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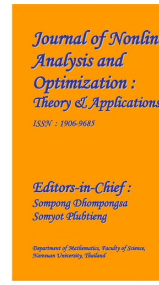

CONCRETE USING BIOCHAR (WOOD WASTE ASH) AS A PARTIAL REPLACEMENT FOR CEMENT

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ABSTRACT:

The demand for cement, the primary ingredient in concrete, has increased as a result of the present period of growth in the construction industry. Significant amounts of energy and raw materials are used in the production of cement, which also emits a lot of carbon dioxide into the atmosphere.**[1]**One partial solution to environmental and ecological issues is the utilization of waste materials and by-products. Paper mills, other wood-burning industries, and wood-fired power plants produce wood waste ash as a by product of combustion. The primary goal of the present research is to replace certain amounts of the cement in structural grade concrete with wood waste ash (WWA).**[2]**Wood waste ash is partially replacement of cement at different percentage of 0%,1%,3%,5%,7% and 9%. The compressive strength of concrete was measured at various curing times to determine its mechanical characteristics**.[3,4,5,6]**When compared to cement, the mechanical qualities of wood waste ash concrete have improved by 10%. Subsequently raising the WWA replacement level significantly lowered the mechanical characteristics.

Keywords:Wood waste ash, carbon dioxide emits,Biochar concretecubes,Compressive strength

1. INTRODUCTION

Every year, thousands of tons of wood wastes are produced worldwide from furniture and wood items. Wherever these wastes grow up and present an important problem with the environment. Engineers are looking for a way to employ it in concrete to solve this issue**[7,8]**. Portland cement is the primary ingredient in concrete, which is one of the most commonly used building materials. The globe now produces 4.5 billion tons of cement yearly; with the rising urbanization of developing nations, this figure is predicted to increase to 5.5 billion by 2050. [**9,10,11]** Unfortunately, a huge amount of cement contributes to the atmospheric emissions of about 8% CO2. Over 65% of the global warming issue is caused by CO2 gas emissions from the cement industry. An equivalent of 640 kg of CO2 are released into the atmosphere with each ton of cement produced Thus, it is advantageous in order to include waste wood and use it to partially replace cement in order to lessen the global demand for cement and lessen its negative effects on the environment and the economy. [**12,13,14,15**]The need for renewable energy sources and a variety of currently available energy production technologies has increased recently due to increased environmental consciousness and enhanced energy security. Among these resources is biomass, which comprises forestry and agricultural wastes and has enormous promise as a sustainable energy source. In the current trends of energy production, biomass-based power plants offer low operating costs and a consistent supply of renewable fuel.**[**16,17,18**]** These energy sources are regarded as CO2-neutral when their fuel consumption rate is lower than their growth rate. Furthermore, a safe and efficient way to dispose of biomass industry wastes is to use them as fuel. Examples of such wastes include sawdust, woodchips, wood bark, sawmill scraps, and hard chips. **[19**]Wood wastes are generally preferred as fuels because, upon combustion, they leave less fly ash and other residue than other plant and agricultural wastes. One of the primary problems with using sawdust materials as fuel is the enormous amount of ash that is produced during the burning process. The characteristics of biomass, or wood, the manner of combustion, and the site of ash collecting define the attributes of ash. **[20**]Since wood waste ash is largely made up of small particles that are easily blown by winds and could harm nearby residents' respiratory systems, it poses a potential risk.site or might leak dangerous materials into the water, contaminating groundwater. [**21**]With the amount of ash and its disposal costs increasing, a sustainable ash management strategy that incorporates the ash into natural cycles needs to be implemented. With the amount of ash and its disposal costs increasing, a sustainable ash management strategy that incorporates the ash into natural cycles needs to be implemented. There has been a great deal of research done on the use of industrial waste products and other agricultural ash, like wood waste ash, as cement substitutes in concrete.

2. LITERATURE REVIEW:

1. The effects of wood waste fly ash from a wood biomass fired power station on the compressive strength of cement mortar mixes were investigated by Rajamma et al. [7]. Ten, twenty, and thirty percent of the total weight of the binder was replaced with wood waste in place of cement. When compared to the control combination, mortar mixtures that had a 10% replacement ratio of wood ash showed greater 28-day strength. However, compared to the control mixture of the neat cement mortar mix, it was found that the 28-day strength was decreased at greater replacement percentages of 20% and 30% of the total binder weight.
2. Ellinwa et al. investigated the process of adding a trace amount of metakaolin to a concrete mix containing wood waste ash and cement, with the goal of reaching a compressive strength of 20 MPa. At each step, the replacement percentage increased by 5%, ranging from 0% to 40%. Furthermore, a consistent dosage of 3% of the total binder weight was added as metakaolin. It has been noted that the early strength of blended cement concrete is increased by the addition of metakaolin in tiny amounts. When compared to the control combination, the SDA/cement concrete mix with 10% replacement of wood waste ash demonstrated a 37% and 7% increase in compressive strength and modulus of rupture, respectively, and all specimens were able to reach the desired strength after 28 days of curing.
3. The impact of biochar particles made from wood biomass on the mechanical strength and permeability characteristics of concrete was investigated by Gupta et al., 2020b. At the 28th day of curation, it was discovered that the addition of 0.5 and 2% biochar enhanced the concrete's compressive strength by 16% and 9%, respectively.

