

Tensile Strength Characteristics of Concrete Blocks Using Abaca Fiber

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ABSTRACT

The role of concrete as a material to strengthen buildings with long-term durability is an important goal of construction. Abaca fiber has the potential to strengthen concrete network materials. The purpose of this study was to identify the tensile strength characteristics of concrete using abaca fiber. The method used is through experimental studies in the laboratory to test the tensile strength of concrete blocks. This research was carried out in the Materials and Structures Laboratory using five stages. The results of this research have found that the potential of abaca fiber as a binder for cylindrical concrete aggregates with a certain fiber length and fiber volume allows the concrete to be stronger and have high resistance compared to ordinary concrete. In the split tensile strength section, the results obtained show that abaca fiber concrete provides stronger resistance than ordinary concrete if the fiber length is 50mm high and the fiber volume is at 0.15%. The same results are shown in the flexural strength of the beam without reinforcement, namely concrete with abaca fiber has strong toughness if the fiber length content used is 50mm and the fiber volume is at 0.15%. Overall, abaca fiber is very influential on the resistance of concrete if the fiber length and fiber volume are at a certain point, namely 50mm and 0.15%

INTRODUCTION

Today's building construction is very important because of its rapid development in the world of architecture (Abd & Abd, 2017). Along the way, a strong architecture requires good construction for overall development (Lund et al., 2018). Construction technology is generally in great demand by the public, one of which is the manufacture of paving blocks or known as concrete bricks (Moffatt et al., 2017). Concrete is a composite material formed from a mixture of aggregates, generally, gravel and sand, which are chemically bonded together by hydrated Portland cement (MacGregor, J and Wight, J) (Kanchanason & Plank, 2017). Concrete is an important building material in building infrastructure such as houses, hotels, bridges, dams and others (Plusquellec et al., 2018) (Wyrzykowski et al., 2018). The use of traditional concrete structures is still very susceptible to sudden physical fracture and collapse, the most influential thing is due to the low tensile strength and high brittleness of the concrete material consisting of aggregates, cement paste (mortar), and pores (Zhang et al., 2017).

The role of concrete strength is very important for the survival of a building with high construction (Hansen et al., 2018) (Krakowiak et al., 2018). However, in general, stronger concrete still has several weaknesses that allow the building to not last long (Lund et al., 2018). There need to be continuous efforts to get a good concrete strength, composition in accordance with standardized materials. This is very important to ensure the quality of the concrete used is good and suitable for use in various construction projects. A difficult challenge is to produce a concrete composition that is environmentally friendly, easy to produce, and low in price so that it can be used by the public. Building a concrete composition using environmentally friendly, easily available and natural materials is an option that is very possible to use. The option that can be used is abaca fiber which is produced from banana trees. Banana trees are found in many countries in the world. Abaca fiber has been widely used as a material to retain heat and is widely used in clothes worn by firefighters. Due to its heat-resistant and fibrous nature, it is considered to be used as a mixed material in concrete blocks. The function of the abaca fiber is expected to bind structural concrete whose performance depends on the characteristics of the concrete in order to reduce deformation problems and provide long-term durability. Therefore, it is important to do an experiment to prove whether abaca fiber can make a column beam stronger or vice versa abaca fiber does not provide reinforcement for columnar beams.

LITERATURE REVIEW

This research is very important to do to get a conclusion on the utilization of abaca fiber. We tried to do a study by combining abaca fiber, namely fiber from banana trees to help strengthen the aggregate pores of the concrete to produce strong and sturdy concrete to be able to withstand difficult situations such as earthquakes and floods due to heavy rains. The purpose of this study was to determine and identify the tensile strength characteristics of concrete by utilizing abaca fiber.

