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UTILISATION OF SANDAL WASTE FROM HOME INDUSTRY IN KEPUH KIRIMAN VILLAGE, WARU DISTRICT, SIDOARJO REGENCY, AS COARSE AGGREGATE MATERIAL IN MIXING MATERIALS FOR PAVING BLOCK PRODUCTION

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ABSTRACT

Keywords: Rubber Sandal Waste; Paving Block; Compressive Strength; Water Absorption; SEM.

Industrial activity is one of the factors that supports the growth of the economic sector. One industry that is currently proliferating is rubber sandal waste. This paper will use a mixture of rubber sandal waste as a coarse aggregate material. Sandal waste can be reused to produce products with a sale value, such as a mixture for making paving blocks. They were paving blocks that will be made using B-quality K-200. This paper aimed to determine compressive strength, water absorption, and SEM results. The method which is used in this research is descriptive quantitative. Paving Variations in sandal waste used in this study were 0%, 10%, 15%, and 20% of the volume of coarse aggregate. The optimal results produced are a 15% variation with a compressive strength age of 28 days with an average value of 18.8 MPa, a 10% variation with a compressive strength age of 7, and 14 days with an average value of 21.2 MPa and 21.8 MPa. The most optimal water absorption test results are at 10% variation with an average value of 5%. SEM test results with 15% and 20% variations showed a high air void content and microcracks spread in the specimen's topography. Meanwhile, at 0% and 10%, the spread of microcracks is insignificant, and the test object has a reasonably high density.

Introduction

Along with the increasing rate of urbanisation, it certainly causes significant industrial development in Indonesia. Industrial activities are one factor that supports the economic sector's growth (Eva, 2021). The relationship between industrialisation and urbanization is very close because the increasing population urbanisation rate is accompanied by the increasing demand for various products (Luo, Xiang, & Wang, 2020). Therefore, the industrial sector is essential, reflected in the increasing Gross Domestic Product (GDP) industry share. The growth rate of the industrial sector in 2018 was 17.7%. According to data from the annual report (Al-Tarbi et al., 2022), slippers or sandals are one industry proliferating today. Footwear that is common and often used in Indonesia by many people is sandals. Due to the significant demand from the community, the home industry that produces sandals continues to increase, causing the amount of waste or residue in making sandals to be very high. According to the United States Environmental Protection Agency or U.S. EPA, waste is any substance or object disposed of or required by its holder by the provisions of applicable national laws and regulations (Okvianti & February 2022).

One of the areas in East Java that is a sandal industry craftsman is in Kepuh Kirim, Waru, Sidoarjo Village. Most residents in the village make a living as sandal craftsmen and operate daily to produce sandal products that will be sold. The types of sandals produced vary, such as wedges sandals, strap sandals, sandals for sports, flat sandals, and so on. In this study, we will use a mixture of rubber sandal waste as a substitute for some coarse aggregate material. The sandal waste is a leftover from the production process of the sandal home industry, which is widely produced in Kepuh Kiriman Village. Rubber sandals reach 400-500 pairs daily (Al-Kheetan, 2022). The rubber sandal waste is enormous and no longer used; many artisans throw the waste into the river or leave it scattered in front of the sandal manufacturing factory yard. This will undoubtedly cause pollution and damage in the surrounding area.

According to SNI 03-0691-1996, the paving block indicates building materials made from a mixture of Portland cement and water and additional aggregates with or without other additives that do not reduce paving blocks' quality. Paving blocks also have good water absorption to withstand erratic or extreme weather. Paving blocks are widely used for roads, sidewalks, and parking equipment (Mina, Subia, & Ermita, 2020). Paving Blocks can be used for pavement on parking equipment; pavement in parking areas usually uses class B quality concrete paving with a minimum thickness of 60 mm with a tolerance of water absorption ± 6%; in general, the condition of parking lots in each area in the rainy season occurs inundation, this is due to high rainfall is also unable to absorb rainwater runoff into the ground. Using natural materials to construct sidewalks is a must in supporting the achievement of green roads (Larasati & Rupiah, 2023).

Using sandal waste as a mixture of paving blocks can reduce the costs incurred to make paving. Therefore, using sandal waste as part of the coarse aggregate substitution material, paving does not require much coarse aggregate such as gravel, river stone, or crushed stone. Cost analysis includes material prices for paving block materials, workers' wages, equipment and operational costs (Juara, 2023). Thus, using rubber sandal waste is expected to reduce environmental problems related to the accumulation of waste from production waste produced and provide economic value to the material or construction materials used by the waste. Besides that, rubber has elastic and flexible properties, one reason for being a mixture of paving block making (Zăinescu et al., 2018).

