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Experimental Project on Concrete - Partial Replacement of Cement by Prosopis Juliflora Ash

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Abstract - In order to save the environment and to save the resources we have come up with using the Prosopis juliflora(Semai Karuvelam in Tamil) ash as the partial replacement of cement. Cement will produce equal amount of greenhouse gas (co_2) which increase the global warming. As the amount of cement is reduced greenhouse gases also reduced. Utilization of Juliflora ash as a partial substitution for cement is one of the promising method to increase the strength and thermal insulation for cement blocks. The strength parameters (compressive strength, split tensile strength and flexural strength) of concrete with blended Prosopis juliflora cement are evaluated.

Keywords: environment, Prosopis juliflora, partial replacement of cement, strength parameter

I. INRODUCTION

Prosopis juliflora is a type of tree which absorbs ground water and atmospheric moisture heavily. Recently the Tamilnadu government started removing the tree with the help of PWD. Hence the Juliflora has been mostly used in industries, power plants, incineration, etc. hence the residue generation is more. The industrial byproducts (waste) are being accumulated to a large extend leading to environmental and economic concerns related to their disposal. Cement emits vast amount of greenhouse gases, forcing researchers to look for an alternative such as sustainable building practice. This paper presents an overview of the work and done on the incorporation of Prosopis juliflora ash as partial replacement of cement in concrete.

The characteristics of the ash depends 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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Due As the disposal cost of the ashes is rising and volume of ash is increasing, a sustainable ash management which integrates the ash within the natural cycles needs to be employed. Extensive research is being conducted on industrial by products and other agricultural material ash like wood ash which can be used as cement replacement in concrete. to current boom in construction industry, cement demand has escalated which is the main constituent in concrete. Also, the cement industry is one of the primary sources which release large amounts of major consumer of natural resources like aggregate and has high power and energy demand for its operation. So utilization of such by product and agricultural wastes ashes solves a twofold problem of their disposal as well providing a viable alternative for cement substitutes in concrete. Hence, incorporating the usage of Juliflora ash as replacement for cement in blended cement is beneficial for the environmental point of view as well as producing low cost construction entity thus leading to a sustainable relationship. Rice husk ash and fly ash, are major players which already proven to be effective mineral admixtures to cement at various percentages. Juliflora ash is also a similar waste materials produced from Juliflora burning industries which is mainly used as a fertilizer for soil. Significant quantities of Juliflora ash is currently land filled near the industries that uses Juliflora as a fuel partially or fully which poses a threat to the environment in many ways to life stock around. Chemical analysis of Juliflora ash shows that it has pozzolanic property, and using it as a partial replacement to cement may be one of the best application in the current environment scenario.

II. EXPERIMENTAL

1. Cement

In this work, Portland Pozzolona Cement of Ultratech has been used. It was procured from a single source and stored as per IS: 4032 – 1977. Care has been taken to ensure that the cement of same company and same grade is used throughout the investigation. The cement thus procured was tested for physical properties in accordance with the IS: 1489-1991(part 1).

Tests on Cement

i) Specific Gravity Test

ii) Initial and Final Setting Time Tests

iii) Test for Fineness of Cement

Table 2.1

S. No	Property	Cement
1	specific gravity	3.15
2	Initial and final setting time	50mins & 550mins
3	Fineness of cement	3%

2. oarse and Fine Aggregate

The fine aggregate used was locally available sand without any organic impurities and conforming to IS: 383 – 1970 [Methods of physical tests for hydraulic cement].

The coarse aggregate chosen for SCC was typically round in shape, well graded and smaller in maximum size than that used for conventional concrete. The size of coarse aggregate used in self-compacting concrete was between 10mm to 16mm.The aggregates were tested for their physical requirements such as gradation, fineness modulus, specific gravity and bulk density in accordance with IS: 2386 – 1963 [Methods of test for aggregate for concrete] and is shown in table 2.2. The aggregates were surface dried before use.

