

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: www.ijirset.com

Vol. 6, Issue 5, May 2017

Experimental Investigation on Prosopis Juliflora Ash as a Partial Replacement of Cement in Conventional Concrete

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ABSTRACT: In today's world the main emphasis is on green and sustainable development. Cement industry is one of the major contributors to pollution by releasing carbon dioxide. So by partially replacing cement with pozzolanic material such as prosopisjuliflora ash, the cement industry can serve both the purposes of meeting the demands of construction industry and at the same time providing a green and clean environment. Prosopisjuliflora ash is difficult to decompose. So using prosopisjuliflora ash is a major step towards sustainable development. Also the concrete is weak in tension, so with the addition of steel fibres its flexural and tensile strength is also enhanced. Prosopisjuliflora ash is obtained from biomass waste power plants as a waste material. Prosopisjuliflora ash does not have cementitious property by itself which is responsible for strength generation. But in presence of water it reacts with free lime obtained from cement and form hydrated products (C_2S and C_3S) which helps in attaining the strength and also improving the durability. As the prosopisjuliflora ash is very fine in structure, it fills more voids and provides superior pore structure and thereby improves its strength at later stages due to reduced permeability.

KEYWORDS: Juliflora ash, concrete material.

I. INTRODUCTION

In the recent years, growing consciousness about global environment and increasing energy security has led to increasing demand for renewable energy resources and to diversify current methods of energy production. Among these resources, biomass (forestry and agricultural wastes) is a promising source of renewable energy. In the current trends of energy production, power plants which run from biomass have low operational cost and have continuous supply of renewable fuel. It is considered that these energy resources will be the CO₂ neutral energy resource when the consumption rate of the fuel is lower than the growth rate. Also, the usage of wastes generated from the biomass industries (sawdust, woodchips, wood bark, saw mill scraps and hard chips) as fuel offer a way for their safe and efficient disposal. Wood wastes are commonly preferred as fuels over other herbaceous and agricultural wastes as their incineration produces comparably less fly ash and other residual material. A major problem arising from the usage of forest and timber waste product as fuel is related to the ash produced in significant amount after the combustion of such wastes. It is commonly observed that the hard wood produces more ash than softwood and the bark and leaves generally produce more ash as compared to the inner part of the trees. The characteristics of the ash depend upon biomass characteristics (herbaceous material, wood or bark), combustion technology (fixed bed or fluidized bed) and the location where ash is collected. As wood ash primarily consists of fine particulate matter which can easily get air borne by winds, it is a potential hazard as it may cause respiratory health problems to the dwellers near the dump site or can cause groundwater contamination by leaching toxic elements in the water.

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II.LITERATURE COLLECTION

1.Swaptik Chowdhury, Mihir Mishra, Om Suganya, The incorporation of wood waste ash as a partial cement replacement material for making structural grade concrete.

With increasing industrialization, the industrial byproducts (wastes) are being accumulated to a large extent, leading to environmental and economic concerns related to their disposal (land filling). Wood ash is the residue produced from the incineration of wood and its products (chips, saw dust, bark) for power generation or other uses. Cement is an energy extensive industrial commodity and leads to the emission of a vast amount of greenhouse gases, forcing researchers to look for an alternative, such as a sustainable building practice. This paper presents an overview of the work and studies done on the incorporation of wood ash as partial replacement of cement in concrete from the year 1991 to 2012. The aspects of wood ash such as its physical, chemical, mineralogical and elemental characteristics as well as the influence of wood ash on properties such as workability, water absorption, compressive strength, flexural rigidity test, split tensile test, bulk density, chloride permeability, freeze thaw and acid resistance of concrete have been discussed in detail.

2.K .Naveen, D .Naresh, Ch.Chandrasekhar, Evaluation Of Wood Ash As Partially Replacement To Cement Etavenimadhavi.

