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The Effect of Addition of Agave Sisalana Fiber and Sikacim Concrete Additive on Tensile Strength and Concrete Absorption

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ABSTRACT
This paper presents an experimental study that was carried out to determine the potential of natural fiber Agave Sisalana and sikacim concrete additive chemicals on concrete used as construction materials. The concrete mix ratio 1: 1,34: 2,37 was prepared using a water-cement factor of 0,45. Sikacim concrete additive is added as much as 0,8% of the cement weight and a reduction of water as much as 15%. The Agave Sisalana fiber added as much as 0,3% and 0,6% of cement weight. Tensile strength concrete testing was carried out at the age of 21 and 28 days. The experiment result indicated that the tensile strength and water absorption in concrete increase with the addition of Agave Sisalana Fiber and sikacim concrete additive. Thus, the Agave Sisalana Fiber and Sikacim Concrete Additive can be used as an additive in concrete mixing to increase tensile strength.

Keywords ; *Agave Sisalana, Absorption, Tensile Strength, Basic Material*

INTRODUCTION

Technological developments in the construction sector in Indonesia continue to increase, this cannot be separated from the demands and needs of the community for increasingly advanced infrastructure facilities, such as a bridge, the high-rise building, and other facilities. This encourages the need for appropriate construction technology both technically and from an economic point of view. Many studies and research have been carried out to obtain construction specifications that are strong and economical, there is no concrete which is a component that is almost always used in every construction [1].

Concrete is a material that has high strength against compression, but on the other hand, it has a very low relative strength to tensile. Due to its shortcomings, it requires quite extensive knowledge, such as regarding the nature of the basic materials, how to make them, how to evaluate them, and variations of added materials to improve the function of the concrete itself for the better. The importance of concrete construction for an idea of good quality concrete and meets the requirements. Many studies have been carried out to obtain an alternative discovery of the use of concrete construction in various fields appropriately and efficiently so that better concrete quality will be obtained. [2]

In considering the renewable and sustainable nature, natural fiber is growingly being used in composite material, especially in building construction. Natural fiber generally offers low production cost, friendly processing low tool wear and less skin irritation, and good thermal and acoustic insulation properties [3].

Sisal plants in Indonesia are developed in Madura Island, South Malang, Jember, and South Blitar, as well as in Sumbawa Regency. Most of the sisal fiber is sent to Jakarta to make ropes, mix carpets, brushes, doormats, brooms, and so on. Natural fibers from plants have long been used in various aspects of life, for example for textiles, rigging, brushes, patches, weaving, roofing, paper, handicrafts, building and construction materials, and the manufacture of synthetic fibers [4]. Says that sisal (agave sisalana) is a plant that only grows in tropical and subtropical areas. Sisal fiber is widely used for rope, boat rope, and fishing lines. Around the world, about 314 thousand tons of sisal fiber are produced annually, mainly by Tanzania and Brazil. Sisal fibers are extracted from the leaves. One sisal plant produces about 200-250 leaves of which one leaf consists of 1000-1200 fiber bundles. From 100 kg of sisal leaves, the fiber produced from these leaves is about 3-4 kg (3-

4%). Based on dry weight, sisal fiber consists of 54-66% cellulose, 12-17% hemicellulose, 7-14% lignin, 1% pectin, and 1-7% ash. Sisal fiber in the form of bundles has a length of 1-1.5 m and a diameter of 100-300 μm. Sisal has a hard, coarse, very strong fiber and is yellowish-white in color. Fiber density is 1.3-1.5 g/cm3, fiber tensile strength 510-635 N/mm2, and tensile modulus 9.4-22.0 GPa [5].

In the test of concrete with 0.15% pineapple leaf fiber added, it produces a greater tensile strength than concrete with 0.09% pineapple leaf fiber added material. The addition of pineapple leaf fiber variations in the concrete mixture resulted in an effect on the tensile strength of the concrete. Based on the data on the tensile strength of 28-day-old concrete, it can be seen that the variation in the percentage of pineapple leaf fiber can affect the quality of the concrete. So this informs that the use of agrarian waste such as pineapple leaves can be useful for improving the quality of concrete and it is recommended to use pineapple leaf fiber as an additive to the tensile strength of concrete [1].

