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Comparison of the Compressive Strength of Palm Fiber Mixed Concrete and Bamboo Fiber Mixed Concrete with the Addition of Damdex

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Abstract**—** *The addition of palm fibers and bamboo fibers to the concrete is expected to make the concrete more ductile. The advantages of palm fiber and bamboo fiber composites compared to other fibers are that the fibers and bamboo fiber composites are more environmentally friendly because they are able to degrade naturally and the price is cheaper when compared to other fibers. Palm fibers also have properties that are elastic, hard, waterproof and difficult to digest by destructive organisms. The addition of natural fiber, especially bamboo fiber, is an option because it is a natural product that is easy to cultivate. Bamboo has several advantages, namely that it does not experience corrosion, is relatively inexpensive and has low tapering and shrinkage properties and a relatively high tensile strength. Palm fibers and bamboo fibers are renewable natural products that can be obtained easily, cheaply, are easy to plant, grow fast, can reduce the effect of global warming and have high tensile strength. Based on previous research, the addition of damdex to the mixture can increase the compressive strength of concrete. The compressive strength test was carried out at the age of the concrete 14 and 28 days. The research will be carried out at the Laboratory Concrete Structures of Civil Engineering, Faculty of Engineering, Siliwangi University. Increasing the compressive strength of concrete using the addition of damdex with a compressive strength of a concrete plan of 34 Mpa as follows: the highest compressive strength of concrete in the test object at 28 days of age is 37.736 Mpa at the addition of 2.0% damdex or an increase of 19.23% from normal concrete compressive strength 31,619 Mpa. The addition of damdex fibers and bamboo fiber damdex to the concrete mixture is expected to improve the mechanical properties of concrete which is much better than concrete without using added materials and can improve the properties of concrete without reducing its quality. The research that will be carried out aims to analyze the compressive strength of concrete with a concrete mix design with added variations of 0% damdex 0% palm fiber, 0% damdex 0.5% palm fiber, 0% damdex 1% palm fiber, 0.5% damdex 0 % palm fiber, 0.5% damdex 0.5% palm fiber, 0.5% damdex 1% palm fiber by weight of cement. Then compare it with the compressive strength of concrete with a concrete mix design with added variations of 0% damdex 0% bamboo fiber, 0% damdex 0.5% bamboo fiber, 0% damdex 1% bamboo fiber, 0.5% damdex 0% bamboo fiber, 0.5% damdex 0.5% bamboo fiber, 0.5% damdex 1% bamboo fiber by weight of cement.*

Keywords**—** *Bamboo fiber, Concrete, Compressive strength, Damdex, Palm fiber.*

I. INTRODUCTION

Concrete is one of the main components in infrastructure development such as buildings, bridges, roads, and others. Simple concrete is formed by hardening a mixture of cement, water, fine aggregate, coarse aggregate (crushed stone or gravel), air, and sometimes other additional mixtures. In some cases, the concrete mixture requires additional materials to support its performance. The purpose of adding additives is to change one or more of the properties of the concrete, when it is fresh or after it has hardened. For example, to accelerate hardening, increase workability, increase compressive strength, increase ductility (reduce brittle properties), reduce hardening cracks, and so on.

The basic material of concrete consists of a mixture of cement, water, fine aggregates and coarse aggregates, but lately the increasing use of concrete has led to the development of research on concrete mixtures. In this experimental study, concrete research was conducted with the addition of damdex and fibers and concrete with the addition of damdex and bamboo fibers to the concrete mixture.

Ductility is an important property of concrete. The low concrete ductility is described by its strain voltage curve which has a rapid decrease in compressive strength in the post-peak load area, resulting in a relatively sudden collapse. The addition of natural fibers, especially fibers, is expected to make concrete more daktail.

The advantage of palm fiber composites compared to other fibers is that they are more environmentally friendly because they can degrade naturally and the price is cheaper when compared to other fibers. Palm fibers also have properties that are elastic, hard, waterproof and difficult to digest by destructive organisms. The fibers are natural fibers that maybe only some people know that this fiber is very special compared to other natural ones.

According to the ACI Committee 544, fiber concrete is defined as concrete made of a mixture of cement, coarse aggregate, fine aggregate and a small amount of fiber. The addition of fiber is intended to provide fiber reinforcement in the concrete, which is spread randomly to prevent cracks that occur due to loading.

