iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 8 **Issue:** VII **Month of publication:** July 2020

DOI: https://doi.org/10.22214/ijraset.2020.30720

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 8 Issue VII July 2020- Available at www.ijraset.com

Study on Strength of Partial Replacement of Cement by Wood Ash

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***Abstract:** In this study, Wood Ash is studied its workability and strength as partial cement replacement in conventional concrete. The strength parameters are compressive strength, split tensile strength of concrete with wood ash cement are studied. The concrete mixes are replaced with the amorphous wood ash as an admixture of cement having grain size less than 90 microns in proportions of 0%, 2%, 4%, 6%, 8% and 10% by weight of cement. From the analysis of results obtained in this study, it was concluded that wood ash could be blended with cement with positive effects on strength of concrete.*
***Keywords:** Wood ash, concrete, tensile strength, compressive strength, flexural strength*

I. INTRODUCTION

Concrete is one of the most widely used construction materials in the world as compared with other materials. But environmental and economic concern is the biggest challenge concrete industry is facing. The ingredients of concrete is cement, fine aggregate, coarse aggregate and water. Mixing of all this components will give a solid durability and sustainability but manufacturing of cement is not friendly to the environment. throwing the waste materials to the environment directly will cause environmental issues. Therefore the reuse of remaining material has been given importance. These waste products can be used to produce new products and also it can be used as admixtures so that other natural resources are used more efficiently and the environment issues can be solved from waste deposits. Form the other research estimation cement production is responsible for about 4% of the global greenhouse gas emission and for 6% of the global CO2 emission. As about 60% of the CO2 released during cement production is related to the decomposition of limestone during burning, mixing of clinker with supplementary materials called blending was considered as a very effective way to reduce CO2 emission. Here attempt has been made to use the wood waste to substitute the cement.

Wood ash is the residue powder left after the combustion of wood, such as burning wood in a home fireplace or an industrial power plant. It is used traditionally by gardeners as a good source of potash. The wood ash incorporated as partial replacement of cement helps avoiding insignificant and bulk consumption of pure cement. Besides this the 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. Apart from this, this replacing technique reduces the cost also. The characteristic of ashes will be different for different types of agricultural wastes, timber, etc.

Table 1. Constituents of wood ash

CONSTITUENTS(% AGE)	VALUES
SiO2	21.23
Al2O3	5.02
Fe2O3	3.14
CaO	63.60
MgO	4.57
Losonigniton	3.36

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II. OBJECTIVES

A. The concrete mixes are replaced with the amorphous wood ash as an admixture of cement having grain size less than 90 microns in proportions of 0%, 2%, 4%, 6%, 8% and 10% by weight of cement.

B. To study the mechanical strength (compressive and tensile strength) of concrete along with the wood ash as partial replacement for cement

III. MATERIALS USED

1) *Cement:* ULTRATECH brand, OPC 43 grade cement was used.

2) *Fine Aggregate:* M sand was used.

3) *Coarse Aggregate:* size of 20 mm t0 12.5 mm was used The aggregate is in the shape of angular.

4) *Water:* Tap water having the PH value satisfying the I.S. Code was used.

5) *Wood Ash:* Sieved on 90 micron was used.

IV. MIX DESIGN

Grade designation - M30

Type of cement - OPC 43 grade conforming to IS 8112

Maximum nominal size of aggregate - 20mm

Minimum cement content - 320 Kg/m^3

Maximum water-cement ratio - 0.5

Workability - 50 mm (slump)

Exposure condition - Severe (for reinforced concrete)

Degree of supervision - Good

Type of aggregate - Crushed angular aggregate

Maximum cement (opc) content - 450 kg/m^3

PROPORTION= 1 : 2.25 : 3.76

V. TESTS CONDUCTED

Compressive Strength and Split Tensile Strength and flexural strength test was conducted for 7 days and 28 days curing.

A. *Casting of Specimens*

1) Cube = 15

2) Cylinder = 15

3) Beam = 15

VI. TESTS RESULTS AND DISCUSSION

A. *Slump test Results.*

Table 2. Slump test results

Percentage replacement of natural sand	Slump (mm)
0	30
2%	34
4%	38
6%	40
8%	32
10%	28

