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QUALITY OF PAVING BLOCK WITH ADDITIONAL INGREDIENTS OF KING PINEAPPLE LEAF FIBER (Agave cantala roxb)

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Abstract: The king pineapple plant (Agave Cantala Roxb) is a plant that grows in lowlands and hills with a stem height between 150-200 cm, and leaf lengths between 90-100 cm, on the inside of the leaves contain a lot of fiber wrapped in green outer ciliates. The leaves of the king pineapple are processed to obtain fiber by separating the green layer and the fiber. The quality of paving blocks with additional material of fibers of king pineapple leaves with a size of 2-3 cm, with a percentage of 0%, 3%, 5% and 7% of the weight of cement, in a ratio of 1: 5, then molded with a size of 20 cm x 10 cm x 8 cm. Conducted testing of the tensile strength of single fibers and compressive strength of paving blocks. The results of the takari sand fine aggregate gradation test meet the requirements of SNI 03-1986-1990 in zone III. Specific gravity testing is classified as normal fine aggregates of 2.5 to 2.7 according to SNI 1968-1990. The test results of sludge content of 2.62% ≤ 5% SK SNI S-04-1989-F, the content weight of 1,550 Kg/cm ≥ 1.2 Kg/Cm^3 refers to the 1989 PBI. Test results Single tensile of king pineapple leaf fibers averaged 196,692 MPa. The weight of the block paving volume decreased by 2.16%, while the absorption of block paving water increased by 0.91%. The test results of the strongest compressive strength of paving blocks are found in additional materials of 5% capable of withstanding a load of 57.56 Kg / cm^2. The average block paving weight is 2,075 Kg/cm^3. Dry fibers have very fine pores and when entered by cement water make a strong unit after drying, because cement water with fibers occurs hydrophilic filling each other. From this simple study, king pineapple leaf fibers have the potential for strength when mixed with cement water and formed with paving block molds which is one of the binding additives anticipating fractures and cracks of paving blocks and becomes a compatibility of cement water and fibers.

Keywords: Quality paving blocks; king pineapple leaf fibers.

INTRODUCTION

The city of Kupang, which is located in East Nusa Tenggara Province, has undergone many changes and developments with the emergence of buildings, housing, shopping centers, settlements, transportation facilities and other infrastructure and this condition certainly brings pressure and negative impacts on environmental quality with a lack of land cover which causes disruption of the hydrological system which is characterized by increased run-off due to reduced area of water absorption and increased CO2 carbon dioxide gas emissions as a result of changing green areas into development areas. In the Kupang Tengah area, most of the people are red brick makers who always rely on digging clay in the manufacture of bricks that are produced around people's homes which become home industries. and there are holes as a result of exploitation of the soil surface, when it rains it stagnates and landslides can occur and damage land cover and cannot be planted with various productive plants which results in narrow agricultural land, this damages the soil surface and decreases environmental quality, this activity has continued to this day because it is a source of livelihood to continue their lives, while non-renewable raw materials in the form of sand are not produced and gradually decrease because there are only 2 sources of sand in the Kupang Regency area which is still Every day more than 400 M^3 are mined, various efforts are made to reduce the use of non-renewable raw materials, especially the manufacture of paving blocks with the main ingredients being sand up to 90% and 10% cement and water. On the other hand, the king pineapple plant (Agave cantala roxb) is a type of plant of the genus Agave, the Agavaceae family originating from Mexico which was brought by the Spanish to Indonesia in the 17th century and began to be cultivated in Indonesia in the 19th and 20th centuries. This is used as an export commodity (Utomo, 2003). it grows a lot in tropical and subtropical areas such as in Indonesia, it is found on Madura Island, South Malang, Jember and South Blitar, and West Sumbawa Regency produces 92 tons of king pineapple leaf fronds per year and is processed into fiber yields reaching 5% (Verona & Basuki, 2017). King pineapple plants are suitable for cultivation in dry soil and dry climates because these plants cannot stand water stagnation (Edokudo 2014). The NTT region (East Nusa Tenggara) is an area of dry land that is very suitable for growing king pineapples. Raja pineapple cultivation is located on the island of Sumba (East Sumba). Meanwhile, the potential for royal pineapples on Timor Island is found in North Central Timor (TTU) Regency, especially in West Miomafo District, Eban Village. One of the regional potentials that can be superior is natural fiber with the name of the king pineapple plant (Agave cantala roxb), which is produced by fiber, which thrives in Eban village. The fiber from this king pineapple leaf is very fine and strong, the leaves contain a lot of fiber with a length of 90 – 100 cm with a tensile strength of 188.74 MPa – 738.61 MPa, (Musa Bondaris Palungan, 2017), The advantage of this natural fiber is that it is easy to obtain, easily separated from the green layer of leaves, can be renewed and cultivated and environmentally friendly. Paving block is a manufactured building material made from a mixture of cement, water, stone ash, fine aggregate and coarse aggregate. Paving blocks can be used as an alternative to covering or hardening the soil surface. Paving blocks are known as solid concrete bricks or concrete blocks. The climate of the city of Kupang includes a tropical climate between 22 ºC to 35 ºC which greatly affects the construction of buildings so that cracks often occur on the surface of the paving blocks in the transverse direction, while paving blocks form the basis of the yard and the vehicle parking area which often receives loads.