Tests on Coarse and Fine Aggregate

i) Specific Gravity Test
ii) Test for Water Content
iii) Test for Bulk Density
iv) Sieve Analysis
v) Computation of Fineness Modulus

Table 2.2

S. No	Property	Coarse Aggregate	Fine Aggregate
1	specific gravity	2.7	2.60
2	Water absorption	0.6%	1.8%
3	Fineness modulus	7.17	2.91

3. Water

Water used for mixing and curing was potable water, which was free from any amounts of oils, acids, alkalis, sugar, salts and organic materials or other substances that may be deleterious to concrete or steel confirming to IS :3025 – 1964 part22, part 23 and IS : 456 – 2000 [Code of practice for plain and reinforced concrete]. The pH value should not be less than 6. The solids present were within the permissible limits as per clause 5.4 of IS: 456 – 2000.

4. Juliflora Ash (PJA)

Three different proportions of concrete mix (NA replacement of 5%, 10%, 15%, 20%) by weight of cement) including the control mixture were prepared with water to binder ratio of 0.5. The specific gravity of NA was found to be less than that of cement. Specific gravity of Juliflora ash is 2.71 conforming to BS 5628-1: 2005. The suitable range of specific gravity of juliflora ash is 1.6 to 2.8.

Table 2.3

S. No	Property	V.N Ash
1	specific gravity	2.71
2	Water absorption	5%

III. RESULT

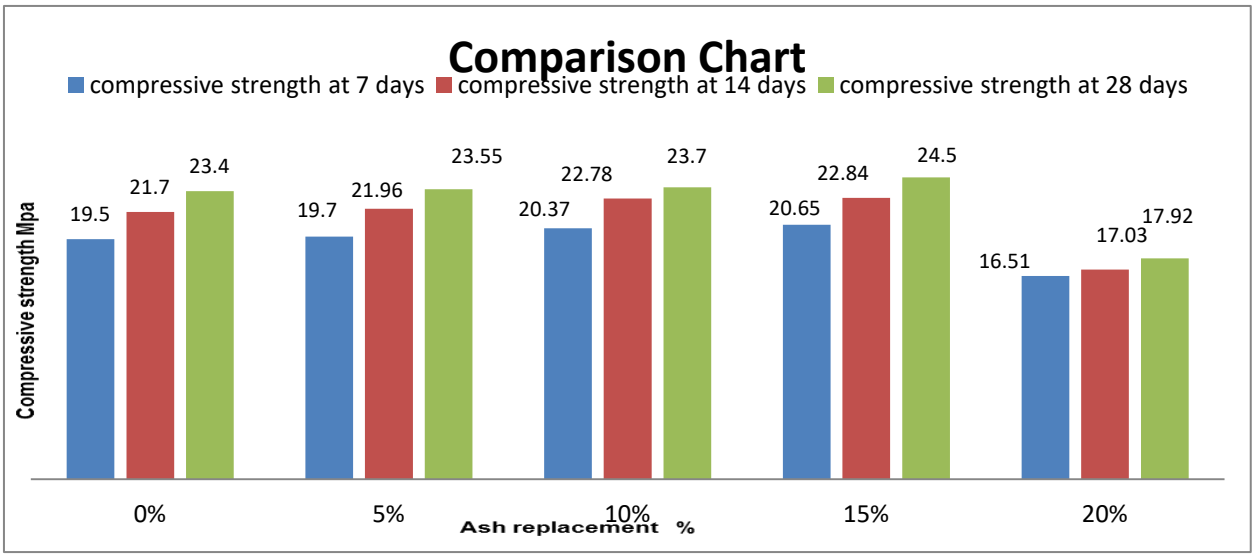
Concrete mix = M20
Target strength = 26.6N/mm^2
The compressive strength, split tensile strength and flexural strength for hard concrete blocks are calculated and the results are tabulated.

Table 3.1. Result of Conventional Concrete Specimen

Test on concrete	7-day strength N/mm^2	14-day strength N/mm^2	28- day strength N/mm^2
Compressive strength	19.5	21.7	23.4
Splitting tensile strength	1.48	2.1	3.13
Flexural strength	2.44	3.42	4.18

1. Cube Test Result

Samples with 5%, 10%, 15% and 20% replacement of cement with PA ash were casted. The cubes were casted as per the procedure specified in IS 516:1959 and IS 456:2000. The strength of 3 samples were tested at 7, 14 and 28 days using compression testing machine. The compressive strength values were compared with that of conventional concrete mix of M20. Following the mix design specified in IS: 10262 (1982), samples were casted. The obtained results are shown in fig 1.