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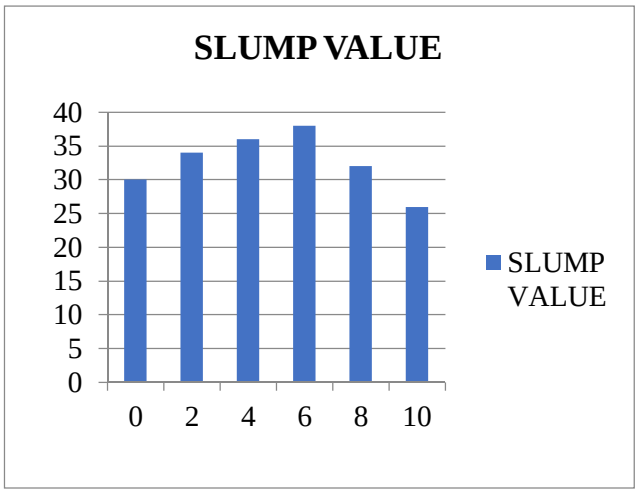

Fig 1. Chart for slump values

B. Compaction Factor test Result

Table 3. Compaction factor test result

Percentage replacement of natural sand	Compaction factor
0	0.8
2%	0.82
4%	0.83
6%	0.85
8%	0.81
10%	0.801

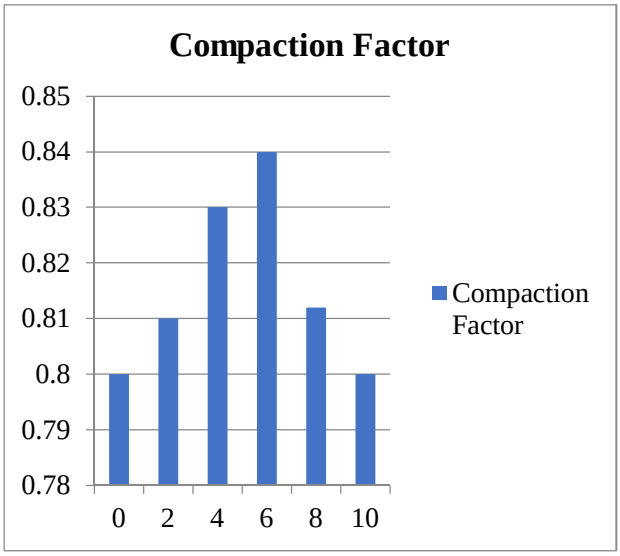

Fig 2. Chart for compaction factor

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C. Vee-Bee Consistometer test Results

Table 4. Vee-Bee consistometer test results

Percentage replacement of natural sand	Vee-Bee time (sec)
0	20
2%	18
4%	17
6%	12
8%	19
10%	21

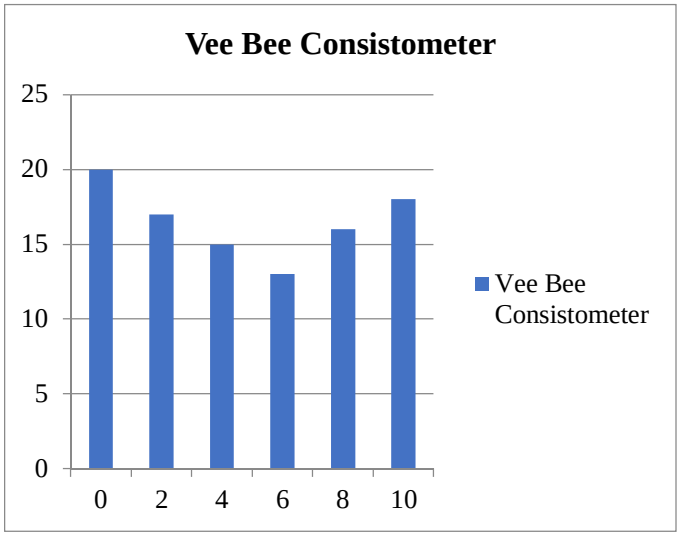

Fig 3. Chart for VEE BEE consitometer test

D. Water Absorption test Results

Table 5. Water absorption test results

Percentage replacement	Water absorption
0%	0.366
2%	0.3
4%	0.28
6%	0.38
8%	0.428
10%	0.45

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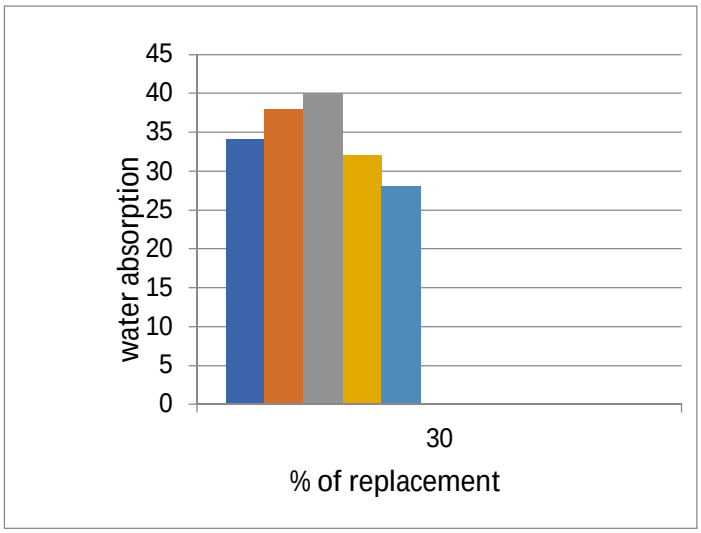

