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EXPERIMENTAL STUDY OF THE UTILIZATION OF PINEAPPLE LEAF FIBER WITH THE ADDITION OF EPOXY RESIN TO THE TENSILE STRENGTH BREAK OF THE CONCRETE

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Abstract. In its development, many new concrete modifications were found, such as lightweight concrete, fiber concrete, polymer concrete, high-strength concrete and ultra-high-strength concrete. Epoxy resin can accelerate the hardening process of concrete because epoxy itself generates heat so that it helps accelerate hardening. In previous studies, the addition of areca nut shell fiber and 0.8% epoxy resin can increase the split tensile strength of concrete. Based on the description above, it is necessary to conduct research on the split tensile strength of concrete that combines a mixture of pineapple leaf fiber and epoxy resin. So this research uses pineapple leaf fiber and epoxy resin. Pineapple leaf fiber and epoxy resin are expected to be strength-enhancing materials that can produce concrete with more optimal split tensile strength. The purpose of this study was to determine the effect of the addition of epoxy resin and the percentage variation of pineapple leaf fiber on the split tensile strength of concrete and its comparison with normal concrete and to determine the percentage level of the addition of the most optimum pineapple leaf fiber to produce the maximum concrete split tensile strength test value among the planned variations. The method used in this research is experimental. From the results of the average split tensile strength test at 28 days, the epoxy resin variation of 0.8% achieved a strength of 2.87 MPa, the 0.15% variation achieved 2.37 MPa, and the 0.5% variation achieved 2.47 MPa

Keywords: Tensile Strength,Epoxy Resin, Pineapple Fiber

1. INTRODUCTION

Concrete has become a staple in infrastructure development in Indonesia [1]. Concrete is a basic form of life in modern society that has a function for development and construction components that have sturdy and durable properties whose mixture consists of aggregate (fine and coarse), water and cement which form a solid mass [2], [3]. The quality of concrete constituent materials affects the results of the concrete [4]. With good quality concrete, advantages are obtained, including being able to withstand compressive forces optimally. In addition, concrete also has many advantages, namely being able to withstand heavy loads, easy to shape as desired, and concrete stages against temperature [5], [6]. Concrete has weak tensile strength properties that result in concrete crumbling easily and breaking freely against changes in shape when the maximum stress has been reached [7].

In its development, many new concrete modifications have been found, such as lightweight concrete, fiber concrete, polymer concrete, high-strength concrete and ultra-high-strength concrete. One of the concrete that has been researched is polymer concrete. Polymer concrete is produced by reducing cement by adding an additive in the form of epoxy resin. Epoxy resin can accelerate the hardening process of concrete because epoxy itself generates heat so that it helps accelerate hardening [8]. In previous research, the addition of areca nutshell fiber and 0.8% epoxy resin can increase the split tensile strength of concrete [9]. The use of waste materials as additives in concrete has now been widely practiced in the world of construction industry. This aims to improve the

mechanical properties of the concrete itself and reduce the amount of waste disposed of into the environment such as the use of pineapple leaf fibers. The use of pineapple leaf fibers can generally improve the quality and durability of concrete. However, the addition of pineapple leaf fiber must be added in the right percentage so that the desired concrete properties can be achieved [10].

Fiber is an additive that can be used to improve the brittle nature of concrete to become more ductile [11]. Fiber is a strong, stiff, and brittle material. The addition of fiber aims to increase tensile strength, increase resistance to cracking, and increase durability in concrete [12]. To obtain strong, smooth and soft fibers, it is necessary to select pineapple leaves that are mature enough and their growth is partially protected from sunlight [13]. Epoxy resin or generally in the market known as epoxy material is one of the most important type of polymer that comes from the thermoset group. Thermoset resin is a liquid polymer which is converted into a solid material by crosslink polymerization and also chemically, forming three-dimensional polymer chain formations. Epoxy resins are widely used for structural materials, so in concrete the use of epoxy resin can speed up the drying process, because epoxy generates heat and can help accelerate hardening [8]. Based on the description above, it is necessary to conduct research on the split tensile strength of concrete that combines a mixture of pineapple leaf fiber and epoxy resin. So this research uses pineapple leaf fiber and epoxy resin. Pineapple leaf fiber and epoxy resin are expected to be strength-enhancing materials that can produce concrete with more optimal split tensile strength.

