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High Density Polyethylene (HDPE) Plastic Waste For Making Paving Blocks Can Improve Environmental Health

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ABSTRACT

Waste management is a problem that this nation has never been able to solve. Based on data from Jenna Jambeck (2018), a waste researcher from the University of Georgia, Indonesia is ranked second in the world as a producer of plastic waste, reaching 187.2 million tons after China, which reached 262.9 million tons. The aim of this research is to utilize HDPE (High Density Polyethylene) plastic waste as an additional material for hexagon paving blocks, where the researcher wants to know the savings results from using shredded HDPE plastic waste on sand aggregates in making one paving block and to find out the results of the compressive strength test on Utilization of HDPE (High Density Polyethylene) Plastic Waste as additional material for making Hexagon Model Paving Blocks. This research is a type of experimental research, experimental research or experiment (experimental research) is research by carrying out experimental activities, which aims to determine the symptoms or effects that arise, as a cause and effect of certain treatments or experiments (Notoadmodjo, 2014). This research design will use a Completely Randomized Design (CRD) where variations in the ratio of 1:6 cement to sand: 0.00% chopped plastic as control, 0.45%, 0.5%, 0.55%. The variations in the size of the HDPE plastic pieces were 1 cm and 1.5 cm for each comparison of the number of variations with 3 treatments for each variation in the number of comparisons and variations in the size of the HDPE plastic pieces. The addition of 0.45% chopped plastic waste with a variation of 1.5 cm in pieces got the highest result, namely 103.99 kg/cm2. The lowest pressure strength was found when using chopped 0.55% HDPE plastic waste and with a variation of 1 cm pieces with a value of 85.98 kg/cm2 and the control (without HDPE plastic) obtained a result of 81.06 kg/cm. and this did not meet the requirements. paving block compressive strength test requirements according to SNI 03-0691-1996. Conclusion: HDPE plastic can be used to additionally make paving blocks that meet the requirements of SNI 03-0691-1996.

Keywords : HDPE, trash, plastic, paving block

ABSTRAK

Pengelolaan sampah merupakan masalah yang tak kunjung dapat diselesaikan bangsa ini. Berdasarkan data Jenna Jambeck (2018), seorang peneliti sampah dari Universitas Georgia, Indonesia berada di peringkat kedua dunia penghasil sampah plastik yang mencapai sebesar 187,2 juta ton setelah China yang mencapai 262,9 juta ton. Tujuan dilakukannya penelitian ini yaitu untuk memanfaatkan sampah plastik HDPE (High Density Polyethylene) sebagai bahan tambah paving block hexagon, dimana peniliti ingin mengetahui hasil penghematan penggunaan cacahan sampah plastik jenis HDPE terhadap agregat pasir pada pembuatan satu paving block dan untuk mengetahui hasil uji kuat tekan pada Pemanfaatan Sampah Plastik Jenis HDPE (High Density Polyethylene) Sebagai bahan tambahan pembuatan Paving Block Model Hexagon. Penelitian ini merupakan jenis penelitian eksperimen, penelitian eksperimen atau percobaan (experimental research) adalah suatu penelitian dengan melakukan kegiatan percobaan (experiment), yang bertujuan untuk mengetahui gejala atau pengaruh yang timbul, sebagai sebab akibat dari adanya perlakuan tertentu atau eksperimen tersebut (Notoadmodjo, 2014). Pada rancangan penelitian ini akan menggunakan Rancangan Acak Lengkap (RAL) dimana variasi jumlah perbandingan semen pasir 1 : 6 : cacahan plastik 0,00 % sebagai kontrol, 0,45 %, 0,5 %, 0,55 %. Variasi ukuran potongan plastik HDPE yaitu 1 cm dan 1,5 cm pada setiap perbandingan variasi jumlah dengan 3 kali perlakuan pada masing masing variasi jumlah perbandingan dan varisi ukuran potongan plastik HDPE. penambahan cacahan sampah plastik sebanyak 0,45% dengan variasi potongan 1.5 cm mendapatkan hasil tertinggi yaitu 103,99 kg/cm2. Kuat tekanan terendah terdapat pada penggunaan cacahan sampah plastik HDPE 0,55% dan dengan variasi potongan 1 cm dengan nilai sebesar 85,98 kg/cm2 dan kontrol (tanpa ada plastik HDPE) memperoleh hasil 81,06 kg/cm.dan ini tidak memenuhi persyaratan uji kuat tekan paving block menurut SNI 03-0691-1996. Kesimpulan plastik HDPE dapat dimanfaatkan untuk penambahan pembuatan paving block yang memenuhi syarat SNI 03-0691-1996..