The addition of fibers to the concrete mortar improves the properties of concrete structures. The fibers in the concrete will be mechanical so that they do not chemically connect with other concrete materials. Fiber is able to bind and unite the concrete mixture after the initial binding with cement. The use of fiber in concrete can also increase concrete ductility from sap properties to more ductile. Other advantages of use are increasing shock load, resistance to melting, resistance to shrinkage, increasing bending strength and increasing beam shear strength.

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Various kinds of fibers have been studied as concrete mixing materials such as steel fibers, glass fibers, concrete fibers, polymer fibers, asbestos fibers and natural material fibers. Various kinds of fibers are recommended as concrete strengthening, ACI Committee 554 classifies the common fiber type into four:

1) *SRFC (Steel Fiber Reinforced Concrete)*
2) *GFRC (Glass Fiber Reinforced Concrete)*
3) *SNFRC (Synthetic Fiber Reinforced Concrete)*
4) *NFRC (Natural Fiber Reinforced Concrete)*

Bamboo is a clump with grass (pereunial Grass) with woody stems (Woody steams, culus) so in other words the anatomy of bamboo is very different from wood. Bamboo tissue consists of parencima cells and vascular groups (which are rich in reeds). This group consists of reeds, thick-walled fibers and capillary pipes which are fibers that give strength to bamboo.

Based on previous research the addition of damdex to the mixture can increase the strength of concrete press. The strong increase in concrete press using the addition of damdex in research conducted by (Jhonson A. Harianja and Efrain Barus, Faculty of Engineering UKRIM Yogyakarta) that the addition of damdex with a ratio of 0.5% 1% 2% and 2.5% (of cement weight) with a strong press concrete plan of 34 Mpa. Damdex as an additional material in concrete mixture can increase the highest concrete press strength on test objects at the age of 28 days by 37.736 Mpa at the addition of damdex 2.0% or experience an increase of 19.23% from normal concrete pressure of 31,619 Mpa. With the addition of damdex and fibers in the concrete mixture, it is expected to improve the mechanical properties of concrete much better than concrete without the use of added materials and can improve the properties of concrete without compromising its quality.

II. RESEARCH AND METHODOLOGY

This research is an experimental research with a time series approach. A randomized block design study, with a total treatment of twenty four types, namely:

1) Compressive strength of 0% damdex 0% palm fiber for 14 days;
2) Compressive strength of mixed concrete 0% damdex 0.5% palm fiber for 14 days
3) Compressive strength of 0% damdex 1% mixed concrete for 14 days
4) Compressive strength of mixed concrete 0.5% damdex 0% palm fiber for 14 days
5) Compressive strength of mixed concrete 0.5% damdex 0.5% palm fiber for 14 days
6) Compressive strength of mixed concrete 0.5% damdex 1% palm fiber for 14 days
7) Compressive strength for mixed concrete 0.5% damdex 0% bamboo for 28 days
8) Compressive strength of mixed concrete 0.5% damdex 0.5% palm fiber for 28 days
9) Compressive strength of mixed concrete 0.5% damdex 1% palm fiber for 28 days
10) Compressive strength of 0% damdex 0% palm fiber for 28 days;
11) Compressive strength of 0% damdex 0.5% palm fiber for 28 days
12) Compressive strength of 0% damdex 1% mixed concrete for 28 days
13) Compressive strength of 0% damdex 0% bamboo fiber for 14 days
14) Compressive strength of 0% damdex 0.5% bamboo fiber for 14 days
15) Compressive strength of 0% damdex 1% bamboo fiber for 14 days
16) Compressive strength of mixed concrete 0.5% damdex 0% bamboo fiber for 14 days
17) Compressive strength of mixed concrete 0.5% damdex 0.5% bamboo fiber for 14 days
18) Compressive strength of mixed concrete 0.5% damdex 1% bamboo fiber for 14 days
19) Compressive strength of mixed concrete 0.5% damdex 0% bamboo fiber for 28 days
20) Compressive strength of mixed concrete 0.5% damdex 0.5% bamboo fiber for 28 days
21) Compressive strength of mixed concrete 0.5% damdex 1% bamboo fiber for 28 days
22) Compressive strength of mixed concrete 0% damdex 0% bamboo fiber for 28 days
23) Compressive strength of mixed concrete 0% damdex 0.5% bamboo fiber for 28 days
24) Compressive strength of mixed concrete 0% damdex 1% bamboo fiber for 28 days

Data research flow is seen in fig.1:

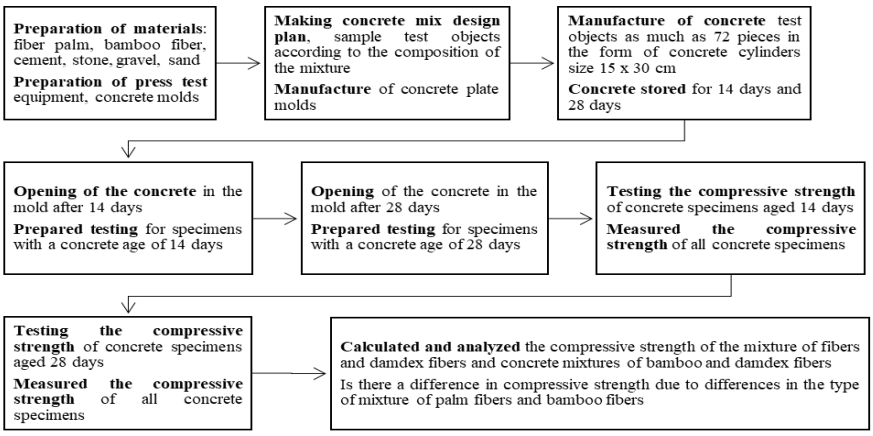

Fig. 1.

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III. RESULT AND DISSCUSION

A. Compressive Strength of Concrete with a Mix of Damdex and Bamboo Fiber

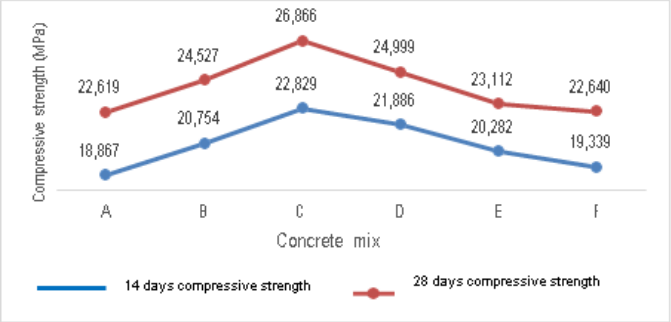

Fig. 1. Compressive Strength of Damdex Mixed Concrete and Bamboo Fiber 14 and 28 Days

Where **A**: 0% damdex and 0% bamboo fiber, **B**: 0% damdex and 0.5% bamboo fiber, **C**: 0% damdex and 1.0% bamboo fiber, **D**: 0.5% damdex and 0% bamboo fiber, **E**: 0.5% damdex and 0.5% bamboo fiber, **F**: 0.5% damdex and 1.0% bamboo fiber.

The test results of the compressive strength of concrete with the addition of bamboo fibers are greater than the compressive strength of normal concrete (0% damdex and 0% bamboo fibers). Figure 1 shows the optimum compressive strength of concrete given the addition of 0% damdex mixture and 1% bamboo fiber by weight of cement with a concrete age of 28 days (26.866 MPa). At the age of 14 days of concrete, the optimum compressive strength also occurs in concrete which is given an additional 0% damdex mixture and 1% bamboo fiber (22.829 MPa).

B. Compressive Strength of Concrete with a Mix of Damdex and Palm Fiber

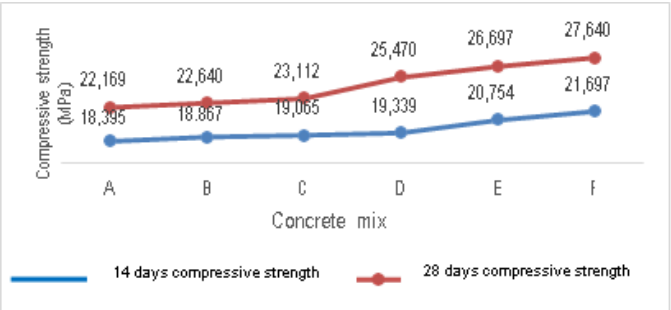

Fig. 2. Mixed Concrete Compressive Strength of Damdex and palm fiber 14 and 28 Days 3

Where **A**: 0% damdex and 0% palm fiber, **B**: 0% damdex and 0.5% palm fiber, **C**: 0% damdex and 1.0% plam fiber, **D**: 0.5% damdex and 0% palm fiber, **E**: 0.5% damdex and 0.5% palm fiber, **F**: 0.5% damdex and 1.0% palm fiber.