METHODOLOGY

This type of research is an experimental laboratory study based on the main objective of this research, namely the flexural behavior of reinforced concrete beams using abaca fiber. This research was conducted at the Materials and Structures Laboratory, Department of Civil Engineering, Faculty of Engineering, Hasanuddin University. This research design was carried out in the following stages:

- Stage I: Characteristics of concrete.
- Phase II: Experiment of concrete mixing method with the addition of abaca fiber.
- Stage III: Optimization of the composition of the concrete mix by adding abaca fiber with a variety of fibers; 0%; 0.15%; 0.20%; 0.25% of the weight of concrete and fiber length variation: 25.4-mm; 38.1-mm; 50.8-mm.
- Stage IV: Compressive strength test, split tensile strength test of cylindrical concrete, and flexural test of unreinforced concrete beams.
- Stage V: Testing of flexural reinforced concrete beams using abaca fiber and without fiber

Aggregate Characteristics

Aggregate characteristics testing is carried out with the aim of knowing whether the coarse and fine aggregates to be used for casting meet the specifications based on SNI for the manufacture of test objects. The types of tests carried out include filter analysis, specific gravity, water absorption, volume, air cavity weight, water content, mud content, and organic content. Each test is carried out using a method based on SNI, as shown in Table 1.

Table 1. Aggregate Characteristic Testing Method

Test	Test method	
	Fine aggregate	Coarse aggregate
Filter analysis	SNI 03-1968-1990	
Specific gravity and water absorption	SNI 03-1970-1990	SNI 03-1969-1990
Air volume and cavity weight	SNI 03-4804-1998	
Water level	SNI 03-1971-1990	
Sludge levels	SNI 03-4142-1996	
Organic level	SNI 03-2816-1992	

Concrete Mixture Design and Proportions

The design mix is based on the defined physical properties of the material according to the ACI 211 standard and specifications (18) using the weight method design basis. See Table 2.

Table 2. Concrete Mix Design 25 MPa

Concrete material	Weight/M3 Concrete	Description
Cement	425,00	Tonasa Cement
Sand	638,68	river sand
Gravel	1057,40	broken stone
Water	188,00	Clear water
Superplasticizer	0.2% of cement weight	Viscocrete 5115N

Table 3. Proportion of Normal Concrete Mix and Abaca Fiber Concrete

Test object	Water/Cement (%)	Gravel (kg)	Sand (kg)	Water (kg)	Cement (kg)	Fiber (kg)
NC-00-000	0,63	26,70	16,10	6,39	10,20	-
FC-25-0,15	0,63	26,70	16,10	6,39	10,20	0,09
FC-25-0,20	0,63	26,70	16,10	6,39	10,20	0,12
FC-25-0,25	0,63	26,70	16,10	6,39	10,20	0,15
FC-38-0,15	0,63	26,70	16,10	6,39	10,20	0,09
FC-38-0,20	0,63	26,70	16,10	6,39	10,20	0,12
FC-38-0,25	0,63	26,70	16,10	6,39	10,20	0,15
FC-50-0,15	0,63	26,70	16,10	6,39	10,20	0,09
FC-50-0,20	0,63	26,70	16,10	6,39	10,20	0,12
FC-50-0,25	0,63	26,70	16,10	6,39	10,20	0,15

Table 3, describes the proportions of different mixtures for all materials used in various concrete mixtures with abaca fiber reinforcement. The sample specimen "FC-50-0.15" shows the type of matrix, fiber length, and abaca fiber content used. "FC" means that the fibrous concrete matrix is abaca. The next term "50" denotes a fiber length of 50 mm, and the last number "0.15" indicates a total fiber content of 0.15% of the weight of the concrete.

Abaca Fibrous Concrete Mix Composition

Variations in the composition of the abaca fibrous concrete mix with 0% fiber content; 0.15%; 0.20%; 0.25 of the total weight of concrete and fiber length of 25 mm, 38 mm, 50 mm. Mixing is done through a concrete mixer. The fresh concrete was then subjected to a slump test immediately after mixing (ASTM C 143). See Figure 1, Figure 2, and Table 4.



