JURNAL IPTEKS TERAPAN
Research of Applied Science and Education V15.i4 (424-430)

ISSN : 1979-9292

E-ISSN : 2460-5611

INNOVATION OF RECYCLING PLASTIC WASTE INTO ENVIRONMENTAL FRIENDLY PAVING BLOCKS

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Abstract

This research is a design on the manufacture of environmentally friendly paving blocks from plastic waste. Paving block is a material that serves as a cover or hardening of the ground surface which can be one solution to deal with plastic problems. The data used by researchers in this study refers to primary and secondary data, primary data obtained directly by researchers in the field by testing the compressive strength at the age of paving blocks 2 and 7 days, namely 2.17 MPa and 28.99 MPa, absorption testing to water 0.76% and 0.59% has no effect on water absorption because plastic is a material that does not easily absorb water. As for the results of resistance testing to sodium sulfate, the results obtained are 0.25% and 0.59%. This is considered good because there are no cracks and physical damage to the paving block. It can be concluded that the used plastic used to make paving blocks meets the requirements of SNI-03-0691-1996 with class C quality.

Keywords: paving blocks, garbage, plastic

INTRODUCTION

At this time, because the use of plastic materials in every human activity is inevitable, most of the world's population uses plastic in their daily activities. However, with the use of plastic in more time and volume of use, new problems such as plastic waste arise. Plastic waste is difficult to decompose in the soil and takes 20 to 100 years to completely decompose in the soil. The use of plastic items is increasing day by day. Based on the assumption of the Ministry of Environment in 2015 the total pile of plastic waste in Indonesia was 175,000 tons/day and 15% of it was plastic waste (Gusniar 2018).

Plastic is the largest contributor to waste that cannot be decomposed naturally and therefore plastic waste must be processed so that it does not become a pollutant in the future. Paving block is one solution for handling plastic waste, paving block itself is a material that works as a cover or hardening of the soil surface. Paving blocks have many benefits including easy installation, low installation costs, and high water absorption ability. In addition, paving blocks made from plastic waste can be recycled again if a crack occurs during installation or use (Setyawan et al. 2020).

Paving blocks are a component of building materials that are often used in the construction world. The use of paving blocks as a cover or road surface hardener

Submitted : 30-08-2021 – Accepted : 15-12-2021 – Published : 16-12-2021

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is used for residential projects, beautifying the yard of the house, covering the surface of the parking area (schools, offices, factories, schools, restaurants, apartments, hotels and so on) (Diana and Fansuri 2020).

The use of cement in the manufacture of paving blocks requires high costs. Therefore, the use of plastic waste can minimize the expenditure of funds and solutions for reducing plastic waste (Andriansah et al. 2020). Many previous researchers, such as research (Amran, Yusuf. 2015) used plastic waste as an added material for making paving blocks as much as 0.2-0.8% to increase compressive strength. (Rohmad, Agung. Heru Sukanto. Wijang Wisnu R. 2013) conducted a study on the use of PP plastic waste and prohibited rubber as materials for making tiles. Research related to plastic waste was also carried out (Agus, R Murdiyoto. 2011) by utilizing PET type plastic waste as coarse aggregate for making paving blocks (Gusniar 2018). Based on the background of these problems, the authors are encouraged to conduct research using plastic waste as the main material for making environmentally friendly paving blocks.

RESEARCH METHODS

Research Site

The location for taking plastic waste directly at the Final Disposal Site (TPA) Medan Belawan, precisely in Kampar Village, Belawan Village 1, saw a lot of garbage scattered around, especially plastic waste in the surrounding environment due to a lack of waste disposal.

The location of the paving block testing was carried out at the Civil Engineering Laboratory of the University of North Sumatra (USU) to test compressive strength, wear resistance, air absorption and resistance to sodium sulfate paving blocks made from plastic waste to obtain paving blocks that meet the standards (SNI 03-0691-1996).