2. METHODS

This research was conducted at the Laboratory of the Faculty of Engineering, Indo Global Mandiri University. This type of research is experimental research in the laboratory in the form of an experimental study on the use of pineapple leaf fiber with the addition of epoxy resin on the split tensile strength of concrete.

2.1. Materials

The materials used in this research were: fine aggregate, coarse aggregate, portland cement, water, pineapple leaf fiber and epoxy resin and hardener. Pineapple leaf fiber variation 0.15%, 0.5% and 1%, Variation of epoxy resin 0.8% to the volume of material weight.

2.2. Materials Testing

Material testing aims to obtain aggregate characteristic data so that it can be mixed in making concrete. Testing of this material consists of gradation analysis testing, mud content testing, water content testing and Specific Gravity and Absorption testing. In this case, the material testing reference refers to the National Standard Indonesia (SNI) and equipped with the American Society For Testing and Materials (ASTM).

2.3. Mix Design

This mix planning refers to SNI [14]. In this research, cylindrical test objects were used with dimensions of 10 cm x 20 cm. The mixture proportions for 1 cylinder in this study are in Table 1.

Tabel 1. Concrete Mix Proportion

Sample	Composition (kg)
Cement	0.963
Fine aggregate	0.999
Coarse aggregate	1.960
Water	0.424
0,15% Pineapple leaf fiber	0.006
0,5% Pineapple leaf fiber	0.021
1% Pineapple leaf fiber	0.043
Epoxy	0.026
Hardener	0.008

2.4. Concrete Compressive Strength

Testing the split tensile strength of concrete is carried out after curing using a Compression Testing Machine. In this study, testing the split tensile strength of concrete was carried out at the Indo Global Mandiri University Laboratory using SNI [15].

$$Fct = \frac{2P}{\pi.L.D} \quad (1)$$

3. RESULTS AND DISCUSSION

The results discussed in this research are material testing, analysis of concrete characteristics such as cement water factor, slump test, and concrete split tensile strength test.

3.1 Material Testing Results

To analyze the characteristics of the fine aggregate, various tests were conducted, as shown below:

Table 2. Results of material testing

Material	Composition (Kg)	Spesifications	Test Results
Sieve Analysis	Coarse aggregate	≤ 8.5 %	4.29
	Fine aggregate	2.2- 3.2	2.26
Specific gravity	Coarse aggregate	≥ 2.5	2.64
	Fine aggregate	≥ 2.5	2.54
Absorption	Coarse aggregate	≤ 3%	1.84%
	Fine aggregate	≤ 3%	2.26%
Weight of contents	Coarse aggregate	≥ 1.4 Kg/m^3	1.462 Kg/m^3
	Fine aggregate	≥ 1.4 Kg/m^3	1.495 Kg/m^3
Sludge content	Fine aggregate	≤ 5.0 %	1.25 %
Organic matter content	Fine aggregate	Maks No. 3	No.3

3.2. Slump Test Result

Slump testing is done to be able to see the water in the concrete mixture either less, more or enough in this case the essence of this test is to know the consistency in the fresh concrete mixture [21]. from this study the results of testing the slump value can be seen in table 3.

Table 3. Slump Test

Sample	Slump value (cm)
Normal Concrete	12
BN ER 0,8%	12
BN ER 0,8% + SDN 0,15%	11,97
BN ER 0,8% + SDN 0,5%	11,95
BN ER 0,8% + SDN 1%	11,80

Table 4.9 can be concluded that the slump test obtained there are differences in the results of the slump value in each variation. The results of the slump test can be seen in graphical form in Figure 4.13.