Figure 1. Abaca Fiber and Fiber Length

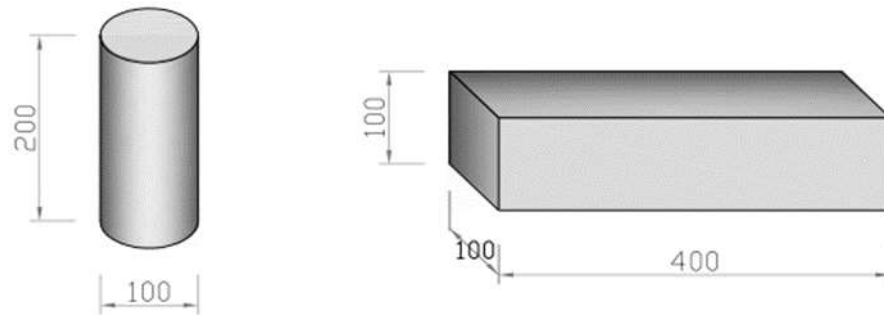


Figure 2. Cylindrical and Beam Test Specimens

Table 4. Variation of Test Specimens with Fiber Composition

Variation of test object				
Fiber length	Fiber volume (%)	Compressive strength	Pull apart	Flexural strength
25 mm	0,15	3	3	3
	0,20	3	3	3
	0,25	3	3	3
38 mm	0,15	3	3	3
	0,20	3	3	3
	0,25	3	3	3
50 mm	0,15	3	3	3
	0,20	3	3	3
	0,25	3	3	3
Amount		27	27	27

Division of Concrete Test Group

Different test batches of concrete are required at each stage of the test plan, with a total of three batches of concrete. The use of each group is given in table 5. The required volume of concrete is determined by manually prepared concrete groups. A physical test of concrete material (SNI 2847 - 2013) was carried out by testing concrete cylinders without abaca fiber and with the addition of abaca fiber. The size of the concrete cylindrical specimen is made with a diameter of 100 mm and a height of 200 mm (each variation of 3 specimens) with a design compressive strength (FC) of 25 MPa with a slump value of 100 mm.

Table 5. Division of Concrete Groups

Concrete group	Test object	Manufacture of test objects	The main purpose
1	Cylinder and beam	Manually	Fiber composition
2	Normal reinforced concrete beam (NRC) 3300	Manually	Static behavior
3	Fiber reinforced concrete beam (FRC) 3300 mm	Manually	Static behavior

Abaca Fibrous Concrete Dry Mix Method

The concrete mixing process is carried out by the dry mixing method with a concrete mixer (concrete mixer) where to get good quality concrete, the implementation in the field must be good and correct. The steps for making the test object are as follows:

1. The tools to be used are cleaned first, then weigh the materials to be used according to the composition of the mix design results. Weighing of cement, abaca fiber, coarse and fine aggregate, and water that has been determined by the mix design before being put into the concrete mixer.
2. Then enter the coarse aggregate, fine aggregate, cement, and abaca fiber, which is entered per 1/3 part, Stir until the ingredients are evenly mixed. Add water, then turn the mixer for 3 minutes later, then wait until it produces a homogeneous concrete mixture, as in Figure 3.
3. After thoroughly mixed, a slump test is carried out to measure the workability of the mortar. Next, the concrete mixture is poured into cylindrical and block molds, then pounded on all sides of the concrete and vibrated so that the concrete becomes solid and the air voids in the mold come out. Let stand for 24 hours until the mold is opened, then do the concrete treatment (curing). See Figure 4.