Sikacim concrete additive is one of the additives that can be used for concrete mixtures. According to PT. Sika Indonesia, one of the advantages of using Sikacim concrete additive, in concrete is that it can reduce water consumption by up to 15% with a dosage of 250-300 ml/bag of cement. Novrianti et al. [6] from the results of his research suggest the use of Sikacim concrete additive, for a concrete mixture of 0.5% - 1% of the cement weight. Jamal et al. [1] obtained the highest concrete compressive strength from the use of Sikacim concrete additive, which was 0.7% by weight of cement with a 15% reduction in water content.

Desmi [7] says that Sikacim concrete additive is used to reduce the use of water and accelerate the hardening of concrete, which is a liquid that is added to the concrete mixture during mixing, to change the properties of the mortar or concrete. Or to get concrete with the same compressive strength, but the mixture is made thinner to make it easier to pour.

Experimental Program

The experimental program is planned to investigate the effect of adding agave sisalana fiber and sikacim concrete additive on concrete mixing. This research includes the determination of the tensile strength of cylindrical concrete specimens and water absorption in the concrete. Ordinary Portland Cement (OPC) ASTM Type I is used as a binder for mixing cement mortar by ASTM Standard C150. River sand was sieved to obtain a size range that passed the BS 5.00 mm test. In this study, the specific gravity was 2.61. Agave sisalana fiber with a length of 3-5 mm was introduced at 2 different levels, namely 0.3% and 0.6% of the cement weight. Meanwhile, Sikacim concrete additive is used at .0.8% by weight of cement and 15% by water reduction. Control specimens were denoted as CTRL, while BS-03 and BS-06 were denoted according to the percentage addition of agave sisalana. A mix ratio of 1 Ordinary Portland Cement: 1.34 Sand: 2.37 Gravel is made using a water cement factor of 0.45. The composition of the variation of concrete mixing can be seen in Table 1.

Testing the tensile strength of cylindrical concrete specimens by SNI 2491-2014 [8] and carried out at the age of 21 and 28 days of concrete. Meanwhile, the water absorption test in concrete was carried out based on ASTM C642-97 [9].

METHOD

The research begins by seeking information about the research to be carried out, then basic examinations are carried out such as silt content, analytical analysis, water content, specific gravity and unit weight which aim to obtain supporting data obtained in the laboratory.

Then, looking for a mix design to find out the proportion of the mixture for each test object to be made. In this study used agave sisalana fiber and sikacim concrete additive. After the materials needed are ready for use, the next step is the manufacture of test objects. The preparation of the test specimens was carried out according to the needs of each variation of the added material mixture, namely normal concrete to the volume of the mixture, concrete without the use of additives, concrete using 0.3% agave sisalana fiber added to the volume of the mixture, and concrete using 0 agave sisalana fiber added. .6% by volume of the mixture. For each concrete that

uses agave sisalana fiber added, the chemical sikacim concrete additive is added 0.8% by weight of cement and reduces water usage by 15%.

The next step is to make the concrete mix and check the concrete slump value, then put the concrete mixture into a cylindrical mold that has been given Vaseline. Then the specimen is allowed to stand and released from the mold after ± 24 hours. Furthermore, the specimens were soaked for 21 and 28 days.

After reaching the age of 21 and 28 days, the specimens were lifted from the immersion site and then tested for the split tensile strength of the concrete.

Data obtained from research results in the Laboratory, as follows:

1. Aggregate sieve analysis SNI 03-1968-1990.
2. Specific gravity and water absorption:
   - SNI 1969-2008 Coarse aggregate.
   - SNI 1970-2008 Fine aggregate.
3. Examination of sludge content SK SNI S – 04 – 1989 – F.
4. SNI 03-4804-1998 aggregate weight inspection.
5. Examination of SNI 1971-2011 aggregate water content.
6. Comparison of mixed concrete or mix design SNI 03-2834-2000.
7. SNI 03-1972-2008 fresh concrete mix viscosity or slump.

The design of the test object is as follows:

1. Type of specimen: cylinder with a diameter of 15 cm and a height of 30 cm.
2. Variation in the percentage of agave sisalana fiber content as an added ingredient: 0%, 0.3%, 0.6%.
3. Agave sisalana fiber is used with a length of 3 cm – 5 cm.
4. Percentage of chemical sikacim concrete additive: 0.8% by weight of cement.
5. The percentage of water in the concrete mix using a mixture of agave sisalana fiber and sikacim concrete additive is reduced by 15%.
6. Types of testing consist of:
   1) Split tensile strength test carried out at the age of 21 days of concrete.
   2) The split tensile strength test was carried out at the age of 28 days of concrete.
   3) Water absorption test on concrete.