MATERIALS AND METHODS

The study method in this study was an experiment by determining the percentage of natural fiber additives used at 0%, 3%, 5% and 7% with a mixture of 1 cement, 5 sand (which had been tested for gradation, silt content in the laboratory), then carried out a compressive strength test. in the building materials testing laboratory for each test object, a total of 20 test objects for 4 types of treatment, without using fiber and using fiber, totaling 5 test objects.

The problems studied

The use of king pineapple leaf fiber as an additive in the manufacture of paving blocks by testing the compressive strength, fiber strength of king pineapple leaves through a tensile test.

Specific Research Purposes

Producing paving block brick products using additional material from king pineapple leaf fiber as reinforcement which can anticipate cracks, reducing the use of sand as a non-renewable material.

Research urgency

Pineapple leaf fiber is a type of fiber that is tested for tensile strength, anticipating cracks that often occur in paving blocks without using fiber additives, reducing the use of sand as a non-renewable building material, raising awareness to cultivate and maintain pineapple king leaf plants and protect the ecosystem environment, Improving the socio-economic community in cultivation and its sustainable use.

Targeted innovation findings in research

The tensile strength of king pineapple leaf fiber as an additional material in the manufacture of paving blocks, the superior tensile strength of the fiber can anticipate cracks in paving block bricks.

RESULTS AND DISCUSSION

The King Pineapple Plant (Agave Cantala Roxb) is the name for the Eban community in Eban Village, South Central Timor Regency with a distance of 46.9 Km from the city of Soe with a travel time of 1 hour 48 minutes and 156 km from the city of Kupang with a travel time of 4 hours 21 minutes. Grows wild in the garden and scrub forest in the location

The Raja Pineapple plant is a plant that produces natural fiber which has the potential to have the advantage of strong fiber and can be renewed or cultivated and is friendly to the environment.

Fiber from king pineapple leaves is widely used by the surrounding community, among others, for the home industry, simple house construction binders and native regional woven materials. Pineapple King leaves have thorns on both sides of the leaf edges which are very sharp. The effect of these thorns is that people are reluctant and don't understand how to clean them, only manually using a machete and simple tools. These strong natural fibers are often used by the community in tying simple building constructions and the innovation of organic fibers or natural fibers is an option. because of its availability, it can be renewed, it is relatively cheap, and it is produced with the latest technology (Mohanty et al., 2000); (Cherubini, 2010); (Bozell & Petersen, 2010); (Huang et al., 2010); (Kroposki et al., 2017).

The king pineapple plant (Agave cantala roxb), also known as the king pineapple leaf fiber, is a type of plant in the genus Agave, family Agavaceae. This plant comes from Mexico which was brought by the Spanish to Indonesia in the 17th century and began to be cultivated in Indonesia in the 19th century and in the 20th century this plant was used as an export commodity (Utomo, 2003).

The king pineapple plant is a plant whose stems and leaves are fused, has strong fiber, can live on land with a thin layer (lots of surface stones) or classified as critical land. Its strength is better than other fibers, and it is resistant to high salt levels (Şahmaran & Li, 2007); (Santoso, 2009); (Felisberto et al., 2015); (Vaitkevičius et al., 2016); (Zhang et al., 2022); (Su et al., 2022).

Raja pineapple leaf fiber is a composite reinforcement material derived from non-wood natural fibers and its raw materials are widely available in nature. As a composite reinforcement material, king pineapple leaf fiber has advantages including good mechanical properties, biodegradable fiber in the environment, low density, easy to obtain, and low price (Kusumastuti, 2009); (Asim et al., 2018); (Senthilkumar et al., 2019); (Thyavihalli Girijappa et al., 2019); (Radoor et al., 2020); (Siakeng et al., 2020); (Rajeshkumar et al., 2021); (Azman et al., 2021); (Rangappa et al., 2022).