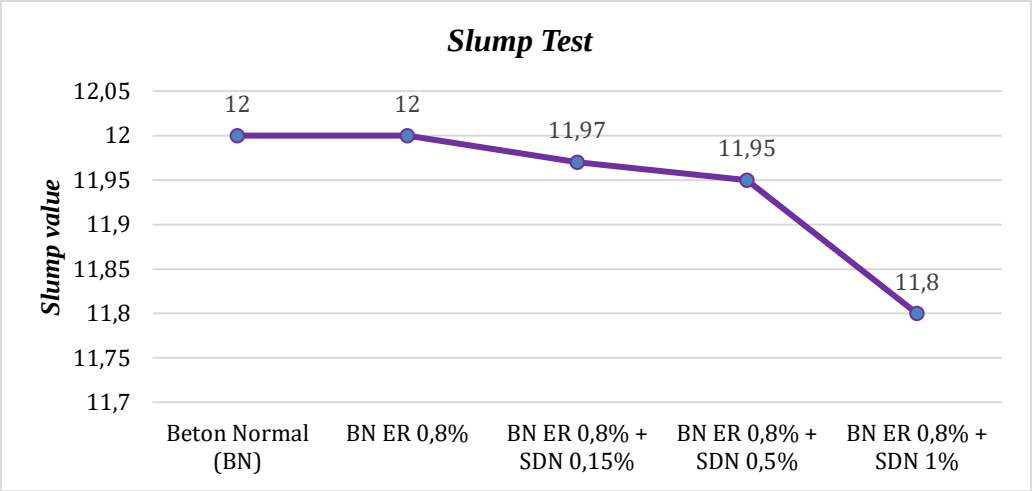

Figure 1. Slump Test

Based on SNI standards, the acceptable slump range value is 8-12 cm. Figure 4.13 shows that the slump value for normal concrete is 12 cm. With the addition of 0.8% epoxy resin, the slump value remains at 12 cm.

However, when 0.8% epoxy resin and pineapple leaf fiber at 0.15%, 0.5%, and 1% are added, the slump values are 11.97 cm, 11.95 cm, and 11.80 cm, respectively. The greater the percentage variation of epoxy resin and pineapple leaf fiber, the more viscous the concrete mixture. The results of the slump test have met the standards and can be used as a concrete mixture.

3.3 Concrete Tensile Strength Test Results

The concrete split tensile strength test in this study was conducted to determine the value of concrete split tensile strength (f't). The research samples made to conduct the test were 9 samples in each variation with a planned age of 7, 14 and 28 days with the aim of getting an overview of the split tensile strength test value of the concrete tested.

Table 4. Recapitulation of Concrete Compressive Strength

Concrete Mix Variations	7 days	14 days	28 days
Normal Concrete	1,78	1,91	2,29
BN ER 0,8%	2,04	2,25	2,87
BN ER 0,8% + SDN 0,15%	1,81	1,94	2,37
BN ER 0,8% + SDN 0,5%	1,88	2,23	2,47
BN ER 0,8% + SDN 1%	1,79	1,93	2,43