The objective of this research work is to reduce the cost of the construction. Now a days the industrial wastes are rapidly increasing. To utilize such materials and to reduce such type of waste in environment. The cement is replaced by the wood ash. Wood ash limited to the grain size of less than 90 micrometer is added to cement by weight percentage of 0%, 5%, 10%, 15%, 20%, 25% and 30% by the method of replacement by weight. The samples were hydrated at different time intervals ranging from one hour to 4 weeks. From this research the results are 6 much better as compared to ordinary Portland cement. The wood ash exhibits an appreciable amount of pozzolanic properties. The water requirement increases with the increase with WA addition. In between 10%- 20% wood ash sample shows higher degree of hydration and compressive strength than conventional concrete. The optimum replacement percentage of wood ash is therefore in between 10%-20% for construction industry.

3. PrabagarSubramaniam, KalyaSubasinghe, W. R. KeerthiFonseka, Wood Ash As An Effective Raw Material For Concrete Blocks

Utilization of wood ash as a partial substitution for cement is one of the promising method to increase the strength and thermal insulation for cement blocks. The present study focused to use wood ash as a partial replacement for cement material during sandcement block manufacturing. The concrete mixtures have been mixed with 10%, 15% 20% and 25% of wood ash as a partial replacement for cement with sand and tested for compressive strength, water absorption and heat release. Higher compressive strength was observed in the samples of 15% containing wood ash replacement material. All the samples other than 25% of wood ash replacement were shown lower water absorption and highest was found in 15% wood ash content. Slower heat release was observed in the samples of 15% and 20% of wood ash replacement after 21 days of curing time. Addition of 15% wood ash for the manufacturing of concrete blocks was developed and these blocks meet standard limits.The wood ash has the potential ability to replace the cement partially in cement block manufacturing industry. According to the results, the optimum percentage of wood ash that can replace cement is 15% and it provides a block with a high compressive strength. Water absorption capacity is obtained at 15% of wood ash replacement after 21 days of curing period. Wood ash is a valuable addition due to its slow rate of heat release and 15% replacement showed slower heat release. The Blocks can be modified with 15% of wood as together with other cement materials.

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III. MATERIALS AND METHODS

The material used for this experimental work are cement, sand, water, steel fibers, and super plasticizer.

Cement:

Cement is a binder that sets and hardens and can bind other materials together. Ordinary Portland Cement (OPC) 53 grade is used. Cement is a binder that sets and hardens and can bind other materials together. A powdery substance made by claiming lime and clay, mixed with water to form mortar or mixed with sand, gravel and water to make concrete.

Fine aggregate:

Aggregate which passed through 4.75 mm IS sieve and retained on 75 micron IS sieve is termed as fine aggregate. The specific gravity of fine aggregate was 2.6.

Coarse aggregate:

Angular shape aggregate which passes through 20 mm sieve and retain on 10mm are used as coarse aggregate in this project work. The specific gravity of coarse aggregate was 2.64 and fineness modulus of 7 was found out

12.5mm. Prosopis juliflora ash:

Prosopis juliflora ash is the residue powder left after the combustion of wood, such as burning wood in a home fireplace or an industrial power plant. Prosopis Juliflora Ash from the biomass power plant unit in the state of Tamilnadu, India was selected to evaluate its suitability as ash for OPC replacement. The Wood Ash (WA) was obtained from open field burning with average temperature being 700C. The material was dried and carefully homogenized. An adequate wood ash particle size was obtained by mixing wood ash and cement together for a fixed amount of time.

PROPERTIES OF MATERIALS:

Fine Aggregate :The physical properties like fineness modulus, specific gravity. Bulk density were studied as per IS: 383-1978, IS: 2386 (part iii)-1963 and the obtained results were as shown in Table.