King pineapple leaves are one of the most widely used natural fibers and the easiest to cultivate. King pineapple leaf plants grow a lot in tropical and subtropical regions.

Results of Sieve Analysis of Fine Aggregate (Sand Takari)

In testing the sieve analysis of fine aggregates, fine aggregate samples (Takari Sand) were used which were also used in the manufacture of paving block specimens. The sample weight used for testing was 1000 grams made into two samples, namely sample A and sample B. To obtain the results of fine aggregate analysis it is required to refer to SNI 1968-1990, concerning the method of testing fine aggregate sieve analysis. The results of the sieve analysis can be seen in table 1. below.

Table 1. Sieve Analysis of Fine Aggregate (Sand Takari)

Sieve (mm)	Sample A = 1000 gr	Sample B = 500	Pass Average	Holding Average

	Total weight	**Stand**	**Get away**	**Total weight**	**Stand**	**Get away**		
	gr	%	%	gr	%	%	%	%
No. 4	0	0.00	100	0	0.00	100	100	0.00
No.8	11.00	2.20	97.80	11.17	2.23	97.77	97.78	2.22
No. 16	37.00	7.40	92.60	37.17	7.43	92.57	92.58	7.42
No. 30	73.60	14.72	85.14	73.77	14.75	85.25	85.26	14.74
No. 50	199.50	39.90	60.10	199.67	39.93	60.07	60.08	39.92
No. 100	333.80	66.76	33.24	335.97	67.19	32.81	33.02	66.98
No. 200	499.82	99.96	0.04	499.99	100.00	0.00	0.02	99.98
Cumulative (%)		**230.94**				**231.55**		

Catatan: Nilai MHB agregat halus Pasir Takari:

Sampel: $\frac{(A+B)}{2}$ / 100 = $\frac{(230.94+231.55)}{2}$ / 100 = 2.31

From the test results of fine aggregate sieve analysis that has been carried out by researchers at the Building Engineering Education Laboratory, Nusa Cendana University, Kupang, it shows that Takari sand can be used as a filler material in the manufacture of paving block test specimens because the fine grain modulus (MHB) value is 2.31%. This modulus value satisfies the fine aggregate requirements viz 1.50-3.80%.

According to SNI, good fine aggregate must meet the graduation requirements as shown in Table 2. below this.

Table 2. Average Measurement Results for Paving Blocks

	Initial Measurements			Final Measurement			shrinkage
No Treatment	Average Length (cm)	Average Width(cm)	Average Height(cm)	Average Length (cm)	Average Width(cm)	Average Height(cm)	(%)
P1 : 0%	20.00	10.00	6.00	19.97	9.97	5.98	0.21
P2 : 3%	20.00	10.00	6.00	19.96	9.96	5.96	0.32
P3 : 5%	20.00	10.00	6.00	19.95	9.96	5.95	0.38
P4 : 7%	20.00	10.00	6.00	19.94	9.94	5.94	0.47

From table 2. the average measurement results show that the greatest shrinkage occurs in treatment P4 with a shrinkage percentage of 0.47% and the smallest shrinkage is in treatment P1 of 0.21%, this shows that the more fiber is used as an additive, the more absorption that occurs in paving blocks, this is supported by research results (Birle et al., 2008); (Thomas et al., 2012); (Ewy, 2014); Anita Christine S., Jetri J., (2017), that the more water content will increase shrinkage, the number of test objects is presented in Figure 1.

Figure 1. Numbering of test objects

Results of Volume Weight and Water Absorption Tests for Paving Blocks

a. Paving block volume weight

In testing the volume weight of paving blocks, 20 specimens were used with the additional material of king pineapple leaf fiber, 5 paving blocks were taken for each treatment. The purpose of this test is to determine the volume weight of paving blocks. The results of the paving block volume weight test are presented in Table 3. below:

Table 3. Average Results of Paving Block Volume Weight Test

No Treatment	Average weight initial (kg)	Average Weight oven dry(kg)	Average Weight Average (kg)	Average volume(cm^3)	Volume Weight (kg/Cm^3)	Volume Weight %
P1	3.032	3.026	3.029	1589	1.907	2.8
P2	3.026	3.007	3.017	1583	1.905	2.4
P3	2.998	2.976	2.99	1579	1.893	2.2
P4	2.978	2.954	2.966	1574	1.884	1.9

