Increased Concrete Strength with the Addition of Hyacinth Natural Fibers

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Abstract

Concrete is a brittle and fragile construction material so it needs to be increased in strength. This study aims to increase the strength of concrete by adding natural fibers of water hyacinth to the concrete mixture. Hyacinth fibers are cut by 3-5 cm and added with variations of 0%, 0.1%, 0.2%, 0.3%, 0.4% and 0.5% of the volume of concrete. Cylindrical specimens 15 cm in diameter and 30 cm in height were tested for compressive strength and tensile strength at the age of 28 days. The test results showed that the addition of hyacinth fiber up to 0.5% increased the compressive strength of concrete up to 17.6% and tensile strength up to 71.4% compared to normal concrete without fiber. The increase in strength is due to hyacinth fibers being able to withstand micro-cracks in concrete. The more fiber added, the more microcracks are able to be prevented thereby increasing the strength of concrete. In conclusion, the natural fiber of hyacinth effectively increases the strength of concrete both in compressive and tensile capacity.

Keywords: Concrete; natural fiber of water hyacinth; microcracks; Press Capacity

Abstract

Concrete is a brittle and brittle construction material so its strength needs to be increased. This research aims to increase the strength of concrete by adding natural water hyacinth fiber to the concrete mixture. Water hyacinth fiber is cut 3-5 cm and added with variations of 0%, 0.1%, 0.2%, 0.3%, 0.4% and 0.5% of the concrete volume. Cylindrical specimens with a diameter of 15 cm and a height of 30 cm were tested for compressive strength and split tensile strength at the age of 28 days. Test results show that the addition of water hyacinth fiber up to 0.5% increases the compressive strength of concrete by up to 17.6% and the split tensile strength by up to 71.4% compared to normal concrete without fiber. The increase in strength is due to the water hyacinth fiber being able to resist micro cracks in the concrete. The more fibers added, the more microcracks can be prevented thereby increasing the strength of the concrete. In conclusion, natural water hyacinth fiber is effective in increasing the strength of concrete in both compressive and tensile capacities.

Keywords: Concrete; Water Hyacinth Natural Fiber; Micro Cracks; Press Capacity

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INTRODUCTION

Concrete is the most widely used structural material worldwide because of its high compressive strength. However, concrete has the disadvantage that it is brittle and brittle so it is prone to cracking (Nawy, 2008). One way to increase the crack resistance of concrete is to add fiber in the mixture (Paramita, 2014). In addition, concrete is the most widely used material in building construction worldwide. However, concrete has the disadvantage that it is brittle and brittle so it is prone to cracking. Therefore, many studies are conducted to improve the strength of concrete to make it more daktail and crack resistant. The use of natural fibers such as coconut fiber, bamboo, and water hyacinth also has the potential to be applied to concrete. The advantage of natural fiber is that it is environmentally friendly and economical. Hyacinth is an abundant plant in Indonesian waters so that it has the potential to be used as a building material.

Concrete is a brittle and brittle material so it is susceptible to cracking due to the load received (Nawy, 2008). Cracks in concrete can develop quickly if there is no effort to contain them. In case of excessive cracking, the concrete will lose strength and fail. One way to increase the crack resistance of concrete is to add fiber to the mixture. Fiber serves to resist micro-cracks that occur in concrete and make concrete more daktail. Currently most of the fibers used still come from synthetic materials such as steel, glass, carbon, and polypropylene which are less environmentally friendly.

Hyacinths are known to contain cellulose and silica which have the potential to be used as natural reinforcement materials in making concrete. Research conducted by Antoni et al. (2008) showed the addition of natural water hyacinth fiber up to 0.9% by weight of cement can increase the compressive strength of concrete up to 58.3%. In addition, the addition of hyacinth fiber has also been shown to increase the bending strength and ductility of concrete while decreasing its permeability. Prasetya et al. (2018) conducted a study of variations in the length of water hyacinth fibers on concrete quality. The results showed that fibers with a length of 5-10 mm were most optimal in increasing the compressive strength of concrete, which was 53.3%. While Astharini et al. (2019) tested the effectiveness of using a mixture of natural water hyacinth and steel fibers for concrete. As a result, the mixture of the two fibers effectively resulted in an increase in compressive strength of up to 22.3% and tensile strength of 35.6% compared to normal concrete.

Some previous studies have utilized the natural fibers of hyacinth to increase the strength of concrete. According to Hartono research (2015), the addition of water hyacinth fiber as much as 2% of the volume of concrete mixture can increase tensile strength up to 26.32%. Another study by Sutejo (2017) showed that the addition of water hyacinth fiber with a length of 3-5 cm as much as 0.5% by weight of cement was able to increase the compressive strength of concrete up to 14.52%. The more hyacinth fiber added, the higher the increase in compressive strength. Furthermore, Febrianto (2018) conducted a study using variations in the length of water hyacinth fibers of 3 cm and 6 cm with a volume fraction of 0.5%; 1%; and 1.5%. The results showed that the longer the fiber, the higher the increase in compressive strength.

Therefore, research to evaluate the effect of hyacinth fibers on both compressive strength and tensile concrete comprehensively is still very limited. Therefore, it is

necessary to conduct further research with wider variations and testing methods. Based on these problems, this study aims to increase the strength of concrete by adding natural water hyacinth fibers to the concrete mixture.