Fig. 4. Chart of Water absorption test

E. Compressive Strength

Compression testing is a very common testing method that is used to establish the compressive force or crush resistance of a material and the ability of the material to recover after a specified compressive force is applied and even held over a defined period of time. Compression tests are used to determine the material behaviour under a load. Compressive strength of each concrete cube casted for 7 days and 28 days curing are given below

Table 6. Compressive Strength For Different Trails Mixes

Percentage replacement of cement by wood ash	Compressive strength of concrete at 28 days	Percentage increase or decrease of 28 days compressive strength w.r.t reference mix
0%	32.15	-
2%	24.4	-7.75
4%	25.68	-6.47
6%	35.82	+3.7
8%	24.73	-7.42
10%	23.33	-8.82

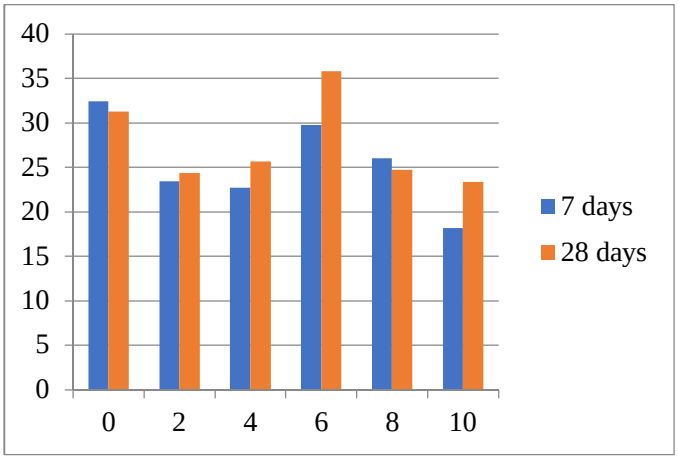

Fig 5. Chart for Compression strength test

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F. Split Tensile Strength

The concrete is very weak in tension due to its brittle nature and is not expected to resist the direct tension. The concrete develops cracks when subjected to tensile forces. Thus, it is necessary to determine the tensile strength of concrete to determine the load at which the concrete members may crack.

Table 7. Split tensile Strength For Different Trails Mixes

Percentage replacement of cement by wood ash	Split tensile strength of concrete at 28 days	Percentage increase or decrease of 28 days split tensile strength w.r.t reference mix
0%	3.11	-
2%	2.87	-0.24
4%	2.94	-0.617
6%	3.23	+0.12
8%	2.79	-0.33
10%	2.63	-0.48

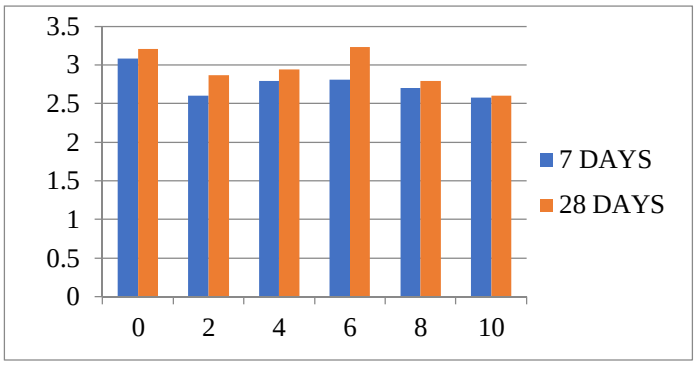

Fig 6. Chart for Split Tensile Strength for different %

VII. CONCLUSION

A. The experiment result shows increase in the strength of concrete with use of Wood ash. Therefore with the use of Wood ash as a partial replacement of cement in the concrete we can increase the strength and durability of concrete with the reduce in consumption of cement.

B. Mechanical strength tests confirmed that the optimum percentage of Wood ash replacement with cement is 6% as it gives best strength improvement in comparison to other specimens for 7 days and 28 days for curing period.