From the test results, it was obtained that the highest average volume weight was in treatment P1 or 0% without the addition of fiber of 1,907 Kg/cm^3 (2.8%) and the lowest volume weight was in treatment P4 with the addition of 7% fiber and a volume weight of 1,884 Kg /cm^3 (1.9%), the average weight reduction of paving blocks with fiber additives was 2.16%, this shows that the addition of fiber to paving blocks can reduce the weight of paving blocks. Mulyono (2005); (Huberman & Pearlmutter, 2008); (Shoubi et al., 2013); (Arrigoni et al., 2017); (Crini et al., 2020) said that the lighter the building materials used, the better the quality of the building materials because they can reduce the calculated load.

b. Paving block water absorption

This test was carried out to determine the water absorption of paving blocks using added king pineapple leaf fiber with several treatments. For more details, this will be presented in Table 4. below.

Table 4. Average Results of Paving Block Absorption Test

No Treatment	Average Wet Weight (Kg)	Average Weight Oven Dry (Kg)	Absorption (%)
P1 : 0%	3.404	3.026	12.49
P2 : 3%	3.396	3.007	12.95
P3 : 5%	3.370	2.982	13.01

P4: 7%	3.350	2.954	13.40
	ΣR		12.96

The results of paving block water absorption tests as shown in table 5.11 above show that the lowest average water absorption was in treatment P1 with 0% water absorption of 12.49% and the highest average absorption was found in treatment P4 or 7% addition of fiber with absorption paving block water is 13.40%, this shows that the higher the addition of fiber, the higher the water absorption. In accordance with (SNI 03-0349-1989) that the maximum water absorption of paving blocks is 35%, then with the addition of fiber by 7% and the percentage water absorption below 35% is acceptable. The following will illustrate a bar chart for paving block water absorption presented in Fig 5.13.

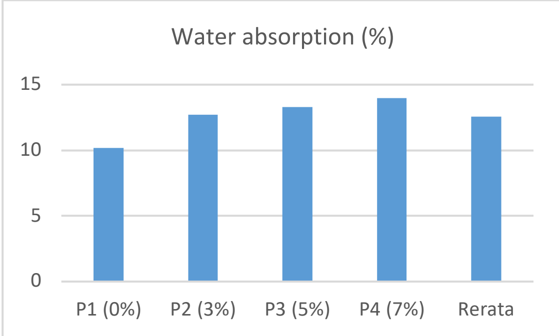

Figure 2. Paving block water absorption bar chart

Compressive Strength Test Results for Paving blocks

Compressive Strength Testing Paving block P1 (0% Fiber)

This test was carried out after the paving block was 14 days old during the curing period, the purpose of carrying out the compressive strength test was to determine the compressive strength in each paving block treatment, where the paving block compressive strength test was carried out on several treatments. For more details will be presented in Table 5.12 below.

Table 5. Testing Paving block P1 (0% Fiber)

Code	No	P (cm)	L (cm)	T (cm)	Large (cm^3)	Volume (cm^3)	Heavy (Kg)	Burden Max (KN)	Strong Presskg/cm^2)
P1	A	19.9	9.91	7.93	197.24	1564	3.031	120	42.14
0%	B	19.96	9.89	7.92	197.34	1563	3.033	120	44.32
	C	19.9	9.92	7.91	197.44	1561	3.033	120	43.53
	D	19.96	9.94	7.92	198.44	1572	3.03	120	43.32
Σxi					790.46	6260	12.127	480	173.31
XR					197.6	1565	3.03	120	43.33

The table above shows that the average compressive strength of paving blocks in the P1 treatment was 43.33 Kg/Cm^2. In accordance with SNI 03-0349-1989 that the compressive strength of paving blocks is included in the paving block III category. With a compressive strength value of > 40 Kg/Cm^2

Compressive Strength Testing Paving block P2(3% Fiber)

This test was carried out after the paving block was 14 days old during the curing period, the purpose of carrying out the compressive strength test was to determine the compressive strength in each paving block treatment, where the paving block compressive strength test was carried out on several treatments. For more details, it will be presented in Table 5.13 below:

Table 6. Testing Paving block P2 (3% Fibre)

Code	No	P (cm)	L (cm)	T (cm)	Large (cm^2)	Volume (cm^3)	Heavy (Kg)	Max.load (KN)	Strong Press (kg/cm^2)
P2	A	19.92	9.93	7.92	197.81	1566.62	3.033	120	52.535
3%	B	19.96	9.89	7.92	197.40	1563.44	3.031	120	53.673
	C	19.93	9.92	7.91	197.71	1563.85	3.033	120	50.557
	D	19.96	9.93	7.93	198.20	1571.75	2.931	120	49.387
Σxi					791.12	6265.66	12.014	480	206.152
XR					197.78	1566.42	3.007	120	51.538

From table 6. the compressive strength test results of paving blocks in the P2 treatment or 3% addition of fiber average compressive strength of 51.54 kg/cm^2. Judging from SNI 03-0349-1989 that the average strength of paving block P2 is included in category III paving block.