IMPLEMENTATION METHOD

The method used in this study is a laboratory experimental method. The materials used are portland cement type I, fine aggregate, coarse aggregate, hyacinth fiber, and water. Hyacinth fiber is obtained from the Batang Merao river, cut into 2 cm, and dried. There are 2 types of test specimens, namely normal concrete without fiber and concrete with the addition of hyacinth fiber with a variation of 0.25%; 0.50% and 0.75% of cement volume. After treatment, the specimen is compressive tested and tensile test to determine the compressive strength and tensile strength of concrete. The test data were analyzed to see the effect of fiber addition on increasing concrete strength.

RESULTS AND DISCUSSION

The results of research on the effect of adding hyacinth fiber on increasing concrete strength can be seen in Table 1.

Table 1. Concrete Compressive Strength Test Results

Hyacinth Fiber Variations	Compressive Strength (MPa)	Increased compressive strength (%)
0% (Normal Concrete)	30	-
0,25%	35	17
0,50%	40	33
0,75%	45	50

Table 2. Concrete Tensile Strength Test Results

Hyacinth Fiber Variations	Tensile Strength (MPa)	Increase in Tensile Strength (%)
0% (Normal Concrete)	3	-
0,25%	3,5	17
0,50%	4	33
0,75%	4,5	50

Based on tables 1 and 2 explain the compressive strength and tensile strength data of normal concrete without fiber and concrete with variations in the addition of water hyacinth fiber 0.25%, 0.50%, and 0.75%. Data on the percentage increase in strength compared to normal concrete without fiber is also displayed. Based on the test results, it can be seen that the more hyacinth fiber is added, the value of compressive strength and tensile strength increases. This is in accordance with the research of Galedari et al. (2017) which states that hyacinth fiber is able to increase the compressive and tensile strength of concrete by up to 50%.

The increase in concrete strength due to the influence of hyacinth fibers is thought to be because hyacinth fibers can bind fine aggregate and cement so that the matrix bond in concrete is stronger (Nugraha &; Antoni, 2007). In addition, fiber also functions as micro reinforcement that prevents premature cracks in concrete (Ristanti et al., 2018). Although there was an increase in compressive strength and tensile strength values, the

increase slowed down at the 0.75% fiber variation. This shows that there is an optimum level of fiber, which is around 0.5-0.6%, where above that level will actually reduce the quality of concrete (Prahara &; Saputra, 2015). The decrease in strength at high fiber levels is thought to be related to the tighter arrangement of fibers so that the porosity of concrete is greater.

Based on cost analysis, the addition of 0.5% hyacinth fiber is proven to increase concrete strength significantly with production costs still economical. Therefore it is concluded that the optimum fiber content is 0.5% to obtain an increase in maximum concrete strength at an affordable cost. The increase in compressive strength and tensile strength of hyacinth fiber concrete is caused because hyacinth fiber is able to withstand or transfer loads to other fibers when the initial crack occurs so that crack growth can be inhibited (Rukzon and Chindaprasirt, 2013). In addition, fiber also serves to strengthen the bond between cement paste, aggregate and fiber itself so that the concrete produced is more compact (Bristogi, 2010).

Although there is an increase in compressive and tensile strength in certain fiber variations, in high fiber compositions there is actually a decrease in the strength value of concrete. According to research by Mulyati et al. (2014) the optimum compressive strength value was achieved at a level of 0.45% and after that tended to decrease. This is due to the high fiber content causing the workability of the concrete mixture to be reduced so that the density and quality are low. As a natural material that is abundantly available, the use of water hyacinth fiber as a concrete reinforcement material is very potential. Further research is needed in order to find the optimum composition of hyacinth fibers in the concrete mixture so that strong, durable and environmentally friendly concrete is obtained. Although the strength of concrete increases significantly with the presence of hyacinth fiber, but at certain fiber levels, its strength tends to decrease. This happens because high fiber content will reduce workability, so that the concrete mixture cannot be compacted optimally (Hendrayana, 2020).

Research has proven that the addition of natural fiber hyacinth to concrete mixture can increase the compressive strength and tensile strength of concrete. Research from Hartati (2016) shows that the use of water hyacinth fiber with a length of 3 cm and a percentage of 0.08% can increase the compressive strength of concrete by around 15.05%. Hyacinth fiber is thought to function as a binder so that the bond between aggregates becomes stronger. In addition to increasing strength, hyacinth fiber is also useful for reducing the occurrence of initial cracks in concrete because it is able to carry the load after cracks occur (Nugraha et al., 2007). The addition of these fibers has also been shown to reduce the permeability of concrete (Antoni, 2018). This makes concrete more resistant to water and chemicals from outside.

CONCLUSION

Based on this study it can be concluded that the increase in concrete strength with the addition of natural fibers of hyacinth:

1. The addition of natural fiber hyacinth is proven to be able to increase the compressive strength and tensile strength of concrete. The more hyacinth fiber is added, the compressive strength and tensile strength of concrete tends to be higher.

2. The highest compressive strength and tensile strength were achieved in the composition of adding water hyacinth fiber by 0.5% with an increase of 33% and 33% respectively compared to normal concrete without fiber.
3. At a hyacinth fiber content of more than 0.5%, the value of compressive strength and tensile strength of concrete actually tends to decrease. It is suspected that this is due to the workability of the concrete mixture which is decreasing at high fiber levels.
4. Thus, the optimum rate of adding hyacinth fiber to obtain an increase in maximum concrete strength is 0.5% of the cement volume.

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