Kata kunci : HDPE, sampah, plastik, paving block

INTRODUCTION

A global problem that has not yet been resolved is the volume of waste which continues to increase along with the increase in population. BPS estimates that Indonesia's population in 2015 will reach 260,000 people, so it can be estimated that the amount of waste generated is 130 tons/day. Larger amounts are found in Japan, where the volume of plastic waste reaches 10 million tons per year. This causes contamination and potential environmental contamination to become greater. In

overcoming this problem, various efforts have been made to reduce the amount of waste generated which includes the 3Rs (reduce, reuse, recycle) (Nassos & Avlonas, 2020).

Waste management is a problem that cannot be resolved. Tuti Hendrawati Mintarsih, stated that the amount of Indonesian waste in 2019 will reach 68 million tons, and plastic waste is estimated to reach 9.52 million tons or 14 percent of the total existing waste. A waste researcher from the University of Georgia, Jenna Jambeck (2018), Indonesia is ranked second in the world as a producer of plastic waste, reaching 187.2 million tons after China, which reached 262.9 million tons. Plastic waste in Indonesia is the main source of accumulation of waste weight, especially since plastic is broken down within 1 millennium or around 1000 years. (Istirokhatun & Nugraha, 2019).

The increasing productivity of waste is caused by the increasing population. Based on data from the Central Statistics Agency, Indonesia's population is 237 million and is ranked fourth in the world. Various efforts to control the amount of waste have been carried out by parties who care about the environment as well as waste processing technology based on the 3R (Reduce, Reuse, Recycle) or 5R (Reduce, Reuse, Recycle, recovery and research) principles of the waste diktat (2010).

In Indonesia, the need for plastic continues to increase to an average increase of 200 tons per year (Surono, 2011). The large use of plastic in daily life is one of the main factors in the large amount of plastic waste in Indonesia. Plastic has properties that are difficult to decompose, where plastic takes hundreds of years to decompose completely (Theresa, 2017). It is not wise to burn plastic waste because it will produce gas which will pollute the air and endanger human breathing, and if plastic waste is buried in the ground it will pollute the soil and ground water (Nurhenu, 2014).

Based on data from the Indonesian Plastic Industry Association (Inaples) and the Central Statistics Agency (BPS), plastic waste in Indonesia reaches 64 million tons per year. Meanwhile, based on data calculated by the Lampung Environmental Service, waste production at Sang Bumi Ruwa Jurai reaches 7,000 tons/day with a waste collection rate of 60-70 percent. Of this amount, the plastic waste production of Lampung residents is estimated to be more than 16 million pieces per day. The waste is disposed of at 19 final disposal sites (TPA). Of that number, 8 TPAs use an open dumping system, 10 TPAs are countrol landfills and 1 TPA uses a sanitary landfill system, (Lampost, 2019).

Plastic is a material that we can find in almost every item. According to research, the use of plastic that does not meet the requirements will cause various health problems, because it can trigger cancer and tissue damage in the human body (carcinogenic). Apart from that, plastic is generally difficult to degrade (decompose) by microorganisms. Plastic bag waste can last for years, causing environmental pollution. It is not wise to burn plastic bag waste because it will produce gas which will pollute the air and endanger human breathing, and if plastic bag waste is buried in the ground it will pollute the soil and ground water. For this reason, you need to know about the main types of plastic: codes for Polyethylene Terephthalate (PET), High Density Polyethylene (HDPE), Polyvinyl Chloride (PVC), Low Density Polyethylene (LDPE), Polystyrene (PS), PP (Polypropylene) and countermeasures against plastic bag waste (Health & Environment, n.d.).

Scientific literature has recorded a number of studies on the effect of using plastic waste as a partial replacement for cement in the process of making concrete bricks or paving blocks. Research has been obtained from several previous studies, including; Utilization of Plastic Waste to Make Paving Blocks (Sudarno, 2021), Utilization of PP (Poly Propylene) Type Plastic Waste as an Aggregate Substitute for Concrete Bricks (Paving Blocks) (Kusuma, 2019), Method of making hexagon paving blocks from plastic waste using an injection machine molding (Gusniar, 2018), utilization of plastic bottle waste as additional material for making paving (Utilization & Bottles, 2021).