Compressive Strength Testing Paving block P3 (5% Fibre)

This test was carried out after the paving block was 14 days old during the curing period, the purpose of carrying out the compressive strength test was to determine the compressive strength in each paving block treatment, where the paving block compressive strength test was carried out on several treatments. For more details will be presented in Table 4.14 below:

The results of the average compressive strength test for paving blocks in the P3 treatment or 5% fiber addition were 58.91 kg/cm^2. SNI 03-0349-1989 average ompressive strength of solid concrete P3 is included in the paving block category III.

Table 7. Paving block P3 test (5% Fiber)

Code	No	P (cm)	L (cm)	T (cm)	Large (cm^2)	Volume (cm^3)	Heavy (Kg)	Max.load (KN)	Strong Press (kg/cm^2)
P3	A	19.92	9.94	7.93	198.00	1570.18	3.035	120	59.037
5%	B	19.94	9.89	7.92	197.21	1561.88	2.833	120	58.673

	C	19.93	9.92	7.92	197.71	1565.83	2.933	120	57.557
	D	19.96	9.93	7.93	198.20	1571.75	3.031	120	60.387
Σxi					791.12	6269.63	11.832	480	235.654
XR					197.78	1567.41	2.958	120	58.9135

From the table above, it shows that the average compressive strength of paving blocks in the P3 treatment was 58.91 Kg/Cm^2. In accordance with SNI 03-0349-1989 that the compressive strength of paving blocks is included in the category of paving block III.

Compressive Strength Testing Paving block P4 (7% Fiber)

This test was carried out after the paving block was 14 days old during the curing period, the purpose of doing the compressive strength test was to determine the compressive strength in each treatment of the paving block, where the compressive strength test of the paving blocks was carried out on several treatments. For more details will be presented in Table 5.15 below:

Table 8. Testing Paving block P4 (7% Fibre)

Kode	No	P (cm)	L (cm)	T (cm)	Large (cm^2)	Volume (cm^3)	Heavy (Kg)	Max.load (KN)	Strong Press (kg/cm^2)
P4 7%	A	19.93	9.95	7.92	198.30	1570.56	2.914	120	56.837
	B	19.94	9.96	7.93	198.60	1574.92	2.912	120	56.473
	C	19.93	9.95	7.93	198.30	1572.55	3.001	120	55.457
	D	19.95	9.93	7.93	198.10	1570.96	2.831	120	54.345
Σxi					793.31	6148.99	11.66	480	223.112
XR					198.33	1572.25	2.91	122.5	55.778

The results of the average compressive strength test for paving block treatment P4 or by 7% addition of fiber results in a compressive strength of 55.78 kg/cm^2, in accordance with SNI 03-0349-1989 that the compressive strength of paving block P4 is included in category III paving block. In the following, a bar chart of the weight and compressive strength of paving blocks will be illustrated.

Average Compressive Strength

From the results of weight testing carried out on 5 types of treatment, namely: P1, P2, P3 and P4, it can be concluded that the results of the weight of paving blocks are in the form of a bar chart in Figure 5.14 below:

Figure 5.14 Paving block weight bar chart

Average Compressive Strength

From the results of the compressive strength test carried out on 5 types of treatment, namely: P1, P2, P3 and P4, it can be concluded that the results of the compressive strength of paving blocks are in the form of the following bar diagram:

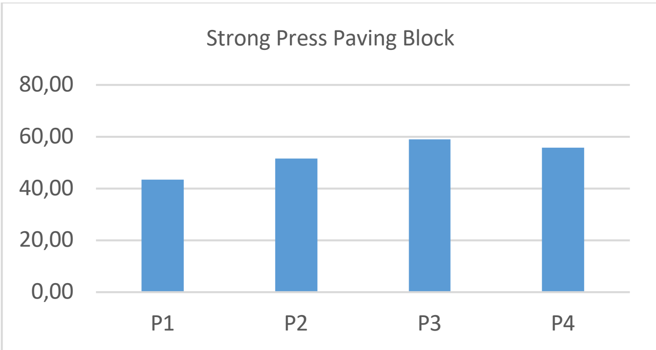

Figure 5.15 Paving Block Compressive Strength Bar Diagram

From the graph above, based on the average compressive strength test results of paving blocks from 3 treatments, it can be concluded that the strength of paving blocks with a normal mixture ratio of 1 Pc: 5 Sand and the addition of fiber is P1: 0%, P2: 3%, P3: 5%, P4: 7%, based on SNI 03-0349-1989 explains that all treatments tested are acceptable in treatments P1, P2, P3 and P4 because the compressive strength test results that have been carried out for the 4 treatments are included in the compressive strength category III paving block, while the P4 treatment with the addition of king pineapple leaf fiber by 7% is acceptable because the results of the compressive strength test that has been carried out with a value lower than that of P3 and can still be used because it exceeds the minimum requirements for the compressive strength of paving blocks without using king pineapple leaf fiber. The physical requirements for paving blocks are presented in Table 5.16 below:

Table 9. Physical Requirements for paving blocks

No	Physical	Unit	Paving block

	Requirements		Quality Level			
			I	II	III	IV
1	Gross Press Strength Minimum average	Kg/Cm²	100	70	40	25
2	Gross Press Strength each thing minimal test	Kg/Cm²	90	65	35	21
3	average water absorption maximum average	%	25	35	-	-

Source: SNI 03-0349-1989

The results of the analysis of the compressive strength of paving blocks without additives, through the compressive strength test of paving blocks in holding the smallest compressive strength were found at the P1 level of 42.14 kg/cm2. The results of the analysis of the compressive strength of paving blocks with additives, through the compressive strength test of paving blocks with the smallest percentage holding compressive strength are at the P2 C, P3 C and P4 D levels with the ability to withstand compressive strength of, 49.38 kg/cm2, 57.56 kg /cm2 and 54.35 kg/cm^2 .

The results of the analysis of paving blocks obtained an average weight of 2.075 kg, an average size shrinkage of 0.45% with an average water absorption of 5% and an average compressive strength without additives 43.33 kg/cm² and with additives an average of 55.41 kg/cm², with the conclusion that the results above are still in B70 quality in SNI 03-0349-1989.

The additional material for king pineapple fiber has a dominant strength in paving blocks, cement water has the perfect opportunity to seep into king pineapple fibers which are smooth and dry and porous, giving rise to binding strength when hardening and drying occurs in paving blocks, this makes the fiber mixture and cement becomes strong to withstand loads. This opinion is different from (Raut & Gomez, 2016) who stated that the porous nature of the fiber surface can reduce the density of the material, even though fine cement can contribute to the absorption of cement water on the fiber surface which causes the mixture to become dense.

Discussion of Water Absorption and Compressive Strength of Paving blocks

The higher the water absorption in paving blocks, the lower the compressive strength, and conversely, the lower the water absorption, the higher the compressive strength of paving blocks. This is proven by carrying out the Pearson correlation test because the data is normally distributed and there is an inverse correlation at $\alpha = 0.01$ between water absorption and the compressive strength of paving blocks.

The strength of paving blocks can be influenced, among other things, by the type of material used, the composition of the material used, material inspection, the manufacturing process, time and weather and the equipment used, including technician skills in managing manufacturing procedures and in carrying out tests related to paving blocks. paving block quality Through observation after 2 months of paving block research results there are no cracks and defects, the edges are angled to one another, and the angles of the edges are not easily broken (broken) with finger strength until the age of the paving block is 14 days.

The water uptake contained in paving blocks increased in volume when the test specimen was made, namely due to the presence of fiber material as an additional ingredient. The increase in water absorption is due to the presence of pores on the dry fiber surface which are filled with cement water, the use of fiber additives has been proven to increase the weight of paving blocks in wet conditions. This is supported by (Taallah & Guettala, 2016); (Taallah & Guettala, 2016); (Mekhermeche et al., 2016); (Kumar et al., 2021); (Vijayan et al., 2021); (Adamu et al., 2022) date palm fiber causes an increase in water absorption. Paving blocks with fiber additives will be lighter in weight when dry because fiber is a light material in a dry state, and a similar study by (Ahmad et al., 2010); (F. N. A. A. Aziz et al., 2014a); (F. N. A. A. Aziz et al., 2014b); (Raut & Gomez, 2016); (A. Aziz et al., 2017); (Hamada et al., 2018) who examined a lightweight mortar using palm fruit fiber with the addition of 0%, 0.5%, 1% and 1.5%.

Discussion of the Effect of Additives on Compressive Strength in Improving the Quality of Paving Blocks

The higher the percentage of additional materials used in paving blocks, the more water is used. The more use of additional materials will increase the use of water when making paving blocks.

