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Impression of ABS Waste (Acrylonitrile Butadiene Strene) as an Alternative Material Eco-Friendly Paving Block Manufacturing

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Abstract

This research was motivated by the question of how to utilize the waste of ABS (acrylonitrile Butadiene Stryene) in the form of leftover cigarette butts produced and applied in making paving blocks. The test results are further processed and interpreted by comparing ABS waste aggregates as well as aggregate standards for normal block paving. The physical properties tests carried out in this study are: filter analysis test, moisture content test, content weight test, and specific gravity test. Furthermore, test specimens were made for testing non-structural building materials in the form of square moulds of paving blocks with sizes a length of 21 cm, a width of 10.5 cm and a thickness of 8 cm. The compressive strength of the plan in making this concrete is 10 MPa which is placed in garden areas with light loads. Making paving block test objects using natural sand and added ABS waste in the form of cigarette butts. From the results of the concrete compressive strength test, using SNI-PD-T-04-2004-C for a composition of 0%, 2.5%, 5% and 7% qualified because the average compressive strength of 7 days is 7,1091 MPa and at 28 days is 11,008 MPa on. From these results, it is concluded that the most optimal mixture of compressive strength is the composition of ABS waste amounting to 5% of the weight of sand.

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1 Introduction

ABS (Acrylonitrile Butadiene Strene) waste is the most littered waste in public places. One type of ABS is the cork that is in cigarette butts. Each cigarette butt takes years to recycle. In line with these problems, as an effort to reduce cigarette butt waste, this research will utilize the waste as a basis for making paving blocks. This study explores the potential of using cigarette butt waste as an added material in making paving blocks and then in press tests and water absorption tests on this paving block model. Test results are compared with global specifications on paving blocks.

Figure 1. Cigarette butt waste

Paving blocks have many advantages and advantages both in terms of strength, ease of manufacture and implementation. The shape and size of paving blocks are designed according to their function and use. Some of the advantages of using paving blocks are durability, good performance in settlement conditions, easier access to underground services, simple construction, and immediate availability. Paving damage is often caused by several things, such as the quality of unqualified stacking materials, the influence of rainwater scouring, and the number of vehicle wheel passes that exceed their impact resistance (usually in three thousand passes, paving blocks will experience cracks). So researchers tried to add cigarette punting waste to the paving block mixture to add quality to the paving block. The urgency of this study refers to the amount of cigarette butt waste that is wasted, resulting in the surrounding environment being damaged by the waste, so this research can reduce the waste and be useful in building structures with sufficient strength (Haque, 2016; Wang et al., 2017; Olofinnade et al., 2021).

2 Materials and Methods

The method used in this study is a quantitative method by conducting testing and experiments. The test was carried out on aggregate samples of ABS waste added to paving by reducing the percentage of sand. The study was conducted with two tests (Vazquez & Barbosa, 2017; Cui et al., 2021). The first test is to test the physical properties of aggregates in the laboratory of the Department of Civil Engineering. Physical properties testing is carried out on aggregates derived from sand buil. Tests include: sieve analysis test, moisture content test, fill weight test and specific gravity test. The second test is in the form of experiments making test objects for testing non-structural building materials in the form of square block paving moulds with a length of 21 cm, width of 10.5 cm and thickness of 8 cm. Test procedures refer to the following test standards:
SNI 03-1749-1990 (Aggregate for Stirring and Concrete, How to Determine Grain Magnitude)
SNI 03-1750-1990 (Concrete Aggregate, Quality and Test Method)
SNI-1970-2008 (How to Test Specific Gravity and Water Absorption of Fine Aggregates)
SNI 03-2816-1992 (Test Method for Organic Impurities in Sand for Mortar or Concrete Mixtures)