Design Method

This research is an environmentally friendly paving block design from plastic waste. The data used by researchers in this study refers to primary and secondary data, primary data obtained directly by researchers in the field to see compressive strength, wear resistance, absorption of air and resistance to Sodium Sulfate paving blocks made from plastic waste in order to obtain paving blocks that meet standard (SNI 03-0691-1996), while secondary data is primary data booster data that is not obtained directly in the field such as literature studies. The implementation of this activity consists of four stages, namely the planning stage, the preparation stage, the implementation stage, and the evaluation stage. The activity planning stage consists of: 1) conducting interviews and field surveys; 2) make observations; and 3) enter into an agreement with plastic waste collectors. The preparation stage includes the preparation of an activity schedule, as well as the purchase of equipment and materials for program implementation. The implementation stage of making, printing, and testing paving blocks. Next is the evaluation stage which

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is carried out to determine the final preparation of the product by managing plastic waste in the manufacture of paving blocks. This stage is measured based on laboratory tests to see the compressive strength, wear resistance, air absorption and resistance to sodium sulfate paving blocks made from plastic waste in order to get paving blocks that meet the standards (SNI 03-0691-1996). Indicators of success at this evaluation stage are seen based on paving block products that comply with standards (SNI 03-0691-1996) and reduced plastic waste.

Stages of making Paving Blocks

The stages of making paving blocks are: tools and materials, namely Tools 1) Used cans/drums 2) Paving molds 3) Iron/wood as a mixing tool 4) Furnace/stove. Material 1) Plastic 2) Used oil/oil. Heat the plastic in a can/drum until it melts. add oil/vegetable oil so it doesn't stick when stirred. add sand when the plastic melts, stir until smooth and reheat. Then after mixed evenly, print paving with concrete. Then flatten it so that the surface is flat. Previously apply oil/oil to the mold so that it doesn't stick and is easy to renew. After printing, put it in a bucket filled with air. Wait for it to cool and ready to use (Andriansah et al. 2020)

Test Results

The test was carried out at the Laboratory of the Civil Method Department, USU. Compressive strength is the amount of load per unit area, which was tested using test equipment at the age of 28 days. Basically a good paving block is a paving block that has a large compressive strength. The equation used in calculating the compressive strength is as follows:

$fc' = P/A$ ……(1)

information: fc' = compressive strength of paving blocks (MPa).

P = maximum load (N).
A = area of compression (mm2)

In testing the energy absorption of water, each paving block with alteration of the test item is put into a water bath. There is also water absorption calculated by the following formula:

$(A-B)/B \times 100\%$ …….. (2)

information:

A = Wet Concrete Brick Weight (gr).
B = Weight of Dry Concrete Brick (gr).

Tests on sodium sulfate try to create the resistance of paving blocks to weathering and local conditions. Lack of weight included in paving blocks as a parameter of resistance to Sodium Sulfate. The shrinkage of paving block weight for SNI 03-0691-1996 is required to differentiate the weight of not more than 1%. Sodium sulfate resistance is calculated by the formula:

Weight Loss = $(E-H)/H \times 100\%$ (4)

information:

E = weight of concrete brick before soaking (gr).
H = weight of concrete brick after soaking (gr).
(Aji, Rakhmawati, and Arnandha 2018)

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RESULTS AND DISCUSSION

1. Results of Paving Block Compressive Strength Test

Tabel 1. Plastic Paving Block Compressive Strength Test Results

Test Item Number	date		Paving Block Age (days)	Test Weight (Kg)	Press Actual load (kN)	Calibration Press load (kN)	Sturdy Press (Kg/cm^2)		Sturdy Press MPa	
	Print	Test					During Testing	Estimated 28 days	During Testing	Estimated 28 days
1	08 Aug 2021	10 Aug 2021	2	0,18	2,0	2,0	8,23	26,56	0,67	2,17
2	03 Aug 2021	10 Aug 2021	7	0,10	56,0	56,5	230,55	354,69	18,84	28,99

by comparing the compressive strength of concrete paving blocks can be seen in table 2

Tabel 2. Hasil Pengujian Kuat Tekan Paving Block Beton

Test Item Number	Date		Concrete Age (days)	Test Weight (Kg)	Press Actual load (kN)	Calibration Press load (kN)	Sturdy Press (Kg/cm^2)
	Print	Test					
1	-	06 Aug 2021		2,82	380,0	375,7	184,18

From the results above, it can be concluded that the highest compressive strength value of plastic paving block test object number 2 with a strong value of 28.99 MPa because the plastic melt adheres and provides perfect density due to a good cooking process and the age of the paving block which is 7 days longer than the age of the paving block. paving block which is only 2 days.

