

Performance Using Bamboo Fiber Ash Concrete as Admixture Adding Superplasticizer

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Abstract. The increasing demand on natural resources for housing provisions in developing countries have called for sourcing and use of sustainable local materials for building and housing delivery. Natural materials to be considered sustainable for building construction should be 'green' and obtained from local sources, including rapidly renewable plant materials like palm fronds and bamboo, recycled materials and other products that are reusable and renewable. Each year, tens of millions of tons of bamboo are utilized commercially, generating a vast amount of waste. Besides that, bamboo fiber is easy availability, low density, low production cost and satisfactory mechanical properties. One solution is to activate this waste by using it as an additive admixture in concrete to keep it out of landfills and save money on waste disposal. The research investigates the mechanical and physical properties of bamboo fiber powder in a blended Portland cement. The structural value of the bamboo fiber powder in a blended Portland cement was evaluated with consideration for its suitability in concrete. Varied percentage of bamboo fiber powder (BFP) at 0%, 5%, 10%, 15%, and 20% as an admixture in 1:2:4 concrete mixes. The workability of the mix was determined through slump; standard consistency test was carried on the cement. Compressive strength of hardened cured (150 x 150 x 150) mm concrete cubes at 7days, 14days and 28days were tested.

1. Introduction

Nowadays, construction development in Malaysia increase very fast. At the same time, the cost of properties is become expensive. Not very numerous white collar class Malaysians can bear the cost of owning a rooftop over their heads. Property costs are presently high as can be and the centre pay wage specialists are constrained to go for leased homes or pick a spot at the edges of the city. Malaysia as a developing nation additionally got no special case to get new innovation in the development business. Since the large demand has been put on building material industry particularly in the most recent decade inferable from the expanded populace which causes an interminable deficiency to building materials, the structural designer has been tested to change over the modern waste to helpful building and development material. [1]

2. Literature Review

Concrete is most common and widely used in construction industry because of its strength and durability. Concrete is made with the mixture of cement, aggregates and water. The aggregates can be either fine aggregates or coarse aggregates. In this research, bamboo is selected as an additive material in concrete design. It also can be one of the recycle materials to cut down the using quantity of cement and aggregates in concrete design. Bamboo is easy to break into pieces by using saw. It is good to use



bamboo because bamboo would not abandon in jungles. By using bamboo will be more sustainable to our environment. If over use the quantity of cement and aggregates will facing the deplete of resources. Besides that, bamboo material can benefit to construction industry. Bamboo is easy to handle and cut without using any specialist equipment. Bamboo is a non-polluting material. Bamboo can considered as saving material and cost because it does not waste any parts. In addition, bamboo's shape is circular form and light in weight [1].

2.1 Properties of Bamboo

In bamboo, specific gravity can be measure the density. The specific gravity of bamboo is a comparison of its density to that of water. The range is from 0.4 to 0.8 due to anatomical structure. The dampness substance moves vertically from the base to the top parts and horizontally from the outside layer to the inward layers. The dampness content in bamboo can has high. Green bamboo may have 100% percent dampness (oven-dry weight basis). It can be up to 155% for the deepest layers and 70% for the fringe layers. The vertical variety from the top (82%) to the bottom (110%) is comparatively less. Next, for the bamboo's fiber saturation point is about 20-22%. [2] Bamboo do not has secondary growth which unlike wood. All gains after all gains reach their own full height are depends on additional of material to cells.[4]

2.2 Mechanical Properties of Bamboo

Bamboo has strong mechanics and great flexibility, simple to be prepared which cause it for extensive variety of utilization in construction industries. With the increase in bamboo's age, the compressive stress also increases. One year old bamboo has the lowest compressive stress, which is 16.1 MPa. For five years old bamboo has the highest compressive stress. The compression properties are equal to the longitudinal direction. Bamboo known as light material and can strengthen product. Meanwhile, it is stable because of its cavities are light and elastic. Original texture of wood is similar to the bamboo texture and the technical conditions. Wood has harder center and make it weaker in the outer and inner parts.