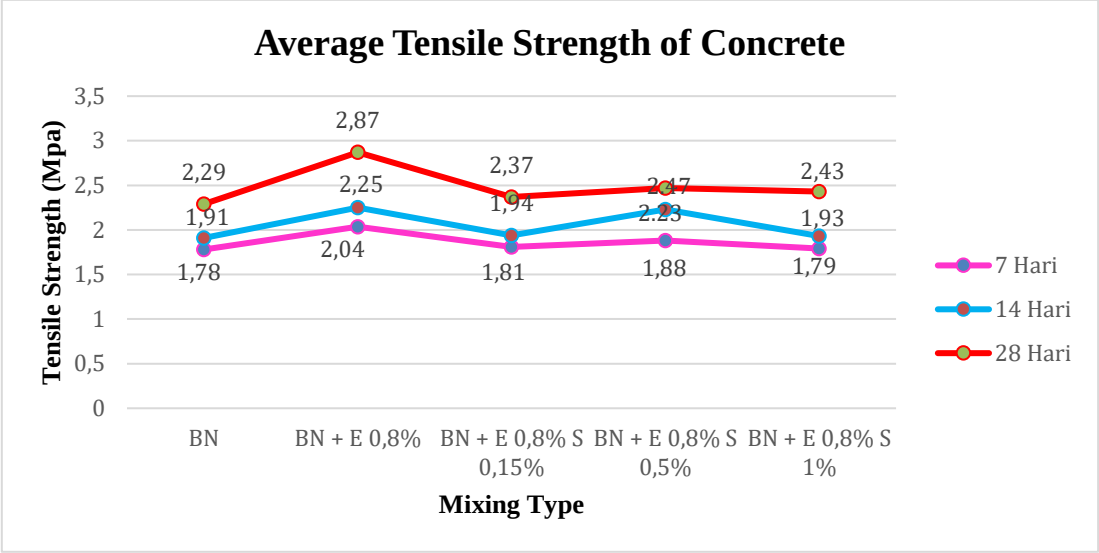

Figure 2. Graph of Recapitulated Tensile Strength of Concrete

Figure 4.20 shows a decrease in tensile strength for the pineapple leaf fiber concrete mixture compared to the concrete with 0.8% epoxy resin. This decrease occurs because the addition of fiber prevents the concrete mixture from binding effectively. The optimum value for the addition of fiber in the stirring process occurs in the addition of fiber with a variation of 0.5% with a resulting tensile strength of 2.47 MPa at the age of 28 days. And the optimum value of the entire variation tested is in concrete with the addition of epoxy resin 0.8% with a split tensile strength value obtained of 2.87 at the age of 28 days. The comparison value between normal concrete and 0.8% epoxy resin concrete has increased. Based on the results of the analysis, it is concluded that the split tensile strength value of concrete epoxy resin 0.8% is greater than normal concrete. The factor that influences the cause of the increase in the value of the split tensile strength of this concrete is the addition of epoxy resin to the volume of concrete. The percentage value of the comparison between 0.8% epoxy concrete and 0.8% epoxy concrete + pineapple leaf fiber variation 0.15% has decreased but still has a higher value than normal concrete. Based on the results of the analysis, it can be concluded that the split tensile strength value of epoxy concrete is greater than 0.15% variation pineapple leaf fiber concrete at the age of 7, 14, and 28 days. The factor that affects the cause of the decrease in 0.15% variation fiber concrete is the addition of pineapple leaf fiber which causes a decrease in the tensile strength of concrete. This is because the fiber addition process is not mixed evenly. The percentage value of the comparison between epoxy concrete with 0.8% + pineapple leaf fiber variation 0.5% and epoxy concrete 0.8% + pineapple leaf fiber variation 0.15% has increased. Based on the results of the analysis, it can be concluded that the split tensile strength value of 0.8% epoxy concrete with 0.5% variation pineapple leaf fiber is greater than 0.15% variation pineapple leaf fiber concrete at the age of 7, 14, and 28 days. The factor that affects the cause of the increase in 0.5% variation fiber concrete is the addition of more pineapple leaf fibers which causes an increase

in the split tensile strength of concrete. The percentage value of the comparison between 0.8% epoxy concrete + 0.5% variation pineapple leaf fiber and 0.8% epoxy concrete + 1% variation pineapple leaf fiber has decreased. Based on the results of the analysis, it can be concluded that the split tensile strength value of 0.8% epoxy concrete with 0.5% variation pineapple leaf fiber is greater than 1% variation pineapple leaf fiber concrete at the age of 7, 14, and 28 days. Factors that influence the cause of the decrease in 1% variation fiber concrete are due to the addition of more pineapple leaf fibers which causes the concrete mixing process not to bind together so that there is a decrease in the tensile strength of the concrete.

4. CONCLUSION

Based on the results of research and analysis that have been carried out at the Concrete Laboratory at Indo Global Mandiri University, Palembang, the following conclusions can be drawn:

1. From the research results, concrete using additional materials of epoxy resin and pineapple leaf fiber has an effect on the splitting tensile strength of concrete so that there is an increase compared to the splitting tensile strength of normal concrete. However, the addition of pineapple leaf fiber to epoxy concrete is not of higher value than epoxy concrete. Because the addition of fiber causes a decrease in the split tensile strength value of the concrete, because the added material of pineapple leaf fiber does not bind each other to the concrete mixture.
2. The average split tensile strength test results at 28 days which occurred with the 0.8% epoxy resin variation were 2.87 MPa, the 0.15% variation was 2.37 MPa, the 0.5% variation was 2.47 MPa, the variation of 1% pineapple leaf fiber is 2.43 and in normal concrete it is 2.29 Mpa. So it was found that the optimum percentage level of added pineapple leaf fiber was 0.15% with an average split tensile strength value of 2.47 MPa. The optimum level, among the tested variations, is achieved with normal concrete containing 0.8% epoxy resin, which exhibits the highest splitting tensile strength value of 2.87 MPa.

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