Table: Physical properties of fine aggregate

Test	Result obtained	As per IS: 383-1978
Fineness modulus	2.53	Fine sand
Specific gravity	2.60	2.55 minimum
Bulk density (Kg/m ³)	1600	-

Coarse aggregate: The physical properties of coarse aggregate like fineness modulus, specific gravity, bulk density, impact test and crushing strength test were performed as per IS: 383-1978, IS: 2386 (part iii)-1963 and the obtained results were as shown in Table.

Table: Physical properties of coarse aggregate

Test	Result obtained	As per IS: 383-1978
Fineness modulus	5.0	5 to 7
Specific gravity	2.64	2.6 minimum
Bulk density (Kg/m ³)	1580	-
Impact value	32.50	<45%
Crushing value	34.50	<45%

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Table: Requirement of fine aggregate as per IS: 383 -1970(Ref. 2002)

IS sieve Designation	Percentage passing			
	Zone I	Zone II	Zone III	Zone IV
10 mm	100	100	100	100
4.75 mm	90-100	90-100	90-100	90-100
2.36 mm	60-95	75-100	85-100	95-100
1.18 mm	36-70	55-90	75-100	90-100
600 micron	15-34	35-90	60-79	80-100
300 micron	5-20	8-30	12-40	15-50
150 micron	0-10	0-10	0-10	0-15
Remarks	Very coarse	Coarse	Medium	Fine

SIEVE ANALYSIS OF FINE AGGREGATE

Grading and Requirements

Grading of aggregate means particle size distribution of the aggregate. If all the particles of an aggregate were of one size, more voids will be left in the aggregate having particles of varying sizes will exhibit less voids. Principle of grading is that smaller size particles fill up the voids left in large size particles. Grading is important as it affects workability of the mix, which controls segregation, bleeding, water cement ratio, handling, placing and other characteristics of the mix. Good strengths require maximum compaction, which can only be achieved with a sufficiently workable mix. The grading is tested by sieve analysis. As per the IS, the grading limits for combined coarse aggregate. Larger the size of the aggregate, higher the strength of the concrete. Consumption of the cement is less; but larger sizes affect the workability. Therefore, the most common size in use for concrete is 20 mm.

Table: Requirement of graded coarse aggregate of nominal size

IS sieve Designation in mm	Percentage passing for graded aggregate of nominal size			
	40 mm	20 mm	16 mm	12.5 mm
80	100	-	-	-
63	-	-	-	-
40	95-100	100	-	-
20	30-70	95-100	100	100
16	-	-	90-100	-
12.5	-	-	-	90-100
10	10-35	25-5	30-70	40-85
4.75	0-5	0-10	0-10	0-10
2.36	-	-	-	-

In case two or more nominal size (some times 20 mm and 12.5 mm coarse aggregate are mixed to have better graded aggregate) with varying grading are used they should be combined in the proportions to achieve the grading pattern given below. For sand, generally fineness Modulus (FM) is calculated as shown in table. Typical range is from 2.2 to

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3.2 higher value indicates coarser grading. The usefulness of FM is in detecting slight variations from same source and its effect on workability as shown below in Table.

Table: Test result of fineness modulus of fine aggregate

Material	% of fine aggregate						
Natural sand	0.00	100	90	80	70	60	50
Fineness Modulus(FM)	0.92	2.53	2.32	2.15	1.81	1.64	1.56
Zone	Out of zone	Iii	Iii	Iv	iv	Iv	iv

PROPERTIES OF PROSOPIS JULIFLORA ASH:

Physical Properties Of wood Ash

To evaluate fineness, average amount of wood fly ash passing sieve

#200(75 μ m) is 50% and percentage of ash retained on sieve #325 (45 μ m) is 31%. Test results showed the average unit weight of (ASTM C 29) of fly ash and bottom ash as 490 kg/m³ and 827 kg/m³ respectively and average specific gravity was 2.48 and 1.65 respectively. The average water requirement for fly ash was 116% and average auto-clave expansion test value 0.2%. Evaluated the physical properties of waste (WWA) wood ash used as partial replacement of cement. WWA had a specific gravity of 2.43, 1.81% of moisture content and a Ph of 10.48. The average loss on ignition was 10.46. The specific gravity of wood fly ash to be 2.54 collected from a forestry biomass fired power plant and observed finer particles with average diameter of 50 μ m. Wood ash was mainly found to be composed of highly angular particles with extensive surface porosity seen through SEM images. Wood ash from five various sources and they were designated as W1–W5. Specific gravity of different sources wood ash varied between 2.26 and 2.60 and fineness of the wood ash (% retained on 45 μ m sieves) was between 23% and 90%. Physical properties of all the wood ashes are given in table.

Table: Physical Properties Of wood Ash

Test	W1	W	W	W	W
Retained on no. 325 sieve	23	26	39	44	51
Strength activity index with					
3 days	88	3	1	5	1
7 days	84	3	8	5	7
28 days	88	3	7	5	6
Water requirement, % of	115	1	1	1	1
Autoclave expansion, %	0.2	0	0	0	0
Specific gravity	2.2	2	2	2	2

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Chemical Properties Of wood Ash

The major oxides in the wood ash are lime (CaO), portlandite (Ca(OH)₂), Calcite (CaCO₃) and calcium silicate (Ca₂SiO₄). The possible hydration of lime and silicates present in the wood ash were attributed to, for the swelling of wood ash in rainy season. The chemical characteristics of wood ash from five different varieties of wood to study the potential of their use in CLSM [12]. The LOI was found to range from 6.7% to 58.1% and moisture percentage varied between 0.5% and 3.3%. The chemical properties of all the five sources wood ash the oxide concentration of the ash using an X-ray diffraction (XRD) test and showed that its major oxide concentration are CaO, SiO₂, Al₂O₃, K₂O, Fe₂O₃, MgO, SO₃, TiO₂ and P₂O₅. Compounds such as Na₂O, ZnO, Cl, MnO, SrO, Cr₂O₃, CuO, ZrO₂ and Rb₂O were detected in trace amount. The chemical analysis confirmed that the ash has Silicon dioxide (SiO₂), Aluminum dioxide (Al₂O₃) and iron oxide (Fe₂O₃) with values 20.8, 11.6 and 5.37 respectively. But combining the percentage masses of these oxides gives a total of 37.8% which is less than 70%, the limit specified for pozzolan in ASTM C 618 (1994).

IV.SIMULATION & RESULTS

To determine the hardened properties of concrete standard tests like compression test on cubes for compressive strength, split tensile test on cylinders for tensile strength and flexural test on beams for flexural strength of concrete were carried out at 7days and 28days of curing.

COMPRESSIVE STRENGTH OF CONCRETE CUBES

For compressive strength test, cube specimens of dimensions 150 x 150 x 150 mm were cast for M20 grade of concrete. Vibration was given to the moulds using table vibrator. The top surface of the specimen was levelled and finished. After 24 hours the specimens were demoulded and were transferred to curing tank wherein they were allowed to cure for 7 and 28days.

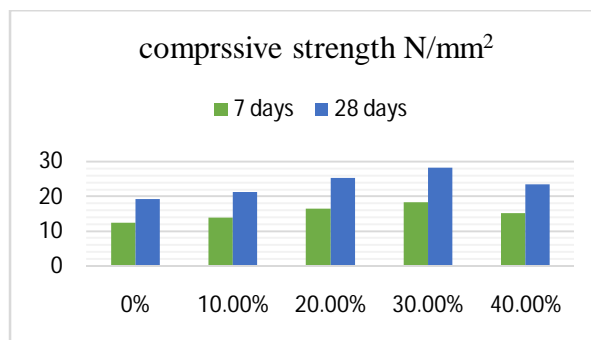
TABLE 1: COMPRESSIVE STRENGTH OF CONCRETE CUBES

% of juliflora ash	Compressive strength N/mm ²	
	7 days	28days
0	12.48	19.2
10%	13.84	21.3
20%	16.44	23.3
30%	18.33	28.2
40%	15.25	23.5

The compressive strength was calculated as follows in Table: 1 and Figure: 1

Compressive strength (MPa) = Failure load / cross sectional area

Fig 1: COMPRESSIVE STRENGTH



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After 7 and 28 days curing, these cubes were tested on digital compression testing machine as per I.S. 516-1959. The failure load was noted. In each category three cubes were tested and their average value is reported.