Industrial waste comes from processes due to industrial activities directly or indirectly; waste is directly sourced from industrial activities and produced from the rest of the production, where waste and product residues are produced simultaneously. Meanwhile, indirect waste is waste produced after the production process and before the production process from these industrial activities (Rasyid & Sarasanty, 2022). Creating solid or industrial waste begins with the presence of materials or materials that can be used to make something or objects that need it. Therefore, the reuse of waste from the production process, as stated in the hadith that cleanliness is one of the things favoured by Allah S.W.T, namely:

إِنَّ اللَّهَ طَيِّبٌ يُحِبُّ الطَّيِّبَ, نَظِيفٌ يُحِبُّ النَّظَافَةَ, كَرِيمٌ يُحِبُّ الْكَرَمَ, جَوَادٌ يُحِبُّ الْجُودَ, فَنَظِّفُوا أَفْنِيَتَكُمْ

It means: "From the Prophet Sallallahu 'alaihi wa sallam: Verily Allah Almighty is holy who likes holy things, He is Most Clean who likes cleanliness, He is Most Noble who loves glory, He is Most Beautiful who loves beauty, therefore clean your places." (HR Tirmidhi).

As we know, cleanliness is part of faith; if we always maintain cleanliness, we will avoid dangerous disease outbreaks.

Based on the formulation of the problem above, the research objectives that can be taken are as follows:

1. Determine the percentage value of the most optimal paving block strength.
2. Analyzing the compressive strength results, water absorption and SEM tests on paving blocks produced using sandal waste as a partial substitute for coarse aggregate material.
3. Analyze the characteristic results of paving blocks that use mixed materials from sandal waste.
4. Calculating the production cost of making paving blocks.

Research Methods

Types of Research

This study used a type of quantitative descriptive research. Quantitative descriptive research is a method that aims to find data to produce information about what you want to know. This method processes the data generated from each paving block-making treatment (Purnama & Sudibyo, 2018).

Time and Location of Research

The implementation time and analysis of the research results will be carried out from March to April 2023, which is a Final Project study activity in the field of solid waste, namely the Utilization of Sandal Waste from Home Industry in Kepuh Kirim, Waru District, Sidoarjo Regency as Coarse Aggregate Material in Paving Block Making Mixture. The waste taken is the leftover result of the sandal home industry in Kepuh Kirim, which will later be tested at the Concrete and Material Laboratory at the UINSA II Gunung Anyar Campus.

Research Mindset

The research framework is a systematic flow or sequence of research to obtain the data needed in research optimally and according to what is expected by researchers based on the scope and objectives of the research (Arsalani, 2023). The framework of this research starts from the large amount of rubber sandal waste produced due to the remaining production of the sandal home industry in Kepuh Kiriman Village. The waste accumulates, is scattered around the home industry, and causes environmental pollution. Innovations are formed to reuse rubber sandal waste that is no longer used, one of which is using rubber sandal waste as a substitute for some coarse aggregate in the mixture of paving blocks. In the process of making paving blocks, referring to SNI 03-0691-1996, as well as rubber sandal waste used as a partial substitute for coarse aggregate has four types of addition variations, namely 0% (without sandal waste), 10%, 15%, and 20%.

Stages of Research

The research stages contain the work steps to be carried out and the stages of research. The purpose of the research stages is to make it easier to explain the description of the research.

Stages of Research Preparation

The preparation stage is to prepare all tools and materials for research to run well. The mixed materials used to manufacture paving blocks consist of Portland cement brand gresik cement, stone ash, crushed stone, clean water, and rubber sandal waste.

Analyses Data

Data analysis is a process for preparation in this study with quantitative descriptive methods. It explains the data obtained to analyse rubber waste in the mixture of paving blocks.

Results and Discussion

Paving Block Compressive Strength Test Analysis Results

Making paving blocks with a mixture of sandal waste and coarse aggregate aims to determine the optimum value of compressive strength resulting from the addition of the waste. The paving mixture comprises cement, sand, gravel, and water. Variations in adding rubber sandal waste are 0% (not using sandal waste), 10%, 15%, and 20%. The test specimen to be made is a 21 cm x 10 cm x 6 cm block. The results of making test specimens are presented in Figures 1 to 4.