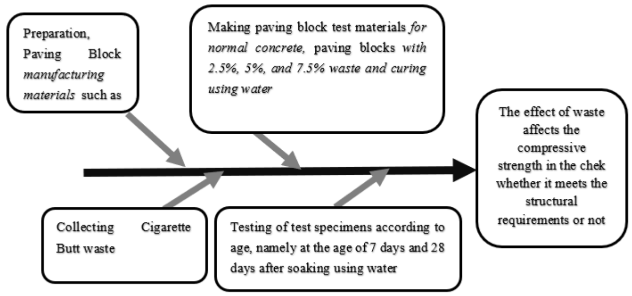

Figure 2. Stages study research and development

This research will be carried out for 5 months. The test was carried out at the Civil Engineering Laboratory of Pontianak State Polytechnic. Research methods are arranged in such a way as to facilitate the implementation of a study so that it runs more precisely, effectively and efficiently. The stages of the implementation process are illustrated in a flow chart below:

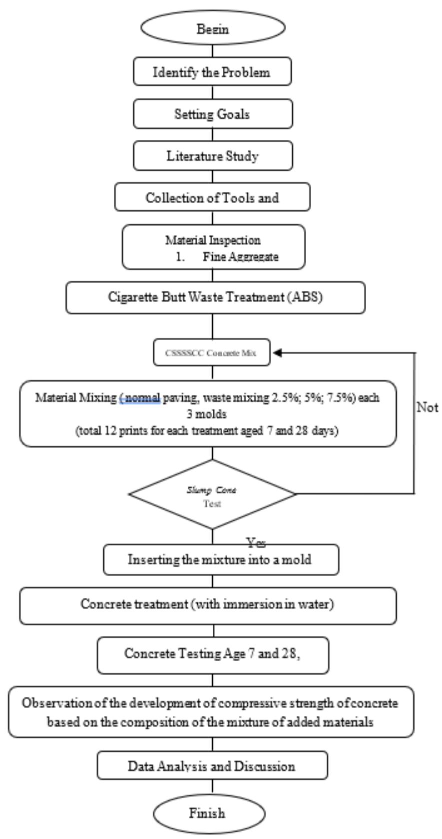

Figure 3. Procedure flow development

Laboratory testing is carried out to determine the physical properties of aggregates derived from quarry buil. The tests carried out include tests: sieve analysis test, moisture content test, fill weight test, specific gravity test and aggregate wear test.

The manufacture of non-structural building materials in this study is in the form of making paving blocks. Making paving blocks is carried out using waste, namely, ABS waste (cigarette butts) which is mixed by substituting the total sand weight used. And later soaked using ordinary water (Marton et al., 2022).

Figure 4. Paving block sample generation

Quality testing of non-structural building materials is carried out on paving blocks made of sand, cement, water and ABS waste. Tests were carried out on normal block paving with block paving with waste-added materials. Tests include: a concrete compressive test using UTM (*Universal Testing Machine*).

Figure 5. Paving block samples

3 Results and Discussions

The material tests we carry out, namely Moisture content testing of fine aggregates. This method is intended as a handle in testing to determine the moisture content of the aggregate (Pacheco-Torgal & Jalali, 2011; Bribián et al., 2011). Aggregate moisture content is a ratio or percentage of the weight of water contained in the aggregate in a dry state, expressed in percent. How to implement:

a) Scales with a precision of 0.1% by weight.
b) Aggregate oven, set temperature to heat up to (110 ±5) °C.
c) Large capacity rust-resistant metal tray for drying test specimens.

Table 1
Fine aggregate moisture content testing

Examination	I	II
Cup No.	1	2
Cup Weight (W1)	555	555
Saucer Weight + Test Specimen (W2)	3823	4380
Test Specimen Weight (W3=W2-W1)	3268	3825
Oven Dry Test Dish Weight + specimen (W4)	3540	4038
Oven Dry Test Specimen Weight (W5=W4-W1)	2985	3483

Examination	I	II	Average
Aggregate Moisture Content = x 100%$\frac{(w3-w5)}{w5}$	9,48	9,82	9,60

Figure 5. The process of checking the moisture content in fine-age

Specific Gravity and Fine Aggregate Absorption Testing. One of the physical properties tests carried out in this study is aggregate specific gravity testing, the data are tabled in Table 2.