Fiber which has 26.50% hemicellulose is a unit that makes up the composition of the fiber. It has an important hydrophilic role, functioning as an adhesive between cellulose (17.15%) which increases physical strength. Loss of hemicellulose during drying of the fibers can break the compound chain and release lignin (23.15%) and water that is present on the surface of the fibers and the fibers break easily. As a result, the fiber surface becomes rough, grooved and porous when dry. Fiber diameter can affect the strength of cement and sand mixtures, this statement is supported by the research of Mohtari, et al. (2015); (Lertwattanaruk & Suntijitto, 2015); (Raut & Gomez, 2016); (Boumhaout et al., 2017), stated that the use of date fiber with a percentage lower than 10% in the strength properties of the mortar is acceptable.

At the time of making the test object using cement mixed with sand, water is used as a unifying agent for the two materials. Mix cement and sand in a dry state, then use water (in a wet state) after being mixed evenly, add king pineapple fiber cut into lengths (2-3 cm) as an additional ingredient for making paving blocks, causing the fibers to absorb cement water to fill in the pores. empty fiber pores, and cement water coats the rough fiber surface. This mixing of materials requires each other to become a unified whole after drying. This material mixing event creates hydrophilic bonds (adhesion), namely bonding on the surface of objects of different types and is greatly influenced by surface roughness and the number of pores present in the fiber. The absorption between the water-cement mixture and the dried king pineapple leaf fiber material causes the compactibility of the composite to stick more, this hydrophilic bond causes the fiber from king pineapple leaves to control cracking in paving blocks. This is supported by (Abani et al., 2015); (Braiek et al., 2017); (Abu-Jdayil et al., 2019); (Azzouzi et al., 2020), which states that plaster reinforced with date fiber with a fine diameter can insulate heat. On the other hand, mixing king pineapple leaf fiber in a wet state will make it difficult for the fiber to absorb cement water for the binding of the two different elements, hydrophilic and the adhesion of the two elements becomes small, because the surface of the fiber is already filled with water, the use of water in the mixture will increase according to the water content contained on the fiber of king pineapple leaves in a wet state.

Paving blocks with the addition of king pineapple leaf fiber show stronger results compared to those without additives, this is due to the smooth diameter and more pores on the fiber surface, and the percentage used influences the mixing of the three cement, sand and plus fiber. This is supported by (Ramli & Dawood, 2011); (Raut & Gomez, 2016); (Belakroum et al., 2018); (Delzendehrooy et al., 2020) which states that the use of palm fiber as much as 0.8% increases the strength 13,4 %-16,1 %.

The use of additional king pineapple leaf fiber can reduce cracking in paving blocks, due to the mixture of cement and sand, which becomes strong after the specimen is 14 days old and undergoes a drying process. This is evident in the paving blocks with the additional material of king pineapple leaf fiber which is cut into 2-3 cm long which is used not broken during the compressive strength test after 2 months of age. as much as 3% is clearly visible in the paving blocks which are still intact and not separated, still bind each other and reduce cracks, especially in areas with tropical climates. It can be interpreted that paving blocks with additional material of king pineapple leaf fiber as much as 7% can generally be used in making paving blocks using a size of 20 cm x 10 cm x 8 cm, and can be used as a building material, namely paving blocks with king pineapple leaf fiber.

Paving blocks using king pineapple leaf fiber additives can directly reduce the use of non-renewable raw materials, such as sand and cement. The use of natural fibers results in a reduction in the amount of coarse aggregate without affecting the flexural performance of concrete (Awad et al., 2021); (Alnahhal & Aljidda, 2018); (Kachouh et al., 2021). Natural fibers are poor heat conductors, this can stabilize indoor temperature levels. (Chikhi, 2016); (Braiek et al., 2017); (Sair et al., 2019) said that gypsum reinforcing date fiber for heat insulation in buildings & (Chaib et al., 2015); (Mekhermeche et al., 2016); (Hakkoum et al., 2017); Hakkoum et al., (2018) adding date palm fiber to concrete bricks can reduce thermal conductivity, specific heat and increase heat resistance.

The continuation of the use of this

king pineapple leaf fiber with results that have many benefits for the community and especially as an additional material in the manufacture of paving blocks will be able to provide added value for knowledge and is a type of plantation business to be cultivated in improving the community's economy which is supported by the type of soil and climate in Eban Village can flourish.