High Density Polyethylene (HDPE) is also a type of plastic used in making paving blocks. This type of HDPE plastic is marked with the number 2 logo and is often recommended for use including

milky white milk bottles, drinking water gallons, bottle caps, children's toys and so on. (Ariansyah, 2020).

HDPE can be produced with metallocene catalysts, Ziegler-Natta catalysts, and chromium/silica catalysts. HDPE is widely used as a material for making milk bottles, detergent bottles or packaging, trash cans, margarine packaging and water pipes. (Supriyanto et al., 2019)

Concrete bricks (Paving Blocks) are a type of non-structural concrete that can be used for roads, parking lots, sidewalks, parks and other purposes. Paving blocks are made from a mixture of Portland cement type I and water and aggregate as filler. Paving blocks can be colored like the original color or colored in the composition and used for floors both inside and outside buildings. (Burhanuddin et al., 2020).

METHOD

This research is a type of experimental research, experimental research or experiments (experimental research) is research by carrying out experimental activities, which aims to determine the symptoms or effects that arise, as a cause and effect of certain treatments or experiments (Notoadmodjo, 2014).
This research design will use a Completely Randomized Design (CRD) where the variation in the ratio of cement to sand is 1: 6: chopped plastic, 0,0%, 0.45%, 0.5%, 0.55%. The variations in the size of the HDPE plastic pieces were 1 cm and 1.5 cm for each comparison of the number of variations with 3 treatments for each variation in the number of comparisons and variations in the size of the HDPE plastic pieces.
The research location was carried out at the Tanjungkarang Health Polytechnic Workshop, Department of Environmental Sanitation and carried out pressure strength tests and water absorption tests at the Materials and Construction Laboratory, Faculty of Civil Engineering, Bandar Lampung University.
The subject of this research is hexagon paving blocks with the additional material of HDPE (High Density Polyethelene) plastic waste.
The independent/independent variable in this research is plastic waste, HDPE (High Density Polyethelene) type plastic, as an additional material for hexagon model paving blocks, knowing alternatives in overcoming waste problems, especially HDPE (High Density Polyethelene) plastic waste. The dependent variable in this research is the use of HDPE (High Density Polyethelene) plastic waste as an additional material for making hexagon paving blocks, conducting compressive strength and water absorption tests.
The steps for collecting research data are as follows; The method for collecting data in research is observation, after that taking samples, and continuing with laboratory tests. The laboratory test results are tabulated in the form of tables, graphs and data analysis techniques using the Two Way Anova test.
Procedure for making paving blocks:

1. Prepare HDPE plastic with dimensions of 1 cm and 1.5 cm.
2. Then prepare a mixture of cement and sand in a ratio of 1:6 (1 cement : 6 sand).
3. The cement and sand mixture was made into 4 groups and added to each group of HDPE plastic mixture in varying amounts:
   a. 0.00% (Mixture of cement and sand without HDPE plastic),
   b. 0.45 % (0.45/100 X sample weight (6kg) = 0.027 kg HDPE plastic),
   c. 0.5 % (0.5/100 X sample weight (6kg)= 0.03 kg HDPE plastic)
   d. 0.55 %. (0.55/100 X sample weight (6kg) = 0.033 kg HDPE plastic),
4. Then mix the 4 variations and after 20 days

5. Carry out a compressive strength test using a Compression Testing Machine.

RESULTS AND DISCUSSION

RESULTS

The number of shredded HDPE plastics used describes the amount of HDPE plastic waste in a mixture. The composition of HDPE plastic in each Paving Block treatment is 0.00%, 0.00%, 0.45%, 0.5%, 0.55% and uses a variety of HDPE plastic pieces of 1 cm and 1.5 cm with 3 replications. To find out whether there is an influence or not between composition variations and size variations in making Paving Blocks using the addition of chopped HDPE plastic waste, you can see the tabulation and results of the Two Way Anova test below.

Table 1.
Paving Block Compressive Strength Test Results

No	Amount of HDPE (%)	Cutting Size (cm)	Ratio Concrete: Sand	Compressive Strength (Kg/cm2)	Average Compressive Strength (Kg/cm2)
1	0.45	1	1:6	66.48	92.71
	0.45	1	1:6	115.12	
	0.45	1	1:6	96.55	
2	0.5	1	1:6	77.1	87.97
	0.5	1	1:6	107.5	
	0.5	1	1:6	79.33	
3	0.55	1	1:6	77.37	85.98
	0.55	1	1:6	94.34	
	0.55	1	1:6	86.25	
4	0.45	1.5	1:6	91.81	103.99
	0.45	1.5	1:6	134.32	
	0.45	1.5	1:6	85.85	
5	0.5	1.5	1:6	84.61	91.25
	0.5	1.5	1:6	109.72	
	0.5	1.5	1:6	79.43	
6	0.55	1.5	1:6	75.56	89.33
	0.55	1.5	1:6	104.23	
	0.55	1.5	1:6	88.2	
	0	0	1:6	88,52	
7	0	0	1:6	69,06	81,6
	0	0	1:6	85,61	