2.3 Chemical Composition of Bamboo

The chemical composition of bamboo is entirely comparative with wood. Their major compositions are cellulose, hemi-cellulose and lignin. The amount of composition is over 90% of the mass. The minor compositions are resins, tannins, waxes and inorganic salts. Thus, bamboo has higher alkaline extracts, ash and silica contents compared to wood. Other than that, bamboo contains some organic composition as well. Bamboo contains 2-6% starch, 2% deoxidized saccharide, 2-4% fat and 0.8-6% protein. The durability and life is depending on the carbohydrate content bamboo. For the natural durability, bamboo is depending on the climatic condition. Next, the composition of starch can prevent attack from fungi. Moreover, the ash content of bamboo has inorganic minerals, primarily silica, calcium and potassium.

3. Experimental Process

In this research is to determine the performance of the concrete that contain the bamboo fiber powder by preparing concrete cube sample and tested to obtain some of the basic engineering properties. The concrete mix design is done by systematic analysis and chooses the proportion of the ingredient to use the concrete mix to produce an economical concrete and also with strength that desired when the cube is hardened. The variables which can be controlled are water cement ratio, maximum aggregate size, aggregate grading and use of admixture.

4. Analysis and Discussion

The Figure 1 gives the results of test conducted on hardened concrete with 0-20% bamboo fiber powder for 7, 14 and 28 days. From figure 2, the results show that the compressive strength increases with increasing curing time. It seems the compressive strength obtained for concrete with 15%

replacement by bamboo fiber powder showed average value compared to control concrete for 7 days, 14 days and 28 days respectively. This increment of the positive value shows that with the mixture of bamboo fiber powder into the concrete will achieve the early strength ratio's for the 14 days.

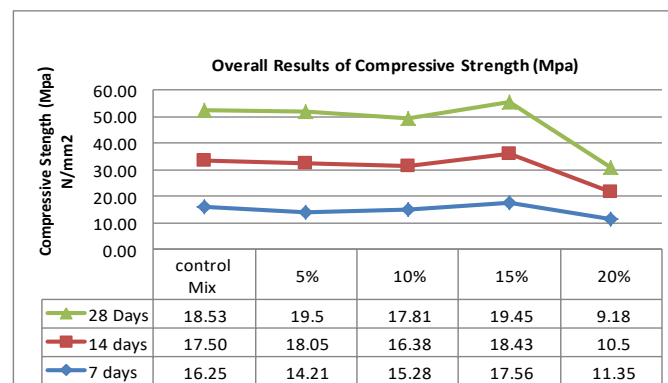


Figure 1. Overall results of compressive strength (Mpa) between control mix and different percentage bamboo fiber powder (BFP) of concrete mix

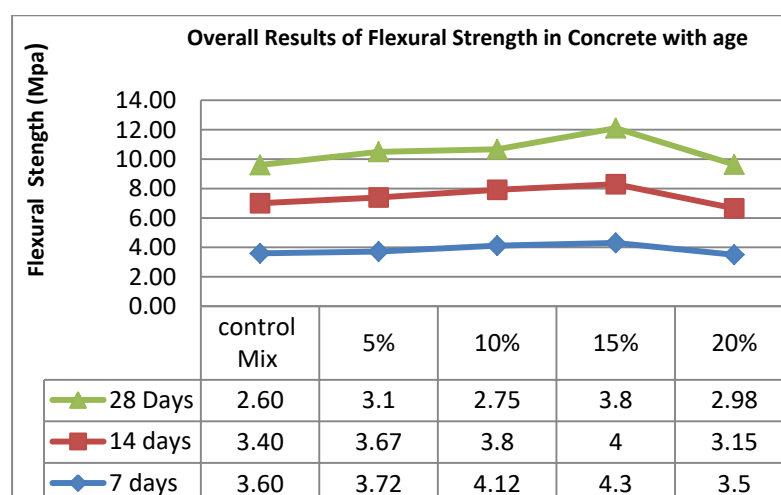


Figure 2. Overall results of flexural Strength (Mpa) between control mix and different percentage bamboo fiber powder (BFP) of concrete mix