Figure 2 shows the compressive strength of normal concrete (0% damdex and 0% palm fiber) aged 28 days (22.169 MPa) is greater than the compressive strength of normal concrete (0% damdex and 0% palm fiber) aged 14 days (18.395 MPa). The optimum compressive strength of concrete aged 14 days occurred in concrete with a mixture of 0.5% damdex and 1% palm fiber (21.697 MPa) and at the age of 28 days occurred in concrete with a mixture of 0.5% damdex and 1% palm fiber (27.640 MPa). Besides that, fig.2 shows that the compressive strength of concrete aged 28 days is greater than the age of 14 days of concrete in all types of additional application of the mixture of damdex and palm fiber.

C. Comparison of the compressive strength of 14 days of concrete between mixed with Damdex with bamboo fiber and mixed with Damdex with fiber fibers

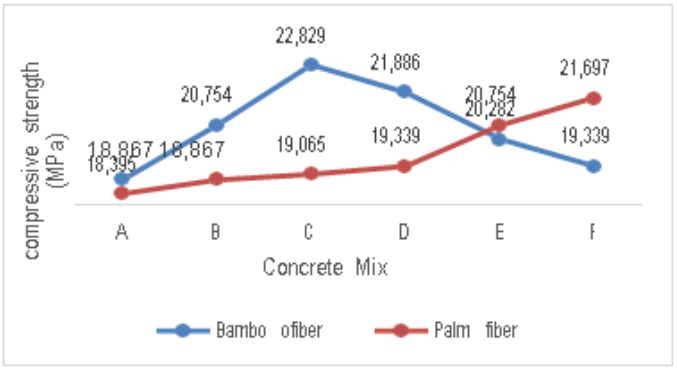

Fig. 3. Graph of 14 Days Concrete Compressive Strength between Mixed with Damdex and Bamboo Fiber with Mixed with Damdex and Palm Fiber

Where **A**: 0% damdex and 0% fiber, **B**: 0% damdex and 0.5% fiber, **C**: 0% damdex and 1.0% fiber, **D**: 0.5% damdex and 0% fiber, **E**: 0.5% damdex and 0.5% fiber **F**: 0.5% damdex and 1.0% fiber.

The compressive strength of normal concrete aged 14 days for testing mixed damdex concrete and bamboo fiber with mixed damdex concrete and palm fiber was not so different, respectively 18.869 MPa and 18.398 MPa.

D. Comparison of the Compressive Strength of 28 Days of Concrete between Mixed with Damdex and Bamboo Fiber and Mixed with Damdex with Palm Fiber

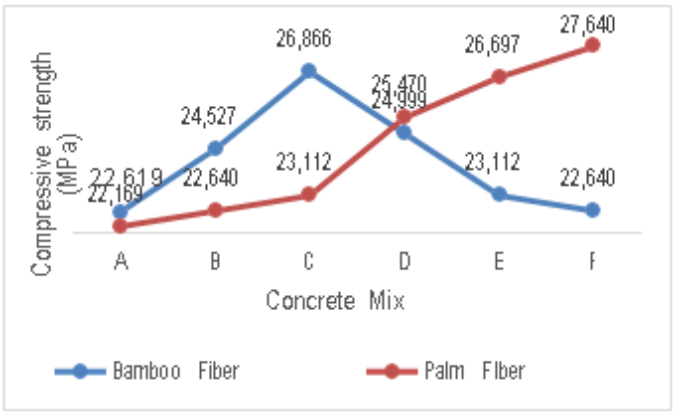

Fig. 4. Graph of 28 Day Concrete Compressive Strength between Mixed with Damdex and Bamboo Fiber with Mixed with Damdex and Palm Fiber

Where **A**: 0% damdex and 0% fiber, **B**: 0% damdex and 0.5% fiber, **C**: 0% damdex and 1.0% fiber, **D**: 0.5% damdex and 0% fiber, **E**: 0.5% damdex and 0.5% fiber **F**: 0.5% damdex and 1.0% fiber.

The normal compressive strength of 28 days old concrete

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for testing mixed damdex concrete and bamboo fiber with mixed damdex concrete and palm fiber were not so different, respectively 22.619 MPa and 22.168 MPa. The compressive strength of concrete which is given additional mixture of damdex and palm fiber shows an increasing graph, the optimum compressive strength of concrete occurs in concrete which is given an additional mixture of 0.5% damdex and 1% palm fiber (27.640 MPa).