Figure 3. Abaca Fibrous Concrete Mix



Figure 4. Slump Test

RESULT AND DISCUSSION

Abaca Fibrous Concrete Dry Mix Method

The tensile strength test of steel is carried out with the aim of knowing the quality of the reinforcing steel to be used for reinforced concrete beams. The quality of the reinforcing steel affects the calculation results of each loading of the beam test object. The results of the tensile strength test for D13 mm diameter reinforcement can be seen in Table 6 and Figure 5

Table 6. Test Results of Tensile Strength of Reinforcing Steel

Iron diameter (mm)	Large (mm ²)	Load (kN)		Stress (MPa)		Strain (μ)	
		Melt	Break	Melt	Break	Melt	Break
D13	132,67	51,92	82,53	391,01	621,53	1948,11	70858,50

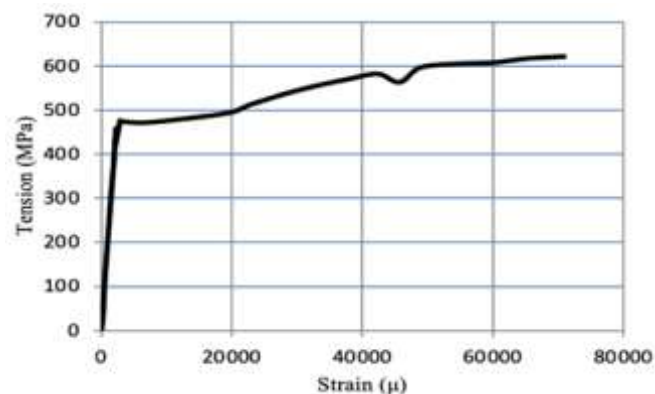


Figure 5. Test Results of Abaca Fiber Concrete Characteristics

The results of testing the characteristics of concrete are shown in Table 7 of the compressive strength test of concrete, Table 8 of the modulus of elasticity of concrete, Table 9 of split tensile strength, and Table 14 of the results of bending tests.

1. *Compressive Strength of Concrete*

The results of testing the compressive strength of concrete with variations in the composition of the addition of 0% abaca fiber; 0.15%; 0.20%; 0.25% with fiber lengths of 25 mm, 38 mm, 50 mm as shown in Table 7.

Table 7. Test Results of Cylindrical Concrete Compressive Strength

Test object	Abaca fiber volume (%)	Fiber length (mm)	Slump test (mm)	Specific gravity (kg/m ³)	compressive strength (MPa)
Normal	0	0	120	2.360,7	26,27
		25	95	2.290,3	24,49
		38	75	2.264,8	21,06
Abaca fiber concrete	0,15	50	50	2.252,5	29,58
		25	80	2.288,1	20,41
	0,20	38	70	2.270,7	18,96
		50	50	2.243,2	23,89
		25	85	2.292,8	19,44
0,25	38	70	2.252,1	15,88	
	50	55	2.222,4	20,83	

The fibrous concrete test object with the addition of 0.15% fiber is shown in Table 7 for the test results of the compressive strength of concrete with a fiber length of 25 mm with a compressive strength value of 24.49 MPa or a decrease of 6.78% against normal concrete. At 38 mm fiber length, the compressive strength value is 21.06 MPa, or a 19.8% decrease compared to normal concrete. At a fiber length of 50 mm with a compressive strength value of 29.58 MPa or an increase of 26% against normal concrete.

CONCLUSION

This research concludes that abaca fiber greatly influences the durability of concrete if the fiber length and fiber volume are at a certain point. This was obtained from the conclusions produced in several experiments with concrete without abaca fiber and concrete containing abaca fiber. The results show that the abaca fiber used in concrete as the compressive strength of concrete gives strong results in concrete with the greater the length of the abaca fiber content, the stronger the strength of the abaca fiber concrete. In the split tensile strength section, the results obtained show that abaca fiber concrete provides stronger resistance than ordinary concrete if the fiber length is at most 50mm and the fiber volume is at 0.15%. This research also concluded that the same results were shown in the flexural strength of unreinforced beams, namely that concrete with abaca fiber has strong toughness if the fiber length content used is 50mm and the fiber volume is 0.15%. Thus it can be concluded that abaca fiber greatly influences the durability of concrete if the fiber length and fiber volume are at a certain point, namely 50mm and 0.15%.

FURTHER STUDY

This research still has limitations, so it is necessary to carry out further research related to the topic of Tensile Strength Characteristics of Concrete Beams Using Abaca Fiber in order to perfect this research and increase the reader's insight.

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