The 18 test objects can be seen in the following table:

The need for specimens for 21 day split tensile strength testing.

No	Percentage of Fiber *Agave Sisalana*	*Sikacim Concrete Additive*	Test age (Days)	Number of Cylinder Samples
	agave sisalana fiber			
1	0 %	0 %	21	2
2	0,3 %	0,8 %	21	2
3	0,6 %	0,8 %	21	2
Total				6

The need for specimens for 28 day split tensile strength testing.

No	Percentage of Fiber *Agave Sisalana*	*Sikacim Concrete Additive*	Test age (Days)	Number of Cylinder Samples
	agave Sisalana fiber			

1	0 %	0 %	28	2
2	0,3 %	0,8 %	28	2
3	0,6 %	0,8 %	28	2
Total				6

The need for test specimens for testing water absorption in concrete.

No	Percentage of Fiber *Agave Sisalana* *agave sisalana fiber*	*Sikacim Concrete Additive*	Test Age (Days)	Number of Cylinder Samples
1	0 %	0 %	28	2
2	0,3 %	0,8 %	28	2
3	0,6 %	0,8 %	28	2
Total				6

The fine aggregate used in this research is sand obtained from Binjai. In the selection of fine aggregate must really meet the requirements that have been determined. Because it is very decisive in terms of ease of work (workability), strength (strength) and level of durability (durability) of the concrete produced. Sand as a material for forming concrete, together with cement and water, functions to bind the coarse aggregate into a strong and dense unit (SNI 03-2834-2000).
The agave sisalana fiber that will be used is fiber with a length of 3-5 cm which has been dried and sorted. Agave sisalana fiber comes from Blitar. Sikacim concrete additive is a chemical substance to reduce water use and accelerate hardening of concrete, in the form of a liquid added to the concrete mix during mixing, with the aim of changing the properties of the mix or concrete.

Table 1. Concrete mix composition

Specimens	**Volume 1 times (m^3)**	**Composition 1 Time Mix**					
		OPC (kg)	**Fine Aggregates (kg)**	**Coarse Aggregates (kg)**	**Water (kg)**	***Agave Sisalana* (kg)**	***Sikacim Concrete Additive* (kg)**
BN	0.0175	7.97	10.52	18.96	3.69	0	0
BS-0.3	0.0175	7.97	10.52	18.96	3.14	0.024	0.06
BS-0.6	0.0175	7.97	10.52	18.96	3.14	0.048	0.06

RESULT AND DISCUSSION

The averaged test results tensile strength of cylindrical concrete specimens with different treatment ages and the results of testing water absorption in concrete are presented in table 2. The value tensile strength of cylindrical concrete specimens is shown in table 1. The water absorption value in concrete is shown in table 2.

Table 2. Test results of tensile strength and water absorption in concrete

Mix	**21 days Tensile Strength (MPa)**	**28 days Tensile Strength (MPa)**	**Water Absorption (%)**
CTRL	3.44	4.06	3.88
BS-03	3.64	4.68	4.22

Mix	21 days Tensile Strength (MPa)	28 days Tensile Strength (MPa)	Water Absorption (%)
BS-06	4.58	4.89	6.01