2. Paving Block Water Absorption Test Results

Tabel 3. Testing Results Water Absorption

Test objects	Dry Paving Block Weight (B)	Wet Paving Block Weight (A)	Results
Kontrol (Beton)	1900 gram	2000 gram	5,26 %
Umur 2 Hari	1180 gram	1189 gram	0,76 %
Umur 7 Hari	678 gram	682 gram	0,59 %

From the results of the data above, the highest absorption value after immersion in water for 24 hours occurred in the control object (concrete) with an absorption value of 5.26%. Meanwhile, the absorption value of plastic paving blocks is only 0.76% and 0.59%. It can be concluded that plastic paving blocks have no effect on water absorption because plastic is a material that does not easily absorb water.

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3. Results of Sodium Sulfate Resistance Testing

Tabel 4. Resistance Test Results To Sodium Sulfate

Test objects	Age (day)	Paving Block Weight Before Soaking (E)	Paving Block Weight After Soaking (H)	Losing Weight	Description
Control (Concrete)	-	1900 gram	1885 gram	0,79%	Substandard
A	2	1180 gram	1177 gram	0,25%	Good
B	7	678 gram	674 gram	0,59%	Good

Based on the test results above, after immersion in sodium sulfate solution, there was a slight reduction in weight in all test samples. This weight reduction can be caused by chemical reactions that occur between sodium sulfate solution and calcium hydroxide which will produce calcium sulfate compounds. The calcium sulfate formed is swell and in the dry state will form a needle-like crystalline solid. The expansion of the volume that exceeds the initial volume causes swelling and forces the surrounding side to cause damage or wear to the paving block structure. In the long term, conditions like this will affect the durability and strength of paving blocks so that their durability and wear resistance will be lower.

Figure 2. Melt Plastic Molding Process

Figure 3. Sodium Sulfate Testing Process

Figure 1. Waste Plastic Melting Process

Figure 4. Finished Paving Blocks

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Figure 5. The Process Of Testing The Compressive Strength Of Paving Blocks

CONCLUSION

Based on the results of research and discussion in the manufacture of plastic-based paving blocks, the following conclusions can be drawn:

1. The highest compressive strength obtained from paving blocks made of plastic with a compressive strength value of 28.99 MPa. While the compressive strength value of the smallest plastic paving block with a compressive strength value of 2.17 MPa. The highest absorption value after immersion in water for 24 hours occurred in the control object (concrete) with an absorption value of 5.26%. Meanwhile, the absorption value of plastic paving blocks is only 0.76% and 0.59%. It can be concluded that plastic paving blocks have no effect on water absorption because plastic is a material that does not easily absorb water.
2. As for the results of testing the resistance to sodium sulfate paving blocks, it is considered good because there are no cracks and physical damage to the paving blocks.
3. Age in the manufacture of paving blocks affects the value of compressive strength, absorption value, and resistance to sodium sulfate.
4. The optimal test rate for the use of used plastic as the main material for making paving blocks for paving block reinforcement is a 7 day old test object
5. The used plastic used to make paving blocks meets the requirements of SNI-03-0691-1996 with class C quality.

THANK-YOU NOTE

Thank you to the Creative Media State Polytechnic for providing grant funds to our group as the winner of the internal Polimedia grant on the Creative Industry Research scheme Based On Product Creation.

We also thank USU's Analytical Chemistry Laboratory, and USU's Civil Engineering Concrete Laboratory for giving us the time and place to be able to carry out sample testing in this research.

Thanks to Allah SWT, and our parents.

We are very grateful.

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Submitted : 30-08-2021 – Accepted : 15-12-2021 – Published : 16-12-2021