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Evaluation of Workability Properties in Light Weight Geopolymer Concrete Using Bamboo Aggregates with Different Percentage of Superplasticizers

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Abstract- The light-weight concrete is a concrete which has a density of 300 to 1850 kg/m3.There are many advantages of having low density. It helps in reduction of dead load, increases the progress of building. The weight of a building on the foundation is an important factor, in case of weak soil. This research focus on reducing the density of concrete by replacing coarse aggregates with bamboo aggregates at different proportion with 10%,20%,30% and 40% respectively. Nowadays,research focus on reducing the self weight of structures, this paper contributes in that area to evaluate the density and workability properties of geopolymer concrete by reducing its density by replacing coarse aggregate with bamboo aggregates. Geopolymer concrete is one of the sustainable concrete in future for developing greener environment by reducing the emission of carbondioxide. This study emphasis to reduce the weight of geopolymer concrete which will help to develop more precast products. Sodium hydroxide of 12M is used in this research. Superplasticizer conplast SP430-Fosroc is used in this study to improve its workability. Low calcium based flyash is used as source material and M-Sand is used as fine aggregate. Density and fresh properties of geopolymer concrete by adding 0.25%,0.5%,0.75% and 1% of superplasticizer by volume of concrete replacing bamboo aggregates are tested.

Index Terms-BA-Bamboo aggregates- CC-Conventional Concrete, FA-Flyash,GPC-GeopolymerConcrete,HRWRA-High Range Water Reducing Agents, NaOH-Sodium Hydroxide,Na2SiO3-Sodium hydroxide,SP-Superplastiiczer

I. INTRODUCTION

There is on-going research concerned with the structural analysis of bamboo frame structures commonly used by local people, improvement of the concrete permanent bamboo shutter slabs and reinforced concrete beams and columns, having in mind its improvement according to available knowledge Fabrication of corrugated composite slabs based on cement paste reinforced with cellulose pulp of bamboo. The cement composites reinforced by bamboo pulps are produced by the vacuum pressure process, seeking to establish the characteristics of a material which can be easily fabricated, utilizing the machinery of asbestos cement industry. Lightweight concrete is usually chosen for structural purpose where its use will lead to a lower overall cost of a structure than normal weight concrete by reducing its dead weight. Density of the normal concrete is 2200 to 2600 kg/m3. This weight will make it an uneconomical structural material. Attempts have been made in the past to reduce the self-weight of concrete to increase the efficiency of concrete as a structural material. The light-weight concrete is a concrete which has a density of 300 to 1850 kg/m3. However, at the present time, even the most modern construction where bamboo is used rely on a craft approach, with the know-how of construction techniques restricted to a small group of researchers, engineers and architects. Although bamboo has an immense potential, standardization and a definition of a correct construction practice still present some difficulties. Actually, there is an on-going research on bamboo with regards to special treatments leading to higher durability ,improved connectors and mathematical modeling for the structural analysis of bamboo structures, along with the micro, macro- and nano-structural properties shutter bamboo concrete slabs, application of bamboo segments as reinforcement of concrete beams, circular columns and pillars in quadratic form of concrete, double–layer spatial and plane truss bamboo structure and special joints between the bamboo elements, which can be easily used for plane and double-layer spatial structures. It is now well established that bamboo is a composite material of cellulose fibres, with an average tensile resistance of about 700 MPa. These cellulose fibres are immersed in a lignin matrix. Studies showed that bamboo is a material with the variation of its physical and mechanical properties in an optimized form, according to the stresses generated due to wind load and its own weight. It has been

observed on a macroscopic scale that the distances between the nodes (stiffeners), the diameter and the thickness vary along the total length of the bamboo Culm. The thickness, size and volumetric fraction of fibres vary, becoming more concentrated as they approach the external shell. This is due to the higher forces applied to the external surface when the bamboo is subjected to bending by wind load. The determination of how the variation of volumetric fracture occurs in the thickness is necessary for applying the theory of composite materials to bamboo, which allows the optimized use of bamboo on engineering sites.

II. MATERIAL PROPERTIES

Flyash: As per ACI Committee 116,flyash is the finely divided inorganic residue resulting from the combustion of ground or powdered coal. Low calium based flyash of specific gravity 2.90 and fineness of 9% is used in this study.

The properties of coarse aggregate, bamboo aggregate, M-Sand is given below in table.1 Graded coarse aggregate of maximum size of 4.75mm is used. The coarse aggregate shall confirm to IS: 383-1970. Similarly,bamboo aggregates are cut into size of coarse aggregate with maximum 4.75mm size. As per IS 383-1970 the size of manufactured sand (M-Sand) is less than 4.75mm. The test procedures for the determination of the physical properties, shall be in accordance with IS: 2386-1963

Table.1.Properties of Coarse aggregate, Bamboo aggregate, M-Sand

Properties	Coarse Aggregate	Bamboo Aggregate	M-Sand
Specific gravity	2.78	1.8	2.78
Fineness modulus	7.80	8.75	2.85
Water absorption	1.4%	2.15%	0.6%

Alkaline Activator Solution: The alkaline activator is the combination of sodium or potassium hydroxide and sodium or potassium silicate.Sodium hydroxide in pellets form and commercially available sodium silicate solution with a silicate modulus of 2.0 and bulk density of 1390 kg/m3 is used in this study.

III. MIX DESIGN

There is no specific mix design code practice for geopolymer concrete.The various parameters to be considered for designing the mix are:

- Grade of Concrete: M25
- Flyash to Alkaline Activator Solution ratio: 0.67
- Molarity of NaOH :12M
- Ratio of NaOH:Na2SiO3 : 2.5
- Superplasticizer : 1% by volume of concrete.