Figure 1 Paving Block 0% Variation

Figure 2 Paving Block 10% Variation

Figure 3 Paving Block Variation 15%

Figure 4 Paving Block 20% Variation

The samples made for the paving compressive strength test are as many as 24 samples; the following is Table 1 of the total number of samples made:

Table 1
Number of Compressive Strength Test Samples

Sample	Test Code	Mixed Variations	Number of test specimens based on soaking duration		
			7 Hari	14 Hari	28 Hari
1	PB.0	0%	2	2	2
2	PB.10	10%	2	2	2
3	PB.15	15%	2	2	2
4	PB.20	20%	2	2	2
The total number of Tajikistan			24		

The samples consisted of 24 samples; from each variation of adding sandal waste, there were two samples based on the length of soaking the paving for the compressive strength test. The results of paving block compressive strength testing can be seen in Tables 2, 3 and Table 4 below:

Table 2
Paving Block Compressive Strength Test Results 7 Days

No	Creation Date	Test Date	Age	The composition of the slipper waste mixture	The Label of the City	Test Specimen Weight (grams)	Wide Penampang of Test Objects(mm)	Compressive Strength Load (KN)	f'c (Mpa)	Average (Mpa)
1	3-May-23	11 May 2023	7 Hari	0%	PB 7 (0.1)	3	21000	660000	31,4	31,2
2	3-May-23	11 May 2023	7 Hari	0%	PB 7 (0.2)	2,98	21000	650000	31,0	
3	3-May-23	11 May 2023	7 Hari	10%	PB 7 (10.1)	2,7	21000	450000	21,4	21,2
4	3-May-23	11 May 2023	7 Hari	10%	PB 7 (10.2)	2,5	21000	440000	21,0	
5	3-May-23	11 May 2023	7 Hari	15%	PB 7 (15.1)	2,2	21000	320000	15,2	13,5
6	3-May-23	11 May 2023	7 Hari	15%	PB 7 (15.2)	2,2	21000	245500	11,7	
7	3-May-23	11 May 2023	7 Hari	20%	PB 7 (20.1)	1,5	21000	205500	9,8	9,7

No	Creation Date	Test Date	Age	The composition of the slipper waste mixture	The Label of the City	Test Specimen Weight (grams)	Wide Penampang of Test Object s(mm)	Compressive Strength Load (KN)	f'c (Mpa)	Average (Mpa)
8	3-May-23	11 May 2023	7 Hari	20%	PB 7 (20.2)	1,3	21000	200000	9,5	

The compressive strength value of the 7-day paving block at a variation of 0% (not using a mixture of sandal waste) gets an average compressive strength value of 31.2 Mpa, classified as B + quality. The compressive strength value of 10% variation gets an average of 21.2%, classified as B+ quality. The 7-day compressive strength value of the 15% variation gets an average compressive strength value of 13.5 Mpa and is classified as quality C; the 20% variation gets an average compressive strength value of 9.7 Mpa is classified as quality D. The compressive strength results obtained are calculated based on equation 5.

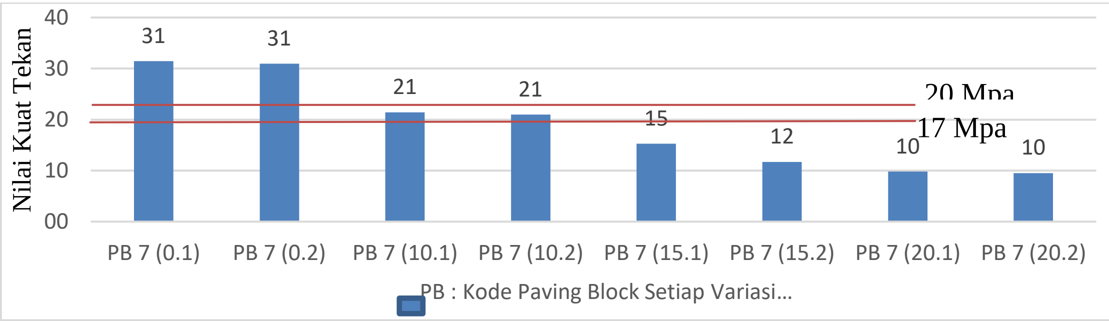


Figure 5

Graph of Compressive Strength Test Results of Immersion Paving Block 7 Days

Based on the compressive strength test results for seven days in Figure 5, the average compressive strength results are not much different from soaking for 14 days. The 10% variation is optimal for quality B paving blocks with an average compressive strength value of 21.2 Mpa. The average compressive strength results in 15% and 20% variations, and we get an average compressive strength value with grades C to D.