C. Compressive Strength of concrete goes on increasing upto 12% addition of Wood ash

D. Split Tensile Strength of concrete goes on increasing upto the 12% addition of Wood ash

E. The waste Wood ash used for this purpose also reduces the environmental pollution is economical.

VIII. FUTURE SCOPE

A. Quantity and quality of wood ash may vary with many factors such as combustion temperature, species of wood and• combustion technology used. Hence proper analysis of wood ash is important before its application in concrete.

B. Effect on different curing periods on concrete.

C. It can be also be tested for water permeability test, water absorption test, modulus of rupture, modulus of elasticity, resistance to abrasion.

D. Effect on the strength of concrete by using wood ash of different trees such as babul, orange etc for the design mix concrete.

E. The logistics of implementing the use of wood ash concrete in developing country construction should also be investigated to ensure that this low cost construction material is helping the people who need it most.

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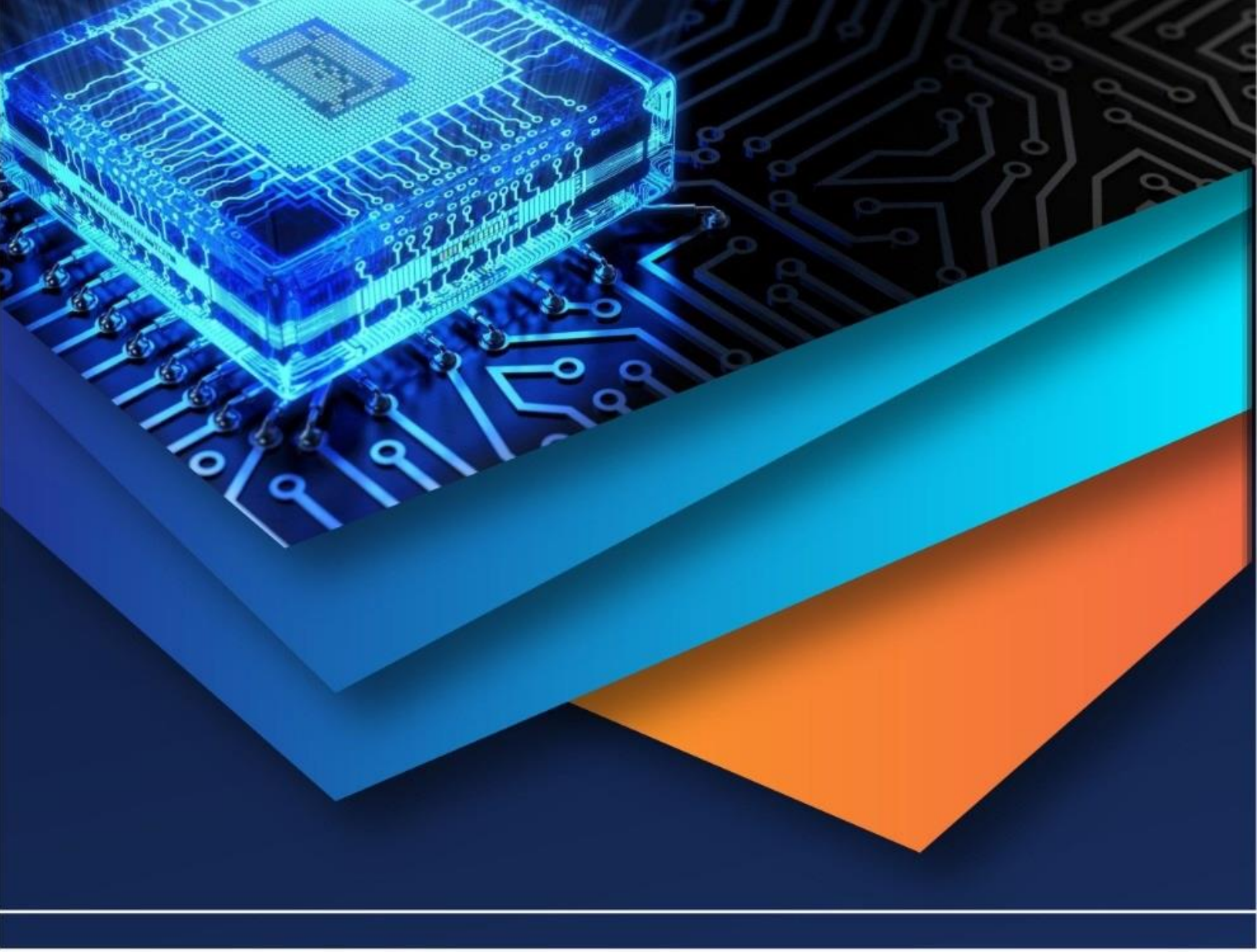

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