Flyash : 550kg/m3
Coarse Aggregate : 1066kg/m3
Bamboo Aggregate: 786kg/m3
M-Sand : 627kg/m3
NaOH : 43.27kg/m3
Na2SiO3: 237.12kg/m3
Extra Water: 32.05kg/m3.

IV. METHODOLOGY

Workability: All the freshly prepared GPC mixes were tested for workability using the standard slump cone apparatus. The slump was filled with freshly mixed geopolymer concrete and was compacted using tamping rod by giving blows in four layers by adding different dosage of superplasticizer of type(SP430-Fosroc) with 0.25%,0.5%,0.75% and 1% by volume of concrete respectively to all batches of mixes that have been replaced with normal coarse aggregates by bamboo aggregates at 10%BA,20%BA,30% and 40% BA. The top of the cone was leveled off and lifted vertically up and the slump was immediately measured.

V. RESULTS AND DISCUSSION

Table.2.Slump Values of all mixes

Percentage of bamboo aggregates	0.25% SP	0.5% SP	0.75% SP	1% SP
Slump Value (mm)				
10%BA	71	75	80	84
20%BA	68	72	78	82
30%BA	62	66	70	75
40%BA	51	58	63	68

Table.2.represents all the slump values of mixes with 10%,20%,30% and 40% of replacement of coarse aggregates and by adding different dosage of superplasticizers at 0.25%,0.5%,0.75% and 1% respectively.From “Fig.1”it was clearly observed that replacement of bamboo aggregates reduces the slump. Replacement of 20% bamboo aggregates produce excellent slump. Whereas, replacement of 40% of bamboo aggregates reduces the workability due to high water absorption nature of bamboo aggregates. Also, increase in addition of dosage of superplasticizer increase the workability of geopolymer concrete mix.Addition of 1% of superplasticizer increase the workability of concrete in an excellent manner.

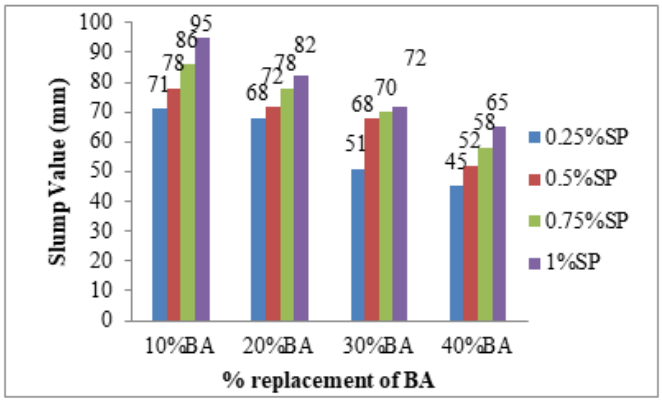

Fig.1.Slump Values of all Mixes

Table.3.Density Values of all Mixes

Percentage of bamboo aggregates	0.25% SP	0.5% SP	0.75% SP	1% SP
Density(kg/m^3)				
10%BA	1125	1007	964	910
20%BA	987	975	830	768
30%BA	755	732	716	650
40%BA	695	667	610	559

Table.3 shows the density values of all mixes. Increase in addition of superplasticizer dosage reduces the density value of geopolymer concrete specimens."Fig.2"clearly shows that increase in percentage replacement of bamboo aggregates reduces the density of specimens. Increase in replacement percentage of bamboo aggregates reduces the density of specimens.Even replacement of 10% of bamboo aggregates reduces the density of concrete in higher percentage. Replacement of 20% and 30% of bamboo aggregates produce better light weight geopolymer concrete specimens.

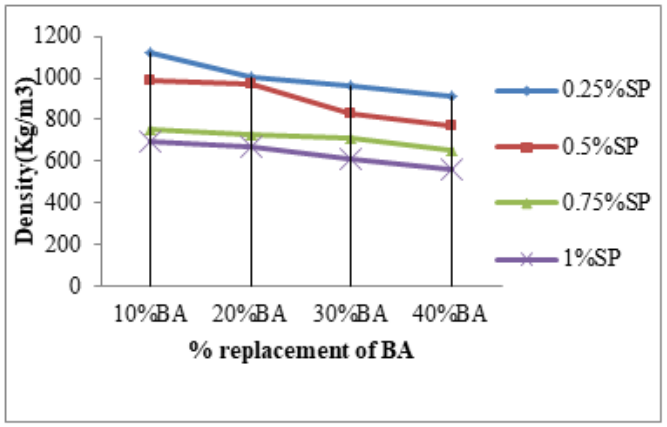

Fig.2.Density Values of all Mixes

VI. CONCLUSION

- Increase in addition of superplasticizer increase the value of slump. Addition of 1% Superplasticizer by volume of concrete shows good workability compared to 0.25%,0.5% and 0.75% addition of superplastizer in geopolymer concrete.
- Increase in replacement percentage of bamboo aggregates reduces the slump of geopolymer concrete. Replacement of 20% of bamboo aggregates produce better slump compared to 10%,30% and 40% replacement of bamboo aggregates.
- Even replacement of 10% bamboo aggregates with coarse aggregates produce light weight geopolymer concrete mixes by reducing the density of geopolymer concrete.
- When replacement percentage of bamboo aggregates increased the density of geopolymer concrete gets reduced to light weight geopolymer mixes.
- Replacement of M-Sand with fine aggregate shows better slump in geopolymer mixes.
- SP430-Fosroc produce better slump by blending coarse aggregates,bamboo aggregates and M-Sand in an excellent manner.

Thus, replacement of 20% of bamboo aggregate with addition of 1% of super plasticizer produce enhanced workability and light weight geo polymer concrete mix..

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