Table 3

Paving Block Compressive Strength Test Results 14 Days

No	Creation Date	Test Date	Age	The composition of the slipper waste mixture	The Label of the City	Test Specimen Weight (grams)	Wide Penampang of Test Objects(mm)	Compressive Strength Load (KN)	f'c (Mpa)	Average
1	27-Apr-23	11 May 2023	14 Hari	0%	PB 14 (0.1)	3	21000	690000	32,9	31,5
2	27-Apr-23	11 May 2023	14 Hari	0%	PB 14 (0.2)	3,2	21000	635000	30,2	
3	27-Apr-23	11 May 2023	14 Hari	10%	PB 14 (10.1)	2,7	21000	470000	22,4	21,8
4	27-Apr-23	11 May 2023	14 Hari	10%	PB 14 (10.2)	2,8	21000	445000	21,2	
5	27-Apr-23	11 May 2023	14 Hari	15%	PB 14 (15.1)	2,2	21000	345000	16,4	16,5
6	27-Apr-23	11 May 2023	14 Hari	15%	PB 14 (15.2)	2,2	21000	350000	16,7	
7	27-Apr-23	11 May 2023	14 Hari	20%	PB 14 (20.1)	1,7	21000	225000	10,7	10,2
8	27-Apr-23	11 May 2023	14 Hari	20%	PB (20.2)	1,7	21000	205000	9,8	

Table 3 shows compressive strength test values with paving immersion for 14 days. A comparison between the previous 28-day paving immersion and the 14-day paving soaking showed a less significant difference. The optimal variation of adding sandal waste is found in the 10% variation, which has an average compressive strength value of 21.8 Mpa. According to (Hitosugi, 2011), the test results are based on variations in concrete compressive strength, with a length of immersion from concrete that is 14 days old. The decrease in compressive strength depends primarily on the composition of the concrete mixture. Concrete consists mainly of aggregate, which can withstand loads and resist cracking. The presence of cement and other constituent materials affects the strength of concrete. In this case, the reduced strength of concrete is due to the partial replacement of the volume of fine aggregate with rubber sandalwood powder. Based on the test data, a concrete mixture containing 10% rubber sandal powder achieved the most optimal results. This combination meets predetermined strength and pressure criteria.

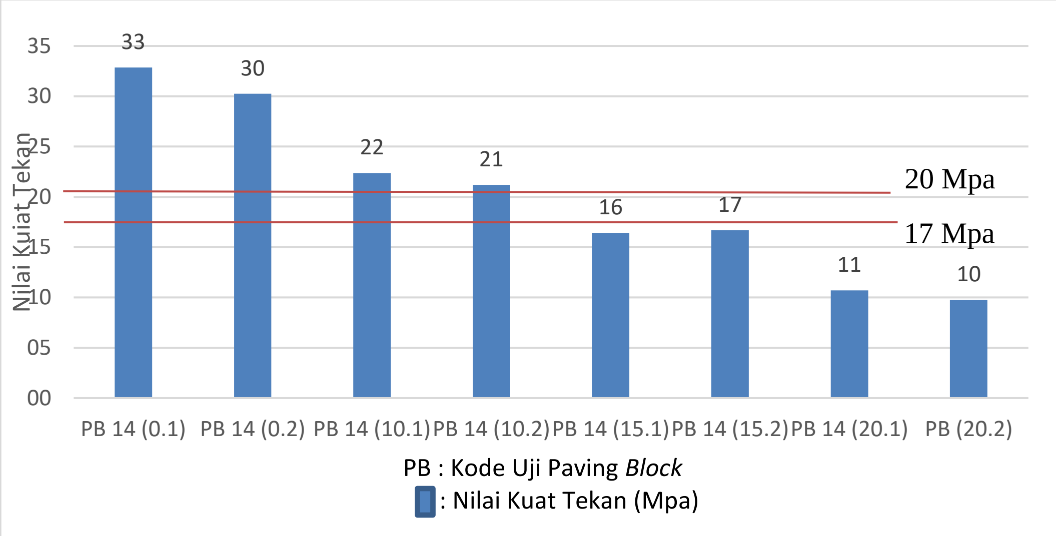


Figure 6
Graph of Compressive Strength Test Results of Immersion Paving Block 14 Days

Figure 6 shows that the compressive strength results with soaking for 14 days decreased compared to the compressive strength results of the previous 28 days. The optimum result is found in a variation of 10% with a compressive strength value by quality B with an average of 21.8 Mpa. According to the study's results (Iwaya et al., 2011), the compressive strength value is caused by the more rubber-crushed waste used as a substitute for sand; the compressive strength and flexural tensile strength of concrete will decrease. The compressive strength test results with 14 days of immersion decreased with the increasing variation of adding rubber crushes.