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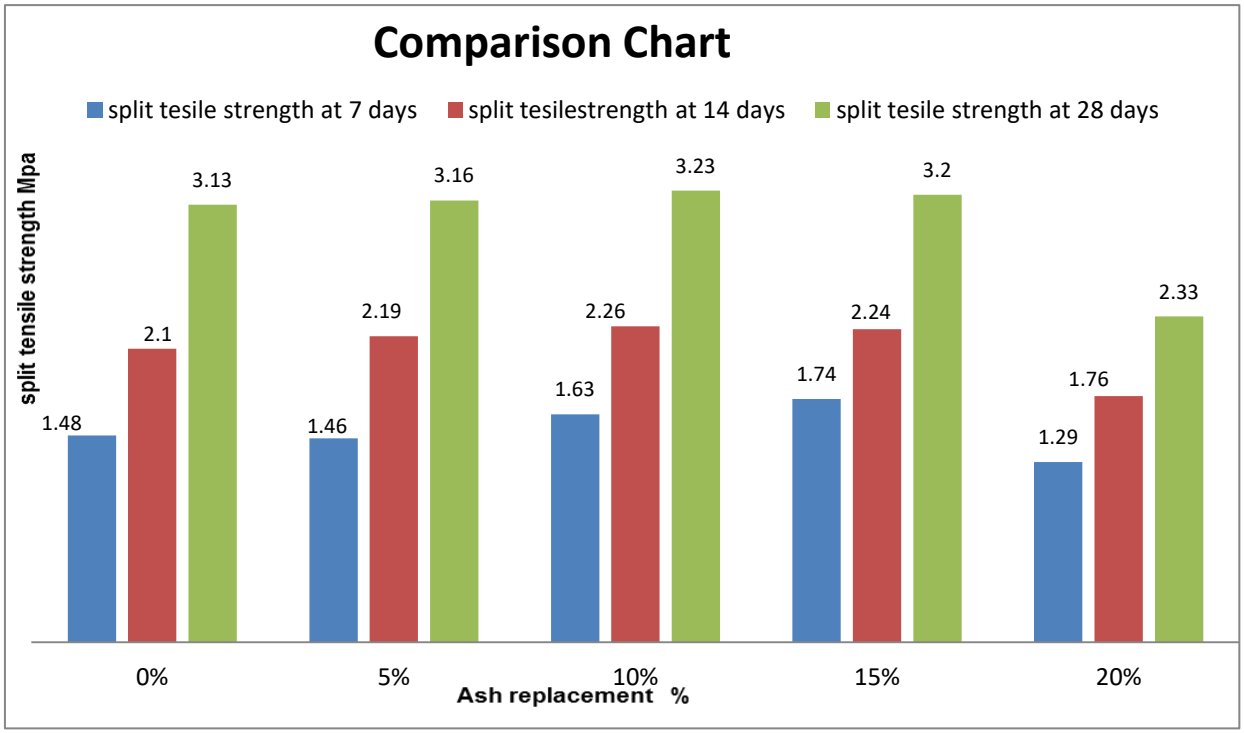
2. Cylinder Test Result