E. Flexural Strength in Concrete with a Mix of Damdex and Bamboo Fiber

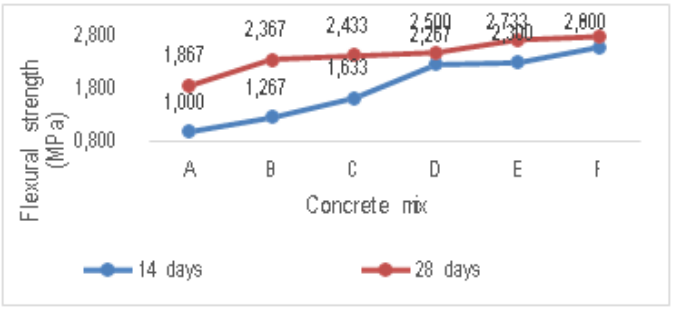

Fig. 5. Flexural Strength Graph of 14 and 28 Days Mixed Damdex Concrete and Bamboo Fiber

Where **A**: 0% damdex and 0% fiber, **B**: 0% damdex and 0.5% fiber, **C**: 0% damdex and 1.0% fiber, **D**: 0.5% damdex and 0% fiber, **E**: 0.5% damdex and 0.5% fiber, **F**: 0.5% damdex and 1.0% fiber.

Figure 5 shows the flexural strength of normal concrete (0% damdex and 0% bamboo fiber) which is 14 days old (1,000 MPa) is different from that of 28 days (1,867 MPa). The picture above shows the mixed damdex concrete and palm fiber which is 14 days and 28 days old, shows an upward graph. The optimum flexural strength of 14-day-old concrete in concrete given a mixture of 0.5% damdex and 1% palm fiber (2,600 MPa) and 28 days old is also optimum given a mixture of 0.5% damdex and 1% palm fiber (2,800 MPa).

F. Flexural Strength in Concrete with a Mix of Damdex and Palm Fiber

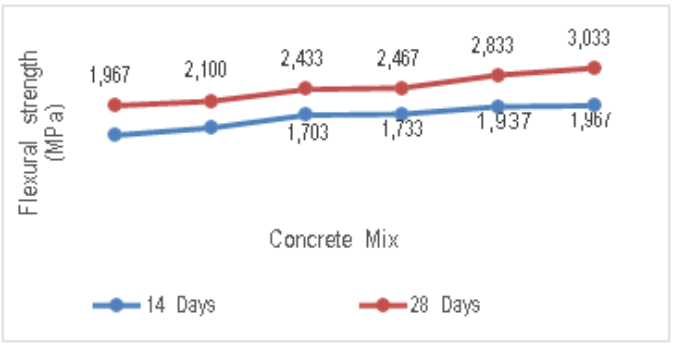

Fig. 6. Flexural Strength Graph of Damdex Mixed Concrete and 14 and 28 Day Fiber Ijuk

Where **A**: 0% damdex and 0% palm fiber, **B**: 0% damdex and 0.5% palm fiber, **C**: 0% damdex and 1.0% palm fiber, **D**: 0.5% damdex and 0%palm fiber, **E**: 0.5% damdex and 0.5% palm fiber, **F**: 0.5% damdex and 1.0% palm fiber.

Figure 6 above shows the flexural strength of concrete which is added with a mixture of damdex and increased injuk fibers. The flexural strength of normal concrete (0% damdex and 0% palm fiber) aged 14 days 1.133 MPa and those aged 28 days 1.967 MPa. The optimum flexural strength of concrete which is 14 days old occurs in concrete which is given a mixture of 0.5% damdex and 0.5% palm fiber, namely 1.967 MPa and 28 days old also occurs in concrete given 0.5% damdex and palm fiber 0.5% of 3,033 MPa.

G. Comparison of the Flexural Strength of 14 Days Concrete a mixture of Damdex and Bamboo Fiber with a mixture of Damdex and Palm Fiber

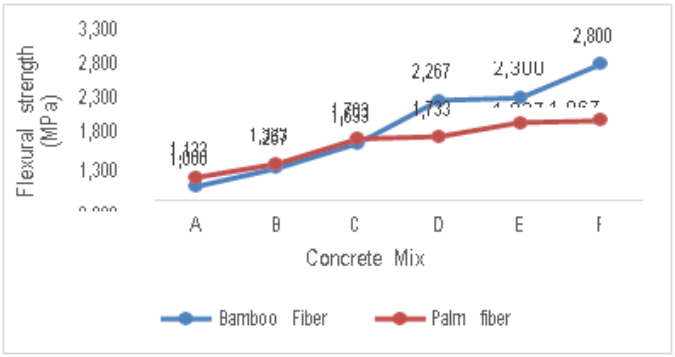

Fig. 7. Flexural Strength of 14 Days Concrete a mixture of Damdex and Bamboo Fiber with a mixture of Damdex and Palm Fiber