Table 4
Paving Block Compressive Strength Test Results 28 Days

No	Creation Date	Test Date	Age	The composition of the slipper waste mixture	The Label of the City	Test Specimen Weight (grams)	The cross-sectional area of the test specimen	Compressive Strength Load (N)	f'c (Mpa)	Average(Mpa)
1	13-Apr-23	11 May 2023	28 Hari	0%	PB 28 (0.1)	3,3	21000	730000	34,8	34,5
2	13-Apr-23	11 May 2023	28 Hari	0%	PB 28 (0.2)	3,35	21000	720000	34,3	

No	Creation Date	Test Date	Age	The composition of the slipper waste mixture	The Label of the City	Test Specimen Weight (grams)	The cross-sectional area of the test specimen	Compressive Strength Load (N)	f'c (Mpa)	Average(Mpa)
3	13-Apr-23	11 May 2023	28 Hari	10%	PB 28 (10.1)	2,93	21000	570000	27,1	26,5
4	13-Apr-23	11 May 2023	28 Hari	10%	PB 28 (10.2)	2,87	21000	545000	26,0	
5	13-Apr-23	11 May 2023	28 Hari	15%	PB 28 (15.1)	2,3	21000	400000	19,0	18,8
6	13-Apr-23	11 May 2023	28 Hari	15%	PB 28 (15.2)	2,5	21000	390000	18,6	
7	13-Apr-23	11 May 2023	28 Hari	20%	PB 28 (20.1)	1,89	21000	235000	11,2	10,6
8	13-Apr-23	11 May 2023	28 Hari	20%	PB 28 (20.2)	1,89	21000	210000	10,0	

Based on the compressive strength test results with paving immersion for 28 days, Table 4 shows two samples for adding rubber sandal waste in each variation. The 0% variation (not using sandal waste) shows a higher compressive strength load result compared to other variations; after calculating using the formula equation in 2.1, a result of 34.7 Mpa was obtained with an average result of 34.5 Mpa, which result is classified as a type of paving block with quality A with an average value of 35-40 mPa according to SNI 03-0691-1996. The 10% variation shows an average compressive strength result of 26.5. It is classified as paving quality B +, which means it is between quality A and Quality B. The 15% variation gets an average compressive strength result of 18.8 Mpa, classified as quality B, which will be used for road pavements and parking equipment lots. Moreover, the last variation of 20% gets an average compressive strength value of 10.6, classified as D quality.

The addition of variations of shredded rubber to the paving block mixture affects the unit weight of the volume. In particular, increasing the proportion of rubber pieces added to the mixture increases the average unit weight of paving. When added to paving, chopped rubber acts as a lightweight aggregate. With increasing proportions of chopped rubber, more light aggregate is introduced into the paving mixture. This produces more lightweight materials than denser mixed components, such as cement, sand, and coarse aggregate. Since lightweight materials have a lower density, increasing the number of rubber pieces in the mixture reduces the overall density of concrete. One thing that affects the unit weight will depend on the proportions, size, and specific characteristics of the chopped rubber particles used, the mixture's design, and the overall curing conditions. These factors can affect the density and performance of the paving itself (RUSYADI, 2021).

Results of Paving Block Water Absorption Analysis

Water absorption testing on this paving aims to determine the percentage of the paving's ability to absorb water during the 24-hour soaking period. The size of the percentage of water absorption produced depends on whether or not the cavity in the test specimen is tight. If the cavity in the test specimen is tighter, the water absorption value will be higher, and vice versa. If the cavity in the test specimen is tenuous, the resulting absorption value is lower. Determination of water absorption in paving blocks is obtained by calculating the difference between wet and dry mass weighed using digital scales with a weight capacity of up to 60 kg. The results of the water absorption test obtained from paving blocks are listed in Table 5 below:

Table 5
Water Absorption Test Results on Paving Block

No	Test Code	Variations	Long Soaking	Wet Mass (gr)	Dry Mass (gr)	Result	Average
1	D.S (0.1)	0%	24 Jam	300	290	3,4%	3,3%
2	D.S (0.2)	0%	24 Jam	296	287	3,1%	
3	D.S (10.1)	10%	24 Jam	245	234	4,7%	5%
4	D.S (10.2)	10%	24 Jam	240	228	5,3%	
5	D.S (15.1)	15%	24 Jam	177	166	6,6%	6,7%
6	D.S (15.2)	15%	24 Jam	174	163	6,7%	
7	D.S (20.1)	20%	24 Jam	163	147	10,9%	11,3%
8	D.S (20.2)	20%	24 Jam	162	145	11,7%	

Based on the results of the water absorption test obtained, the mixture of slipper waste variations of 10% meets the most optimal water absorption in paving, which is an average of 5%. According to SNI 03-0691-1996, the most optimal water absorption in paving blocks with quality B is between 5-6%; from table 5 above, the variation of the mixture of 10% shows optimal results for the quality of quality B paving with water absorption results of 5%. The absorbency test results are presented in Figure 7 below.

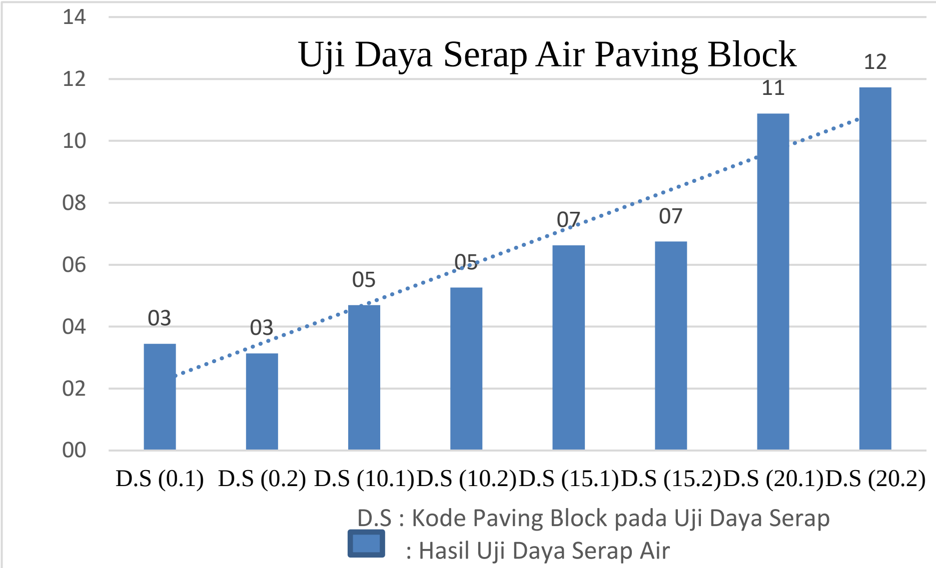


Figure 7
Graph of Water Absorption Test Results on Paving Blocks

Based on the calculation in calculation formula 2.2, the results of the water absorption test are obtained by calculating the difference between the dry mass and wet mass of the paving block and then multiplying and finding the final result in the form of 100% per cent. In this absorbency test, soaking is carried out for 24 hours or equal to 1 day. According to (de Bragança, de Souza, Soares, and Soares, 2023), the process of water absorption in concrete is reviewed based on the composition of the mixture from the foundation of making concrete itself. Westerman explained that the concrete mixture that uses glass powder and plastic crushes affects the process and absorption conditions in the concrete made; therefore, in Figure 4.8, we can see that adding rubber sandal waste as coarse aggregate on paving will affect the results of water absorption produced.

SEM Paving Block Test Analysis Results

Scanning Electron Microscope (SEM) is a technique for investigating the topography and spectroscopic properties of various material surfaces with atomic resolution under various physical conditions. One of the most critical factors in achieving high-resolution measurements is the reduction of external vibrations that might affect the microscope, such as changes in edge-sample separation multiplied exponentially in tunnelling currents (Nasution, 2022). As in the discussion of the SEM test on paving blocks this time, the SEM test was carried out to determine the results of topography, the spread of microcracks, and the condition of the air cavities in the paving. Microcrax is a type of material damage that consists of cracks small enough to require magnification to be observed. Microcracks indicate material failure that can eventually lead to complete failure. This can occur in the coating during the application or drying process or strain load of the coating or material. The following are the results of the SEM test analysis on paving blocks with a variation of 0% sandal waste listed in Table.