SPILT TENSILE STRENGTH OF CONCRETE CYLINDERS

For Split tensile strength test, cylinder specimens of dimension 150 mm diameter and 300 mm length were cast.

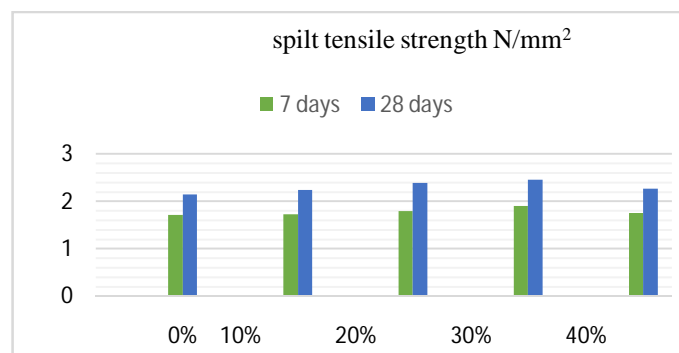
TABLE 2: TENSILE STRENGTH OF CONCRETE CYLINDERS

% of juliflora ash	Spilt tensile strength N/mm ²	
	7 days	28days
0%	1.708	2.137
10%	1.723	2.234
20%	1.785	2.375
30%	1.900	2.455
40%	1.755	2.256

Split Tensile strength was calculated as follows in Table :2 and chart in Figure :2

Split Tensile strength (MPa) = $2P / \pi DL$, Where, P = failure load, D = diameter of cylinder, L = length of cylinder.

Fig: 2 SPILT TENSILE STRENGTH



The specimens were demoulded after 24 hours of casting and were transferred to curing tank wherein they were allowed to cure for 28 days. These specimens were tested under compression testing machine. In each category three cylinders were tested and their average value is reported.

FLEXURAL STRENGTH OF CONCRETE BEAMS

For flexural strength test beam specimens of dimension 1600x150x100 mm were cast. The specimens were demoulded after 24 hours of casting and were transferred to curing tank wherein they were allowed to cure for 28 days.

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TABLE: 3 FLEXURAL STRENGTH OF CONCRETE BEAMS

% of juliflora ash	Flexural strength (N/mm ²)
	28 days
0%	5.25
10%	6.15
20%	7.30
30%	8.10
40%	6.55

The flexural strength was calculated as follows in Table: 3 and chart in Figure: 3

$$\text{Flexural strength (MPa)} = PL / bd^2$$

Where,

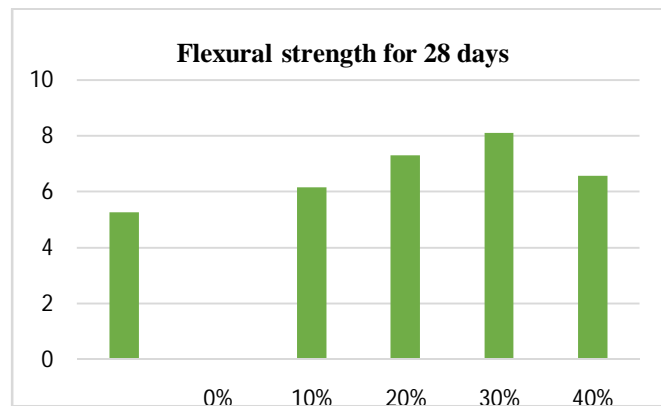
P = Failure load,

L = Centre to center distance between the support = 400 mm,

b = width of specimen=150 mm,

d = depth of specimen= 100 mm.