Every one Clump of King Pineapple has 20 to 34 leaves and 7 of them which are old are harvested which can produce ± 1.6 g of net fiber in a dry state, and to make a 1 m^2 building wall it is estimated that it requires about 4 king pineapple leaf fibers as an additional ingredient .48 g for paving blocks with a length of 20 cm, a width of 10 cm and a thickness of 8 cm, with a mixture ratio of 1 part cement and 5 parts sand.

From the results of research on increasing the utilization of king pineapple leaf fiber through laboratory testing, apart from the compressive strength it meets the requirements of SNI 03-0349-1989, after going through analysis and discussion it is found that the main advantages of fibrous paving blocks are:

1. Paving blocks with additional ingredients of king pineapple leaf fiber can control cracking, during the compressive strength test with maximum strength, the test object is not crushed, only experiences small cracks and does not separate. In the control sample that does not use fiber at the maximum pressure time it is crushed and separated.
2. Paving blocks with the additional material of king pineapple leaf fiber which are particles of wood substances which are poor heat conductors, are very good at stabilizing room temperature, this is supported by (Mohapatra et al., 2014); (Hassanzadeh-Aghdam et al., 2019); (Wang et al., 2020) that the addition of fiber will increase thermal conductivity.
3. Fiber from king pineapple leaves after washing and drying the surface of the fiber becomes coarser and more porous. The dry fiber is mixed with cement water, adhesion bonds occur due to absorption of cement water which can cover the fiber surface, after treatment and drying of cement water and fibers become compactibility, this is what causes paving blocks to only crack small and not separate due to bonding between water cement and fiber control each other. Supported by research on date palm fiber by (Lahouioui, 2016); (Alhijazi et al., 2020); (Awad et al., 2021) that the surface of date palm fiber varies and the fiber becomes hydrophilic naturally with the addition of 5% making paving blocks stronger and causing an increase in thermal conductivity.
4. Opinion from (Raut & Gomez, 2016); (Alhijazi et al., 2020); (Cheng et al., 2020); (Yang et al., 2021) which states that the porous nature of the fiber surface can reduce the density of the material, rough fiber surfaces and cause the mixture to become denser with a lock & key relationship occurring.

(F. N. A. A. Aziz et al., 2014b); (F. N. A. A. Aziz et al., 2014a); (Raut & Gomez, 2016); (A. Aziz et al., 2017) who examined a lightweight mortar using palm fruit fiber with the addition of 0%, 0.5%, 1% and 1.5%. Asrial, et al., (2017); (Souza et al., 2021); (da Silva et al., 2021); (Wu & Montalvo, 2021);

(Tjaronge & Caronge, 2021) using 3%, 6% and 9% palm fiber waste in the manufacture of paving blocks can reduce cracks, be lighter and can reduce heat.

CONCLUSIONS

The results of measurements of paving blocks without additives with a shrinkage of 0.21%, while the results of measurements of paving blocks with additives with an average shrinkage of 0.47% are greater than those of paving blocks without additives.

The results of testing the water content of paving blocks without additives were 12.49%, while the results of testing paving blocks with additives had an average water content of 13.12% more than paving blocks without additives.

The test results for the weight of paving blocks without additives were 3,035 kg, while the results of testing paving blocks with additives had an average weight of 2.95 kg lighter than paving blocks without additives by 2.8%2.8 %.

The compressive strength test results of paving blocks without additives were 43.33 kg/cm², while the results of testing paving blocks with additional materials were able to withstand an average load of 55.41 kg/cm², stronger than paving blocks without additives of 12.23 %.

The material tested in this study was the quality of the paving blocks in the manufacture of which natural fiber was added, namely king pineapple leaf fiber as much as 3%, 5% and 7%. The composition of the mixture is made with a ratio of cement and sand (1: 5). in the manufacture of the treatment will be made 5 parts consisting of P1 treatment 0% fiber addition, P2 treatment 3% fiber addition, P3 treatment 5% fiber addition, P4 treatment 7% fiber addition. The test results will be explained as follows:

Single tensile test of king pineapple leaf fiber with a length of 30 mm, an average diameter of 0.25 mm, and an average cross-sectional area of 0.098 mm2, through a single tensile test of king pineapple leaf fiber with an average single tensile force of 9.834 (F)N having a tensile strength of 196.692 MPa.

The results of measurements of paving blocks without additives with a shrinkage of 0.21%, while the results of measurements of paving blocks with additives with an average shrinkage of 0.47% are greater than those of paving blocks without additives.

The results of the paving block weight test without additional ingredients were 3,035 kg, while the results of the paving block tests with additional materials had an average weight of 2.95 kg lighter compared to paving blocks without additives by 2.8 %.

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