Table 6
SEM Test Results 0% Variation

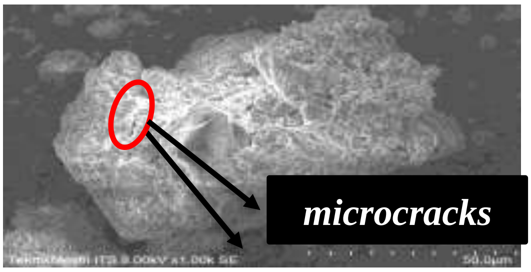
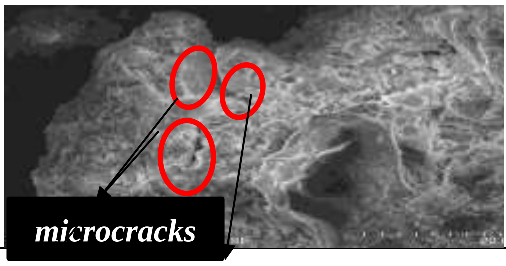
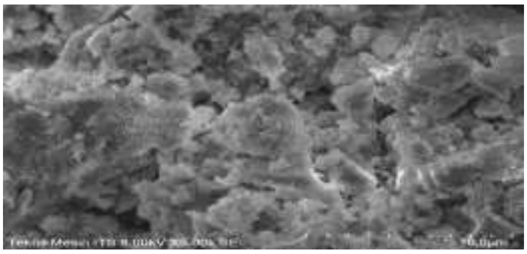
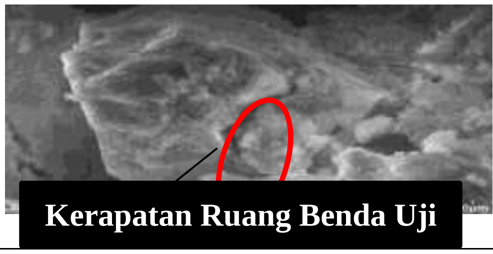
Magnification	Test Results	Information
1000 Kali		The figure shows that paving samples with 0% variations were tested using magnifications of 1000, 2000, 5000, and 10,000 times. It is known that the spread of *microcracks* on paving is not so great, only in certain areas with *a relatively small* microcrack size. In addition to the spread of *microcracks* that affect the compressive strength value produced in paving, the condition of the air cavity also affects the results of the paving's compressive strength. The more air cavities contained in the paving, the smaller the compressive strength value produced, and vice versa. If the air cavity in the paving is small or the density is high, the resulting compressive strength value is even greater. At a magnification of 10,000 times, it can be seen that the condition of the specimen is very dense, and even almost no air-void holes are visible. This is because the composition of the mixture in making paving *blocks* consists of a mixture of paving in general, namely cement, stone ash, crushed stone, and water.
2000 Kali		
5000 Kali		
10000 Kali		

Table 6 shows that the morphological test results on paving blocks with a variation of 0% (without using a mixture of sandal waste) only slightly have microcrack spread. Microcracks can form before the strain on the material reaches its break point. Thus, the pressure on the material must be limited before the resin fibres break off. The condition of the air cavity in the test results with a variation of 0% is also not too visible; this shows that the test specimen has a high enough density so that it does not produce so many air cavities. An example of the air cavity content in concrete brick can be seen in Figure 8 below.

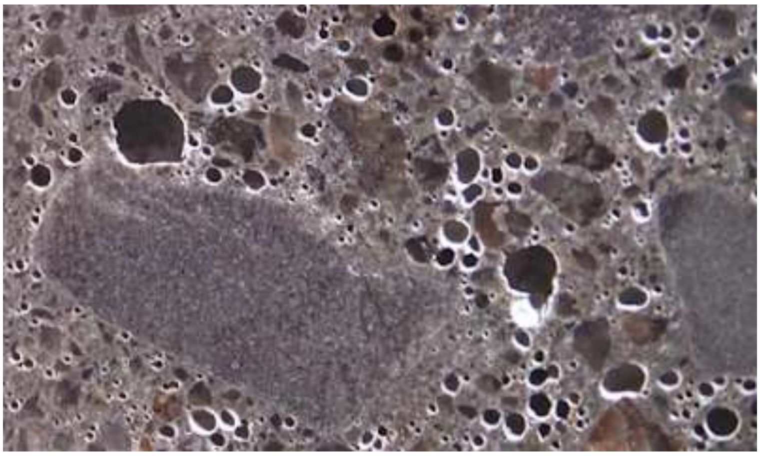


Figure 8
Air Cavities in Concrete

Air cavities can be seen based on the mixture and material that makes up paving blocks, such as adding a variation of rubber sandal waste by 10% on paving blocks.