Where **A**: 0% damdex and 0% palm fiber, **B**: 0% damdex and 0.5% palm fiber, **C**: 0% damdex and 1.0% palm fiber, **D**: 0.5% damdex and 0%palm fiber, **E**: 0.5% damdex and 0.5% palm fiber, **F**: 0.5% damdex and 1.0% palm fiber.

Figure 7 shows that at the age of the concrete 14 days the flexural strength of normal concrete (0% damdex and 0% palm fiber) is not much different from normal concrete flexural strength (0% damdex and 0% bamboo fiber), namely 1,000 MPa and 1,113 MPa. Both treatments showed an upward and optimum trend in concrete which was added with a mixture of 0.5% damdex and 1.0% bamboo fiber at 2,800 MPa while the concrete given a mixture of 0.5% damdex and 1.0% palm fiber had the optimum flexural strength of 1,967 MPa. At the age of 14 days of concrete, the flexural strength of concrete given a mixture of 0.5% damdex and 1.0% bamboo fiber is greater than the flexural strength of concrete given a mixture of 0.5% damdex and 1.0% palm fiber.

H. Comparison of the Flexural Strength of 28 Days Concrete a mixture of Damdex and Bamboo Fiber with a mixture of Damdex and Palm Fiber

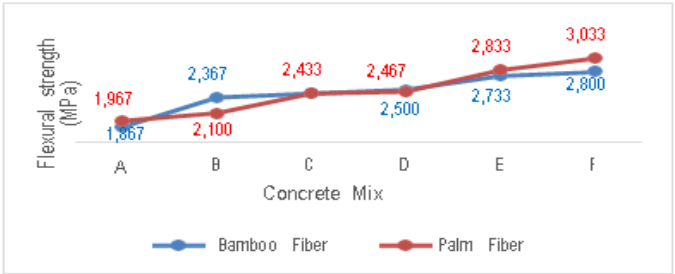

Fig. 8. The Flexural Strength of 28 Days Concrete a mixture of Damdex and Bamboo Fiber with a mixture of Damdex and Palm Fiber

Where **A**: 0% damdex and 0% palm fiber, **B**: 0% damdex and

0.5% palm fiber, **C**: 0% damdex and 1.0% palm fiber, **D**: 0.5% damdex and 0%palm fiber, **E**: 0.5% damdex and 0.5% palm fiber, **F**: 0.5% damdex and 1.0% palm fiber.

Figure 8 shows 28-day-old concrete, normal concrete flexural strength (0% damdex and 0% palm fiber) is not much different (0% damdex and 0% bamboo fiber), namely 1.867 MPa and 1.967 MPa. Both treatments showed an upward and optimum trend in the concrete given a mixture of 0.5% damdex and 1.0% bamboo fiber at 2,800 MPa while the concrete given a mixture of 0.5% damdex and 0.5% palm fiber had an optimum flexural strength of 3.033 MPa . In 14 days old concrete, the flexural strength of concrete given a mixture of 0.5% damdex and 1.0% of fibers is greater than that of concrete given a mixture of 0.5% damdex and 1.0% bamboo fiber.

IV. CONCLUSION

1. The compressive strength of the mixed design concrete without a mixture of damdex and fiber is 21.74 MPa at the age of 28 days, while at the age of 14 days is 18.50 MPa of concrete with a mixture of damdex and bamboo fiber. Testing concrete mixed damdex and fibers, the compressive strength of concrete without mixture at the age of 14 days is 18.04 Mpa.
2. The compressive strength of concrete with the addition of damdex without fiber and the compressive strength of concrete with the addition of fiber without damdex tends to increase.
3. The compressive strength of damdex concrete and bamboo fiber tends to increase. The optimum compressive strength occurs in 1% of the bamboo mixture (without damdex) of 26.37 MPa at 28 days of concrete, and 22.39 Mpa at 14 days of concrete. The compressive strength of damdex concrete mixture and the trend of fibers continues to increase and the maximum compressive strength with a mixture composition of 0.5% damdex, 15 fibers, which is 18.89 Mpa.

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