The Figure 2 shows the result of variation of flexural strength of concrete with cement replacement by bamboo fiber powder for 7, 14 and 28 days. It seems flexural strength of concrete with 15% cement replacement by bamboo fiber powder showed average higher value compared to control concrete for 7 days, 14 days and 28 days respectively. As the percentage of replacement of cement with bamboo fiber powder increases strength increases up to 10% and beyond that it decreases with 20%. The increase in strength up to 15% replacement of cement by bamboo fiber powder may be due to the pozzolanic reaction of bamboo fiber powder due to high silica content. Also it effectively fills the voids and gives a dense concrete microstructure.

4.1 Scanning Electron Microscopy Test (SEM)

After the concrete samples were prepared for SEM studies, images were extracted from each sample. A total of two samples taken from the center and edge of the concrete cylinders in axial direction was studied. The images was acquired by the image analyzer at a magnification of $\times 60$ and digitized into an array of 512×512 pixels with 256 gray levels (1 pixel = $3.3 \mu\text{m}$). Based on figure 3, SEM test can

show the location and present of bamboo fiber powder in concrete. The use of SEM to extract images from the concrete specimens for different testing conditions is explained [3]. The images rendered were analyzed using an image analyzer. The image analyzer identifies Wood's metal, which represents the crack network in concrete specimens. The SEM identifies the geometric aspects of features in the microstructure, such as micro cracks in concrete represented by Wood's metal.

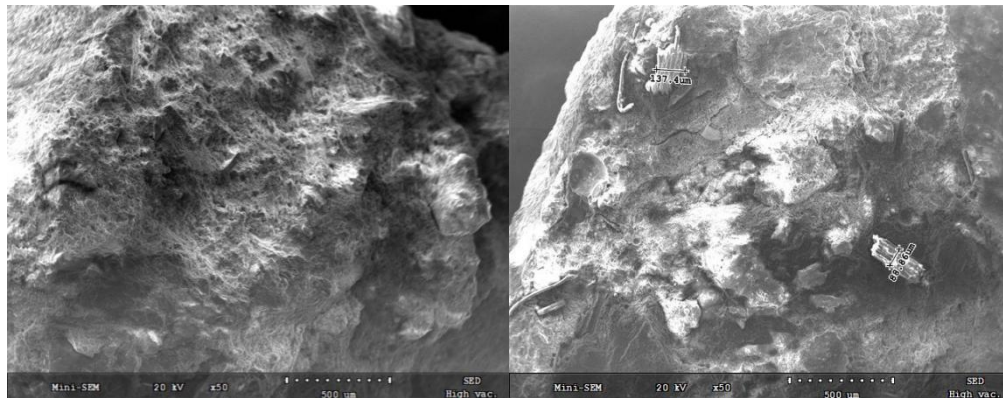


Fig 3. SEM test for control mix concrete and bamboo fiber powder concrete

5. Conclusion and Recommendation

From the results obtained from the laboratory test effect of bamboo ash powder in concrete mix does not give a positive optimism from the result of the laboratory experiment although slightly weak in strength while carry out compression test but the strength is still consider good just it is too weak in workability. This may due to bamboo ash powder can increase the water absorption therefore make the workability of concrete reduce. From the result of the slump test and compaction factor test, the conclusion can be make is the more the bamboo ash powder substitute to the fresh concrete, the lower the workability of the concrete. This might cause by the assumption for the proportion of bamboo ash powder and also the water content. But, superplasticizer (Master Rheobuild 1100 RM)[4] is a good product to use in concrete. The compressive strengths of SP concrete are usually higher than the corresponding strengths of the reference mixes. When SP is used, a water reducer up to 32-33% can be achieved [5]. From this study, I found that the bamboo fiber powder as an admixture in concrete is a be done in actual construction industries. Due to the performance of bamboo fiber powder, it can mix with concrete. The reason is bamboo fiber powder will absorb the water during concrete mix

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