Production Cost Budget Plan (RAB)

In making paving blocks, paying attention to the Cost Budget Plan (RAB) in the production process is necessary. Calculating the RAB for making test specimens consists of the material used in the mixture, which refers to the price of the material in Sidoarjo. In addition, the cost of paving printing also depends on how much paving is produced and the size of the paving to be made. The following is the RAB for the paving production process in Table 7 below.

Table 7
Paving Production Cost Budget Plan

0% variation			
No	**Material**	**Volume**	**Price**
1	Cement	6.750 gram	Rp 8.775,00
2	Batu Ash	6.750 gram	Rp 104.625,00
3	Broken Stone	13.500 gram	Rp 38.796,17
4	Water	Litre	Rp 100,00
5	Printing Cost	Activities	Rp 250.000,00
TOTAL			Rp 402.296,17
Production Cost of Each Paving			Rp 44.699,57
10% Profit			Rp 4.469,96
Price for one paving *block*			Rp 49.169,53
10% variation			

No	Material	Volume		Price
1	Cement	6.750 gram	Rp	8.775,00
2	Batu Ash	6.750 gram	Rp	104.625,00
3	Broken Stone	12.150 gram	Rp	34.916,55
4	Slipper Waste	150 gram	Rp	0
5	Water	Litre	Rp	100,00
6	Printing Cost	Activities	Rp	250.000,00
	TOTAL		Rp	398.416,55
Production Cost of Each Paving			Rp	44.268,51
10% Profit			Rp	4.426,85
Price for one paving *block*			Rp	48.695,36
		15% variation		
No	**Bahan**	**Volume**		**Price**
1	Cement	6.750 gram	Rp	8.775,00
2	Batu Ash	6.750 gram	Rp	104.625,00
3	Broken Stone	11.475 gram	Rp	32.976,74
4	Slipper Waste	225 gram	Rp	0
5	Water	Litre	Rp	100,00
6	Printing Cost	Activities	Rp	250.000,00
	TOTAL		Rp	396.476,74
Production Cost of Each Paving			Rp	44.052,97
10% Profit			Rp	4.405,30
Price for one paving *block*			Rp	48.458,27
		20% variation		
No	**Bahan**	**Volume**		**Price**
1	Cement	6.750 gram	Rp	8.775,00
2	Batu Ash	6.750 gram	Rp	104.625,00
3	Broken Stone	10.800 gram	Rp	31.036,93
4	Slipper Waste	300 gram	Rp	0
5	Water	Litre	Rp	100,00
6	Printing Cost	Activities	Rp	250.000,00
	TOTAL		Rp	394.536,93
Production Cost of Each Paving			Rp	43.837,44
10% Profit			Rp	4.383,74
Price for one paving *block*			Rp	48.221,18

Based on Table 7 regarding the Production Plan for paving with variations of 0%, 10%, 15%, and 20%, the price used is by the Unit Price of Activity (HSPK) of Sidoarjo Regency, East Java. The volume of the mixture material for making paving adjusts to the composition of the mixture (mix design).

Conclusion

Based on the three tests on paving blocks, it can be concluded that the most optimal variation in adding sandal waste is a variation of 15% at the compressive strength of 28 days old and at a variation of 10% at the age of 14 and 7 days with an average compressive strength value, water absorption and SEM test results by the paving quality requirements listed in SNI 03-0691-1996. The value of the compressive strength test results that meet the B quality requirements is 18.8 Mpa with a variation of 15% at a compressive strength of 28 days and a 10% variation of 21.2 Mpa at a compressive strength of 14 days. The results of the water absorption test value are on paving blocks with a variation of 10% by 5% and are classified as quality B. The results of the SEM test analysis on paving blocks use magnifications of 1000, 2000, 5000, and 10000 times. Variations of 15% and 20% showed an even spread of microcracks, air cavities, and high estrangement in the specimen.

The characteristic result of paving blocks that use sandal waste as a mixture tends to have cracks and an uneven texture and is somewhat rough. This is because the mixture of sandal waste has elastic properties that produce a cross-sectional surface on paving that is less even. For the planned paving production cost plan by the HSPK reference of Sidoarjo Regency and Surabaya City. With different prices depending on the variety of slipper waste. For 0% variation of Rp 49,169.53, 10% variation of Rp 48,695.36, 15% variation of Rp 48,458.27, and 20% variation of Rp 48,221.18.

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