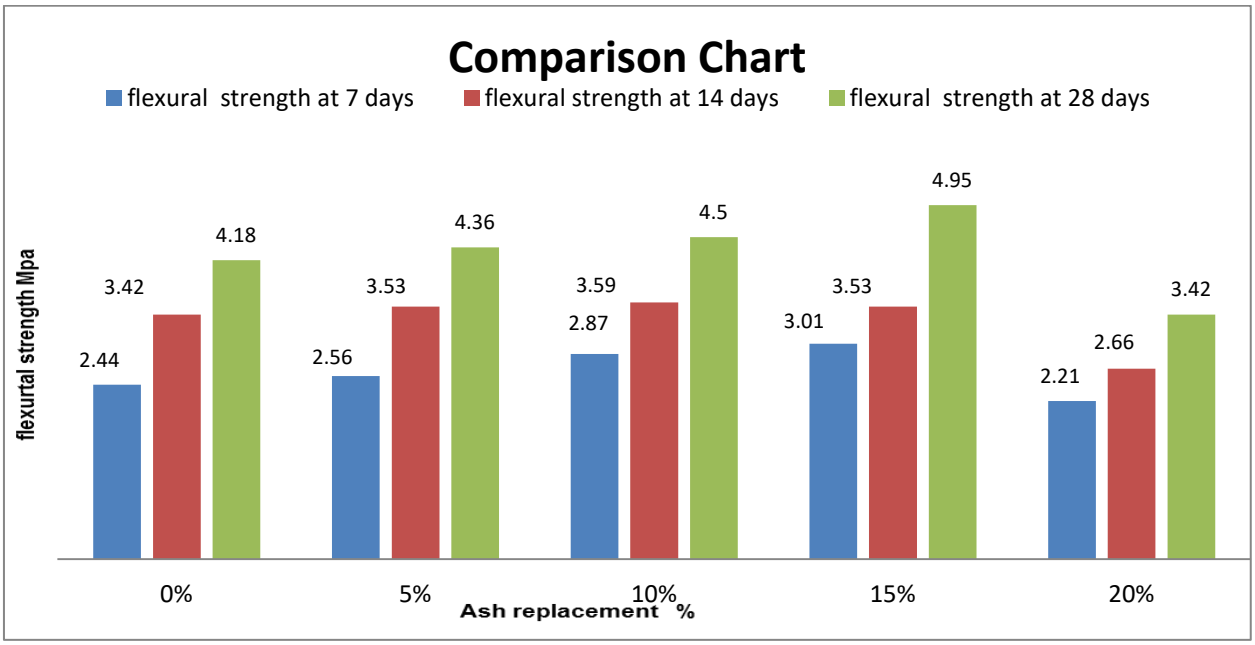
The cylinders were casted as per the design mix specified in IS: 10262 (1982).



The target split tensile strength is given by 0.7 times square root of fck which is 3.1N/mm2.Thesplit tensile strength (28 day) of cylinder for the control specimen was obtained as 3.13N/mm2. The cylinders with 5%, 10% and 15% replacement of cement with Juliflora ash have obtained a greater split tensile strength than 3.13N/mm2. However, 20% replacement did not satisfy this requirement. The maximum strength was obtained for 10% replacement which is 3.23N/mm2.

3. Prism Test

The beams were casted as per the design mix specified in IS: 10262 (1982). The target flexural strength (28 day) of standard M20 beam is 3.5N/mm2.The flexural strength of control sample was obtained as4.8N/mm2.All the three percentages of replacement of cement with Juliflora ash satisfied the flexural strength requirement. The maximum value of 4.95/mm2 was obtained with 15% replacement.



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IV. DISCUSSION

The 7-day compressive strength of cube with all the three percentages of replacement satisfied the strength (13.5N/mm^2) requirement. The 14 and 28- day compressive strength of cube with 20% replacement of cement with Juliflora ash was found less than the standard strength (18 and 20 N/mm^2)of a control specimen. The split tensile strength of 20% replacement of cement with Juliflora ash was found less than the standard value. The 28-day flexural strength of beam for all the three percentages of cement with Juliflora ash was found to be satisfactory. 5%,10% and 15% replacement of cement with Juliflora ash satisfied all the strength requirements. But, 5%,10% replacement will be more economic. Hence, 5% and 10% replacement of cement with Juliflora ash for PPC is suggested. Workability is found to decrease with increase in the replacement. This is because the water absorption of Juliflora ash is greater than that of cement. The presence of much finer particles and hence, larger surface area per particles make Juliflora ash pozzolanic material. Juliflora ash contains amorphous silica making it fit as cement replacing material due to its high pozzolanic activity. The strength parameters decrease slightly with increase in Juliflora ash content in the concrete when compared to control specimen. However, the strength obtained is still higher than the target strength. Also the strength increases with age due to pozzolanic reactions. Thus, use of Juliflora ash in concrete helps to transform it from an environmental concern to a useful resource for the production of a highly effective alternative cementing material.

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