPERIMENTAL STUDY ON PARTIAL REPLACEMENT OF CEMENT WITH WOOD ASH: A RESEARCH

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ABSTRACT

Wood ash is generated as residue/waste from combustion done in boilers at pulp and paper mills, steam power plants, and other thermal power generating facilities. Since wood is a renewable resource for energy and an environmentally friendly material, there is an increased requirement of using waste wood for the purpose of energy production thus leading to formation of more wood ash waste. The study focuses on incorporation of wood ash in combination with ordinary Portland cement while using it for various structural works. A critical review study analysis, consistency and water absorption, setting time and slump test of wood ash added to OPC will produce significant result to emphasize the details study process uncontrolled burning of saw dust to form wood ash in used as a partial replacement of cement ,thereby changing its physical, chemical properties. These properties are found somewhat to similar to flyash. The concrete mixes are replaced with the amorphous wood ash an admixture of cement having grain size less than 75 microns in proportions of 10%, 15% and 20% by weight of cement. In this Study, a research work is conducted for determining the change in workability or consistency of concrete mix, compressive strength along with review of some durability properties.

Keywords: ASTM, Carbonation, Cement, Compressive strength, Saw dust

1. INTRODUCTION

In the era of urbabization now the demand for renewable energy resources have further increased. A part of these resources is made by biomass resources including forestry and agricultural biomasses are considered as efficient and favorable sources fuel for energy production as their availability is in abundance and cheap. In the current period of energy production, power plants which run from biomass industries like sawdust, woodchips, and wood bark etc.can be used as fuel offer a better way for their safe and efficient disposal. The tree residual solid wastes of these agricultural components are produced by thermal incineration which is environmentally safe and economic. These wood ash wastes can be obtained in abundance from industries which require wood as their fuel for operating their boiler units.

The wood ash incorporated as partial replacement of cement helps avoiding insignificant and bulk consumption of pure cement. Besides this production of cement material all alone results in increased emission of certain greenhouse gases and much more pollutants. Hence replacing with wood ash leads to less production of cement, thus proving environmentally safe. At present most of the biomass ash produced from power plants

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and timber factories is disposed using land filling. A detailed study or research is being done to obtain different replacement material for cement.

1.1 OBJECTIVES

The study focuses on the characteristics of wood ash and the properties incurred due to replacement of cement with wood ash. The objectives are:

1. To study the mechanical strength (compressive and tensile strength) of concrete along with the wood ash as partial replacement of cement.
2. To study the carbonation and drying shrinkage.

1.2 Physical properties of wood ash

Wood ash particles are of different sizes and shapes. To obtain the fineness for replacement with cement sieve analysis is carried. Physical properties of wood ash of varying shapes. The average loss on ignition was found out to be equal to 10.46.

1.3 Chemical properties

Some of the major components of wood ash are lime, (Ca (OH) 2), CaCO3 and calcium silicate.

2. MATERIALS AND METHODS

CEMENT: Ordinary Portland cement is used having specific gravity of 3.01. The physical and chemical analysis properties are provide in table---

Constituents (% age)	Values
SiO2	21.25
Al2O3	5.04
Fe2 O3	3.24
CaO	63.61
MgO	4.56
Loss on ignition	3.26
Specific gravity	3.01

WOOD ASH: The wood ash is obtained by incineration of carpentry waste and other agricultural wastes like rotten wood.

AGGREGATE: Course aggregate used which pass through 20 mm sieve and retained at 12.5 mm sieve having specific gravity of 2.6.

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2.1 METHODOLOGY

Selection of mix proportion: The target compressive strength for M20 mix was calculated according to IS: 10262 2009 as 27.8 N/mm2 for 28 days. The water-cement ratio, sand and coarse aggregate content was accordingly then carried as per the IS code.

Cement content = 409.9 kg/m3

Sand content = 545 kg/m3

Coarse aggregate content = 1136 kg/m3

Preparation of mix: Preparation of control mix M20 considered was done first for the which the trial mix having water-cement ratio of 0.5 was prepared. Control specimen was casted for 7 days, 14 days and 28 days. Secondly the preparation of mix for same 0.5 water cement ratio was done along with wood ash in different proportions of 10%, 15% and 20% by weight of OPC.

Cubes of 150 mm*150 mm* 150 mm were casted to check compressive strength. A minimum 3 specimens were casted for a single test to analyse.Whole procedure was carried at room temperature.

Curing of blocks: Curing of all specimens was done after 2 days.

3. RESULTS AND DISCUSSION

The replacement percentage was 10%, 15% and 20% by weight of cement. Tests were conducted on 7 days, 14 days and 28 days using CTM. The results are provided in table

% of wood ash added	7 days	14 days	28 days
10%	16.60	19.04	26.32
15%	17.47	21.43	28.20
20%	16.23	22.65	27.43

The conclusions drawn based on the results are:

1. With the use of wood ash there was an increase in the compressive strength obtained for respective days.
2. The optimum results were obtained at 15% replacement.
3. There was increase in ductile behaviour of concrete for wood ash replacement when tested under CTM. The time required to break the wood ash specimen was long enough as compared to break the control specimen, as the developments of cracks started increasing slowly under same rate of loading. Wood ash was used to replace cement in percentage 10%, 15% and 20% by weight of cement, the optimum and significant results were shown on 10% of replacement exhibited higher 28 days strength.

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(a) (b)

Figure 2: Compressive strength testing.

Figure 5: Failure of specimen along with wood ash.

WATER ABSORPTION

An increase in water absorption was observed maximum for 15% at 28 days which indicates that rate of pozzolonic reaction is much higher at 15% replacement. Beyond replacement the water absorption significantly decreased.

CARBONATION

The carbonation results along with the wood ash as partial replacement when water cement ratio of 0.55 was observed to decrease, providing optimum results at 10% replacement. The test for carbonation showed that with 10% incorporation of wood ash in cement resulted in reduction in depth of carbonation.

Figure 4: Failure of control specimen.

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4. CONCLUSIONS

1. Introducing wood ash into concrete slightly influenced its workability, unit weight, and entrapped air content.
2. The use of wood ash in concrete generally decelerated the setting of concrete.
3. using of wood ash to partially replace cement in conventional concrete reduced in early age and 28 days compressive strength.
4. Up to 60% of wood ash by weight of sand is successfully incorporated into the flow able fill mixture.
5. The use of wood ash to partially replace cement has more impact on main properties like strengths, setting time and hardness.
6. Bulk density of concrete is observed to decrease with the increasing %age age of wood ash.
7. Incorporation of wood ash made concrete enough. It means that concrete is able to bear loads for longer time as the failure is not sudden.
8. Incorporation of wood ash enhanced the quality of paste, thereby increasing both split tensile strength and flexural strength of concrete.

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