Table 2
The specific gravity of fine aggregates

Examination	I	II
Dry Surface Saturation Test Specimen Weight (Bj)	500	500
Oven Dry Test Specimen Weight (B2)	492,1	493,48
Weight of Vessel Filled with Water (B3)	792,46	792,46
Vessel Weight + Test specimen + Water (B1)	955,84	9,7028

Examination	I	II	Average
Specific Gravity *Bulk/ov.* = $\frac{B2}{B3+Bj-B1}$	1,46	1,53	1,50
Specific Gravity of *SSD.* = $\frac{Bj}{B3+Bj-B1}$	1,49	1,55	1,50
Examination	**I**	**II**	**Average**
Specific Gravity *app.* = $\frac{B2}{B3+B2-B1}$	1,50	1,56	1,50
Ingestion = $\frac{Bj-B2}{B2} x100\%$	1,61	1,32	1,50

Figure 6. Fine aggregate specific gravity testing process

Fine aggregate fill weight testing. The aggregate content weight is the aggregate weight of the content/volume union, while the air cavity in aggregate volume units is the space between aggregate grains that are not filled by solid particles (Yuni et al., 2023).

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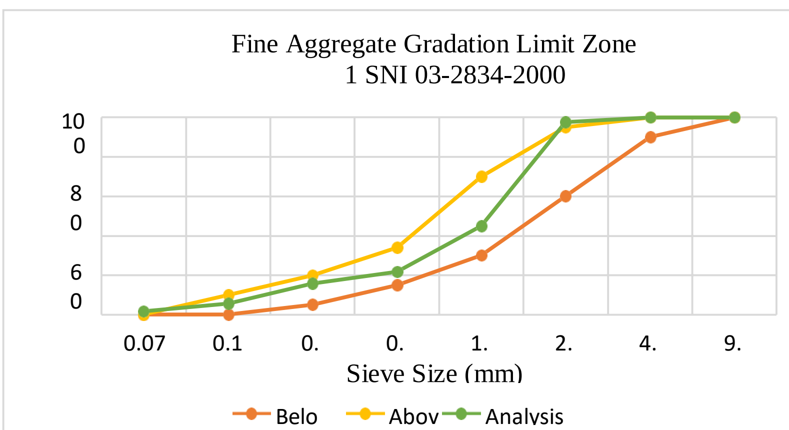
Table 3
Fine aggregate fill weight testing

Examination	Dense		Free	
	I	II	I	II
Mold Weight (W1)	2170	2170	2170	2170
Mold Weight + Test Specimen (W2)	6895	6974	6721	6581
Weight of Test Specimen (W3 = W2-W1)	4725	4804	4551	4411
Mold Weight + Water (W4)	5200	5200	5200	5200
Water Weight/ *Mold Fill* (V= W4-W1)	3030	3030	3030	3030

Examination	I	II	I	II
Fill Weight = (kg/dm^3) $\frac{W3}{V}$	1,56	1,59	1,50	1,46
Average	1,57		1,48	


Figure 7. Fill weight testing process

Fine aggregate gradation testing. This method is carried out as a guideline in the examination and determines the grain division (gradation) of fine aggregate and coarse aggregate using a sieve. The purpose of this test is to obtain the distribution of the magnitude or percentage amount of grains.



Graph 1. Fine aggregate analysis


Figure 8. Sieve shaker test equipment

Mix design stage

Because we want to find the right concrete formula, before mixing at this stage we do calculations to get the right formula (the formula we calculate concrete *mix design*). At this stage, we also determine the material requirements for 3 (three) test objects.


Figure 9. Process of mixing ABS material into mix/paving mixture Block


Figure 10. Paving block test specimen mould process

When mixing the aggregate directly printed with the paving block mould after it is left while waiting for it to harden after hardening, the test specimen is tested for water absorption and a compressive test is carried out on the test specimen (Eskandari-Naddaf & Kazemi, 2017; Naderpour et al., 2018).