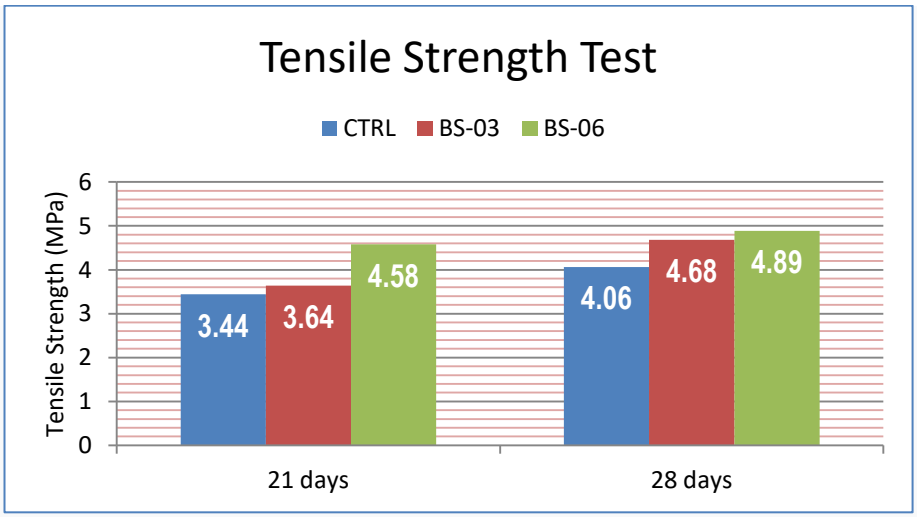

Figure 1. Comparison of tensile strength values

At the age of 21 days, the value of tensile strength in concrete with Agave Sisalana fiber and Sikacim Concrete Additive in variations of BS-03 and BS-06 experienced an increase in the value of tensile strength when compared to CTRL concrete. The value tensile strength of BS-03 and BS-06 concrete is 3.64 MPa and 4.58 MPa, while CTRL concrete has a tensile strength value of 3.44 MPa. The addition of the tensile strength test value for BS-03 and BS-06 concrete was also obtained at the age of 28 days when compared to CTRL concrete with a tensile strength value of 4.68 MPa and 4.89 MPa, while CTRL concrete obtained a tensile strength value of 4,06 MPa.

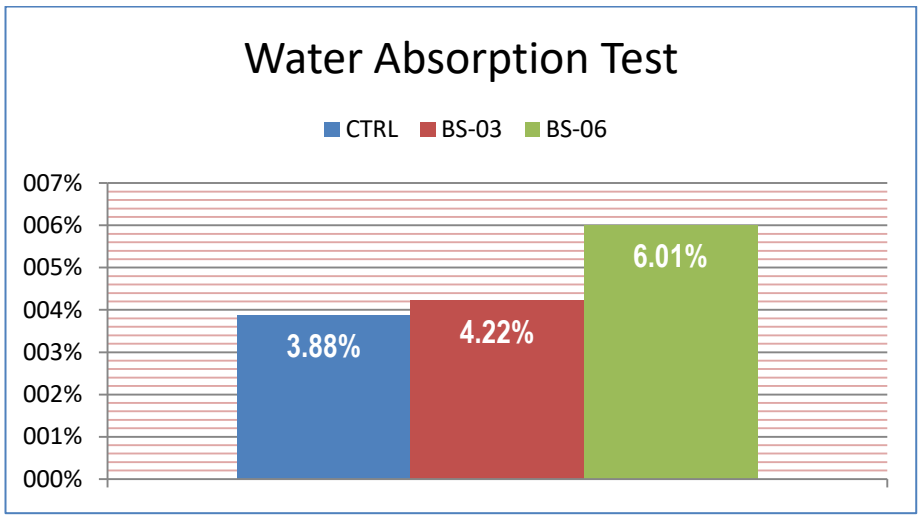

Figure 2. Comparison of water absorption values in concrete.

In testing the water absorption in the concrete in BS-03 and BS-06, the water absorption value increased when compared to CTRL concrete. Concrete with variations of BS-03 and BS-06 got a water absorption value of 4.22% and 6.01%, while CTRL concrete obtained a water absorption value of 3.88%.

CONCLUSION

Based on the experimental work that was carried out, the following conclusions were obtained:
Based on the tensile strength test at 21 days of age on the cylindrical concrete specimen, it was found that the tensile strength in BS-03 and BS-06 was increased when compared to CTRL with a value of 3.44 MPa, 3.64 MPa, and 4.58 MPa.
The tensile strength test at 28 days on cylindrical concrete specimens showed an increase in tensile strength in BS-03 and BS-06 when compared to CTRL with values of 4.06 MPa, 4.68 MPa, and 4.89 MPa.
In the water absorption test, it was found that BS-06 concrete has a water absorption value of 6.1%, BS-0.3 concrete has a water absorption value of 4.22%, and the lowest water absorption value is obtained in CTRL concrete, which is 3.88%. This means that the addition of Agave Sisalana fiber in concrete can increase the value of water absorption.

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