3. MATERIALSUSED:

Cement:

A binder, or chemical material that sets, hardens, and sticks to other materials to bind them together, is what's known as a cement[**22,23,24**].It was discovered that the Ordinary Portland Cement (OPC) of grade 43 complied with the Indian Standard Organization in terms of composition and quality. Cement is a kind of binding material that may be used to join different building materials into compacted structures because it has cohesive and adhesive properties.[**25,26,27,28**] Ordinary, or normal, cement is one of the most often used forms of Portland cement.

Wood waste ash:

Paper mills, other wood-burning companies, and wood-fired power plants produce wood waste ash as a byproduct of combustion and also wood waste ash is generated by burning of wood in furnace with 500-600℃ temperature.[**29,30,31**] The wood waste ash employed in this study has a particle size of 300 microns.

Fineaggregate:

Any natural sand particles that are extracted from the ground during the mining process are considered fine aggregates. [**32,33,34,35**]Natural sand or any crushed stone particles that are 4.75mm or smaller make up fine aggregates. Because this aggregate's size, or grading, is what makes it common to refer to this product as 4.75mm minus.

Coarse aggregate:

A common coarse aggregate used in high-strength concrete is crushed granite.Particles larger than 4.75mm is referred to as coarse aggregate. [**36,37,38,39,40**]The typical range used is 9.5 mm to 37.5 mm in diameter.

4. MIXCALCULATION

M30 grade

By reference of IS 10262-2009 CODE BOOK $ IS 456-2000

Volume of cube =0.15*0.15*0.15 =0.003375m^3

Water cement ratio =0.45

Slump value = 100mm

Max Water Content For 20mm Aggregate = 186liters (for 20-50mm slump)

Max Water Content For 100mm slump = 186 + 6/100 x 186

= 197 liters

Cement Content = 197/0.45

= 437 Kg

Cement in m3 = 437/3.15 x 1/1000

= 0.138 m^3

Water in m3 = 197/1000 = 0.197 m3

Total Aggregates = 1- (0.138 + 0.197)

= 0.665 m^3

Fine Aggregate = vol v% of fine aggregate x Gs x 1000

= 0.665 x 0.3 x 2.072 x 1000

= 542.64 kg

Coarse Aggregate = 0.665 x 0.4 x 2.8 x 1000

= 744.8 kg

Dry Concrete = 1m

Wet Concrete = 1 x 1.52

= 1.52 m^3

Cement content = 0.138 x 1.52

= 0.209 m^3

Mass of cement = 660.744 kg

Water = 0.197 x 1000 x 1.52

= 299.44 liters

C.A = 744 kg

= 1132.096 kg

F.A = 542.69 x 1.52

= 824.88 kg

Quantities For 1 Cube:

Vol. Of Cube = 0.003375m^3

Cement content = 0.003375 x 660.744

= 2.23 kg

Water content = 0.003375 x 299.44

= 1.01 liters

C.A = 0.003375 x 1132.096

= 3.8 kg

F.A = 0.003375 x 824.88

= 2.8 kg

5. METHODOLOGY

A. Preparation of biochar:

- Place the unused wood waste to a crucible dish and place it within a muffle furnace.
- Shut the furnace door to the temperature (between 500 and 600°C).
- Next, remove the wood waste that has burned from the muffle furnace.
- Place the charcoal in a pan and grind it until a powdery form is achieved.

B. Batching:

Collection of required fine aggregate, coarse aggregate, water, cement and biochar.

C. Preparing moulds:

Arrange the mould panel (150 x 150 x 150mm) by using bolts and nuts, then apply the greas to it.

D. Dry mixing:

- Add the ash, cement, and sand first, and mix thoroughly.
- Fill it with aggregates and thoroughly mix it.

E. Wet mixing:

Add water as per the w/c ratio and mix the ingredients with in 5min of pouring the water.