Material data used in environmentally friendly paving block innovation with 10 MPa quality

Table 6
Compressive strength test results on paving blocks

No	Paving Blocks		Weight (kg)	Testing Life 7 days	Testing Life 28 days	F'c (MPa)
1	Normal	1	2.4 Kg	6.11	10.2	Mpa
		2	2.3 Kg	6.8	10.3	Mpa
		3	2.4 Kg	6.5	10.3	Mpa
2	2.5% mixture Acrylonitrile butadiene strene	1	2.3 Kg	7.45	11.2	Mpa
		2	2.5 Kg	7.85	11.6	Mpa
		3	2.4 Kg	7.85	11.2	Mpa
3	5% mixture Acrylonitrile butadiene strene	1	2.5 Kg	7.95	11.8	Mpa
		2	2.4 Kg	7.9	11.9	Mpa
		3	2.5 Kg	7.9	11.9	Mpa
4	7% mixture Acrylonitrile butadiene strene	1	2.6 Kg	6.4	10.6	Mpa
		2	2.5 Kg	6.5	10.6	Mpa
		3	2.6 Kg	6.1	10.5	Mpa

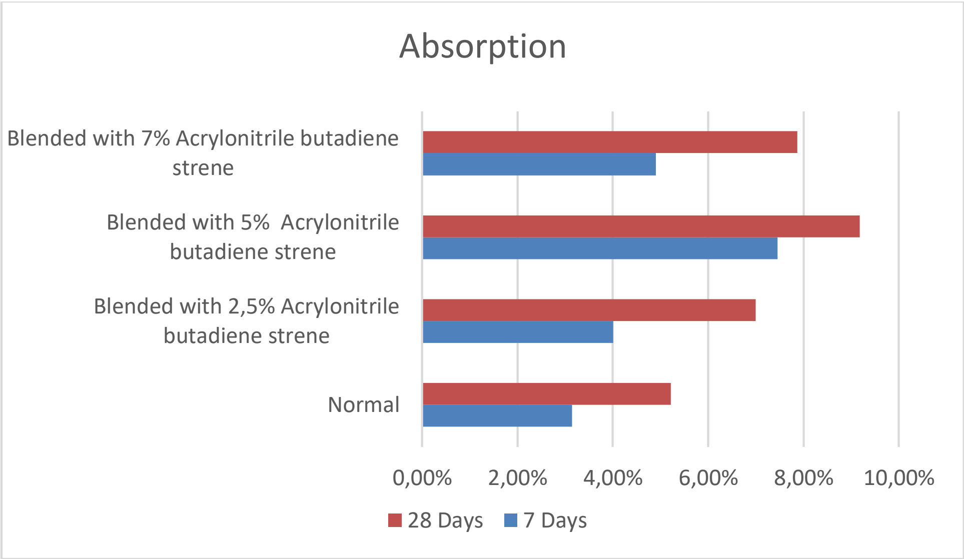
Figure 11. Test specimens

Table 7
Test Specimen Absorption Test Results

No.	Paving Blocks		Starting weight (kg)	Testing Life Final Weight 7 days	Testing Life Final Weight 28 days	Water Absorption Presentation 7 days	Water Absorption Presentation 28 days	Unit
1	Normal	1	2,4	2,04%	4,00%	2,04%	4,00%	%
		2	2,3	4,17%	6,12%	4,17%	6,12%	%
		3	2,4	3,23%	5,51%	3,23%	5,51%	%
2	2.5% mixture Acrylonitrile butadiene strene	1	2,3	4,17%	8,00%	4,17%	8,00%	%
		2	2,5	3,85%	4,58%	3,85%	4,58%	%
		3	2,4	4,00%	8,40%	4,00%	8,40%	%
3	5% mixture Acrylonitrile butadiene strene	1	2,5	7,41%	8,09%	7,41%	8,09%	%
		2	2,4	11,11%	12,73%	11,11%	12,73%	%
		3	2,5	3,85%	6,72%	3,85%	6,72%	%
4	7% mixture Acrylonitrile butadiene strene	1	2,6	3,70%	9,41%	3,70%	9,41%	%
		2	2,5	3,85%	6,72%	3,85%	6,72%	%
		3	2,6	7,14%	7,47%	7,14%	7,47%	%