Fig: 3 FLEXURAL STRENGTH



These flexural strength specimens were tested under two point loading as per I.S. 516-1959, over an effective span of 400 mm on Flexural testing machine. Load and corresponding deflections were noted up to failure. In each category three beams were tested and their average value is reported.

V.CONCLUSION

The basic properties of materials were tested and results tabulated .The Concrete mix proportions are determined by using various trial and error method. The concrete is achieved by Cement, prosopisjuliflora ash, Coarse aggregate, Fine aggregate, and water. The prosopisjuliflora ash are replaced in cement at 20%, 30%, 40%. The concrete test are conducted and to find out the workability.

REFERENCES

- 1.M. RameGowda; M. C. Narasimhan; andKarisiddappa, "Development and Study of the Strength of Self-Compacting Mortar Mixes Using Local Materials" (2011) American Society of Civil Engineers.
- 2.Ho, D.W. S., Sheinn, A. M. M., Ng, C. C., and Tam, C. T. (2002). "The use of quarry dust for SCC applications."Cem.Concr. Res., 32, 505–511.
- 3.Kumar, P., Mehta, and Monteiro, P. J. M. (1997). Concrete—Microstructure, Properties and materials, Indian Ed., Indian Concrete Institute, Chennai, India, 23–285.

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: www.ijirset.com

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4. James, J., and Rao, M. S. P. (1986). "Reaction products of lime and silica from rice husk ash." *Cem. Concr. Res.*, 16(1), 67–73.
5. Nataraja M.C., Nagaraj T.S. and Reddy. A. 2001. Proportioning Concrete Mix with Quarry Wastes Cement. *Concrete and Aggregate Journal*, ASTM. 23(2): 81-87.
6. Kumar, S., and Barai, S. V. (2009). "Determining double-K fracture parameters of Concrete for compact tension and wedge splitting tests using weight function." *Eng. Fracture Mech.*, 76, 935-948.
7. C. Nuntachai, J. Chai, and K. Kraiwood, "Utilization of bagasse ash as a Pozzolanic Material" 32
8. D. A. Adesanya, and A. A. Raheem, "A study of the Workability and Compressive Strength Characteristics of Corn Cob ash blended cement Concrete.
9. R. R. Siddique, "Performance characteristics of high volume Class Fly ash Concrete".
10. S. Jerath, and N. Hanson, "Effect of fly ash content and aggregate gradation on durability of concrete pavement.
11. Dr. V. Bhaskar Desai, A. Sathyam and S. Rameshreddy, "Some Studies on Mode-I Fracture of Artificial Light Weight Silica Fume Pelletized Aggregate Concrete" *International Journal of Civil Engineering & Technology (IJCIET)*, Volume 5, Issue 2, 2014, pp. 33 - 51, ISSN Print: 0976 – 6308, ISSN Online: 0976 – 6316.
12. Rushabh A. Shah and Jayesh Kumar R. Pitroda, "Assessment of Sorptivity and Water Absorption of Mortar with Partial Replacement of Cement by Fly Ash (Class-F)", *International Journal of Civil Engineering & Technology (IJCIET)*, Volume 4, Issue 5, 2013, pp. 15 - 21, ISSN Print: 0976 – 6308, ISSN Online: 0976 – 6316.
13. Madan Mohan Reddy. K, Sivaramulu Naidu. D and Sanjeeva Rayudu. E, "Studies on Recycled Aggregate Concrete by using Local Quarry Dust and Recycled Aggregates", *International Journal of Civil Engineering & Technology (IJCIET)*, Volume 3, Issue 2, 2012, pp. 322 - 326, ISSN Print: 0976 – 6308, ISSN Online: 0976 – 6316.