F. Placing of concrete:

- After adding three layers of concrete to the mould and giving each layer 25 blows, level the surface.
- Store it at room temperature for a full day.
- Cubes are demoulded and then placed in a curing tank for 3, 7, and 28 days.
-

Experimentation:

A.Compression test:

The compression strength test measures the force required to compress a material. [**41,42,43,44**]Compression tests are carried out by placing the test specimen between two plates and then applying force to it by moving the crossheads together. During the test, the specimen is squeezed and the deformation versus the applied load is measured.[**45,46,47,48**] It is one of the most significant characteristics of concrete and mortar.

B. **The apparatus**: specimen (concrete cube), CTM (compression testing machine)

C. **Procedure**

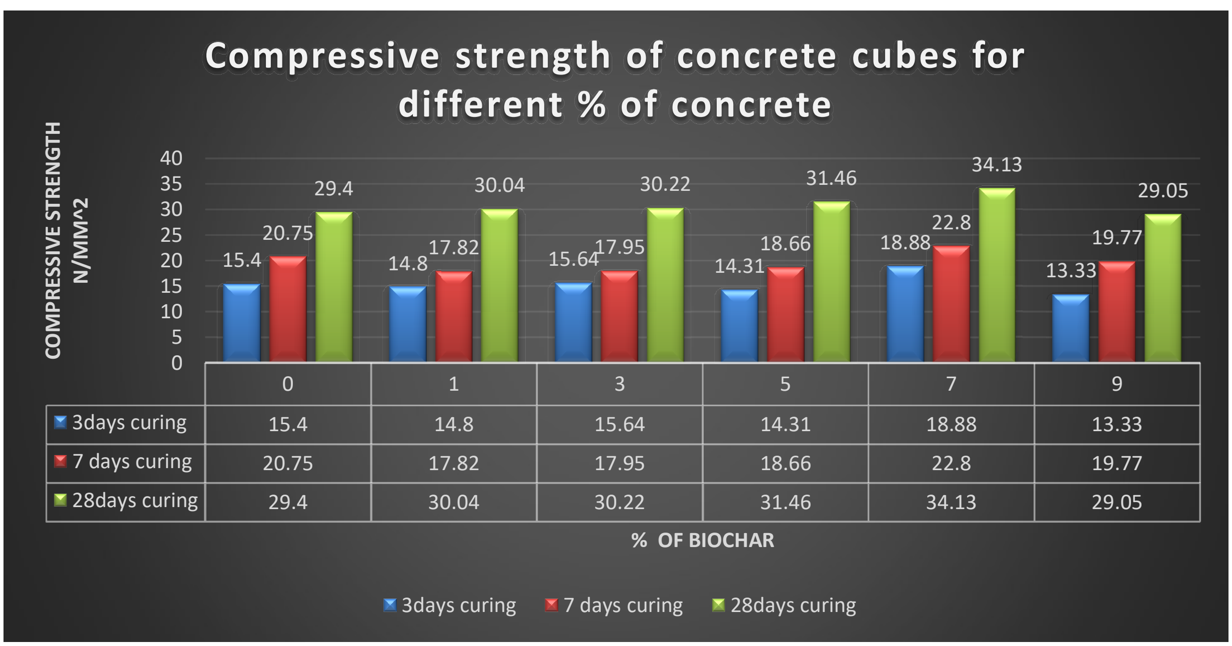
1) After curing, clean the cube with a dry cloth to remove any excess water.
2) Use a trowel to remove excess concrete from the surface and smooth out the cube.
3) Carefully lift and position the cube in the centre of the CTM.
4) Position the loaded spring to make contact with the surface.
5) Once contact is made, set the loading degree to 0.
6) Apply the load gradually on the cube.
7) Record the readings for the initial crack and the final breakage (ultimate load).

Result:

Load appliedonthespecimen=300KN.

7 day – curing, compressive strength =22.8 N/mm^2, 28 day – curing, compressive strength=33.13N/mm^2

% of biochar	Compressive strength for 3days of curing (N/mm^2)	Compressive strength for 7days of curing (N/mm^2)	Compressive strength for 28days of curing (N/mm^2)
0	15.4	20.75	29.4
1	14.8	17.82	30.04
3	15.64	17.95	30.22
5	14.31	18.66	31.46
7	18.88	22.8	34.13
9	13.33	19.77	29.05



CONCLUSION:

Concrete mixes containing 7% wood waste ash demonstrated a 1-20% improvement in compressive strength when compared to normal concrete (without cement replacement), and all specimens achieved greater than the goal strength after curing. Workability decreases as the replacement rate increases. This is because wood ash has a higher water absorption rate than cement. Wood ash is a pozzolanic substance because it contains significantly smaller particles and, as a result, has a higher surface area. Wood ash includes amorphous silica, which makes it suitable as a cement replacement material due to its high pozzolanic activity. When compared to the control specimen, the strength properties of the concrete fall marginally as the wood ash level increases. However, the strength obtained remains higher than normal concrete.

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