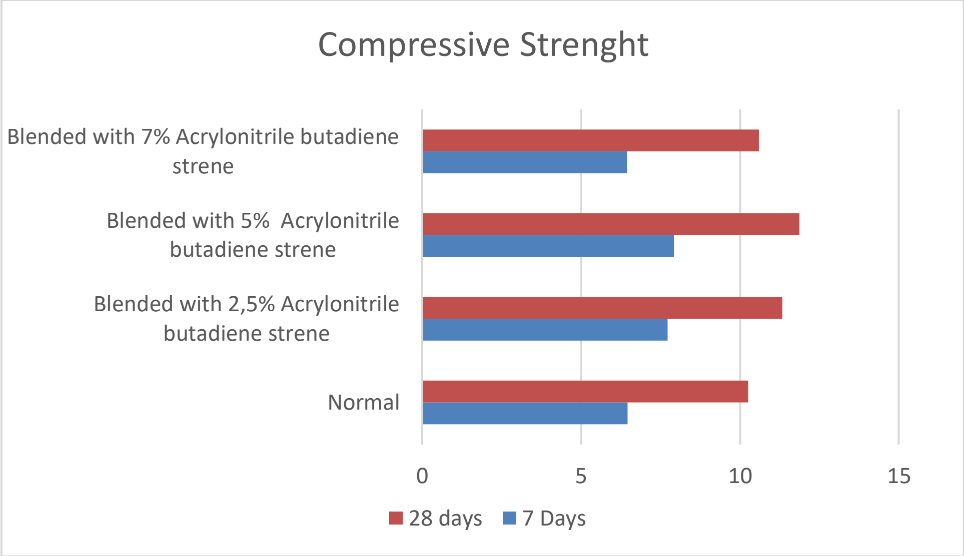
The highest compressive strength in a mixture of 5% ABS waste was an average of 11,867 MPa at 28 days old and the lowest in normal paving blocks with an average compressive strength of 10,267 MPa. In the 5% waste mixture, the water absorption value is also the highest. While the lowest water absorption in concrete is normal, because ABS waste material absorbs water quickly because it is made of cotton.

From the results, it was found that there was an increase in compressive strength in the mixture of about 39% from the age of paving blocks of 7 days to the age of 28 days in a mixture of 7% abs waste mixture than normal paving blocks only increased by 37%. In contrast to the results of water absorption in paving, the largest water absorption value in paving with a mixture of 5% abs waste.



Graph 1. Comparison of water absorption in paving aged 7 days and 28 days

The graph above is the average result of the water absorption value that occurs in paving blocks. The highest absorption occurs in paving mixtures with 5% ABS mixture. While the lowest is in normal paving. As for the compressive strength, it is visible in graph 2.



Graph 2. Comparison of paving compressive strength at the age of 7 days age 28 days

4 Conclusion

From the results of concrete compressive strength testing, it can be concluded that the use of ABS waste can increase the strength of paving blocks if the composition of the mixture follows what is made. There was an increase in compressive strength in the mixture of about 39% from the age of 7 days block paving to 28 days in a mixture of 7% abs waste mixture than normal block paving only increased by 37%. In contrast to the results of water absorption in paving, the largest water absorption value in paving with a mixture of 5% abs waste. From the several stages of assessment and testing, learning media based on 3-dimensional (3D) animation in the Engineering Mechanics course at the Pontianak State Polytechnic Civil Engineering Department is very suitable for learning.

Conflict of interest statement
The authors declared that they have no competing interests.

Statement of authorship
The authors have a responsibility for the conception and design of the study. The authors have approved the final article.

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