According to table 4.1, it can be explained that adding 0.45% HDPE plastic waste with a cut variation of 1.5 cm got the highest result, namely 103.99 kg/cm2. The lowest pressure strength was

found when using chopped 0.55% HDPE plastic waste and with a variation in pieces of 1 cm with a value of 85.98 kg/cm2. With the above results, the paving block with the highest compressive strength, namely 103.99 kg/cm2, became a grade D paving block and the treatment of adding 0.55% plastic composition which had a value of 85.98 kg/cm2 and did not comply with paving block standards. In the control of this research (no addition of HDPE plastic waste or 0.00%), the compressive strength test results were 81.06 kg/cm2, this does not meet the compressive strength requirements for paving blocks for the lowest grade (grade D). According to (Hadi, 2018) "The maximum compressive strength value is due to the fact that the plastic pieces do not overlap with other plastic pieces so that they do not reduce the adhesion of the sand and cement." For the research variation as a control (without the addition of HDPE plastic) it was not included in the subsequent statistical tests. because the results of the compressive test strength are below the standard according to SNI 03-0691-1996 concerning paving block quality standards.

Table 2.
Normality Test Results

One-Sample Kolmogorov-Smirnov Test		
		Unstandardized Residual
N		18
Normal Parameters[a,b]	Mean	.0000000
	Std. Deviation	16.37680202
Most Extreme Differences	Absolute	.203
	Positive	.203
	Negative	-.123
Test Statistic		.203
Asymp. Sig. (2-tailed)		.058[c]

Based on the normality test, it is known that the significance value is 0.058 > 0.05, so it can be concluded that the residuals are normally distributed

Table 3.
Two way anova test results

Tests of Between-Subjects Effects

Dependent Variable: Kuat Uji Tekan

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	3735.612[a]	5	747.122	7.894	.002
Intercept	151941.956	1	151941.956	1605.408	.000
JumlahHDPE	3399.279	2	1699.639	17.958	.000
UkuranHDPE	160.145	1	160.145	1.692	.218
JumlahHDPE * UkuranHDPE	176.188	2	88.094	.931	.421
Error	1135.726	12	94.644		
Total	156813.294	18			
Corrected Total	4871.338	17			

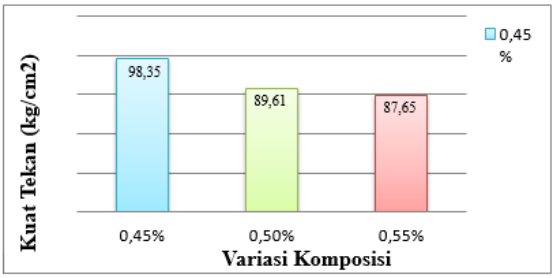
a. R Squared = .767 (Adjusted R Squared = .670)

For the amount of HDPE used, the p-value = 0.000 < 0.05, so it can be concluded that there is a difference in the compressive strength test results of paving blocks based on the percentage of HDPE used. And for HDPE size, the p-value = 0.218 > 0.05 is obtained, so it can be concluded that there is no difference in the compressive strength test results of paving blocks based on the HDPE size used. The p-value obtained = 0.421 > 0.05, so it can be concluded that there is no difference/interaction between the amount of HDPE and the size of HDPE in the compressive strength test results of paving blocks.

Table 4.
Tukey Test Results for Composition

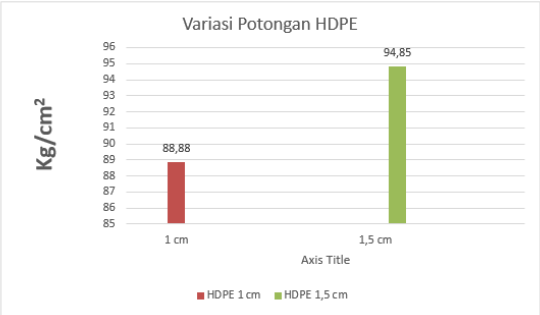
	COMPOSITION PET		
	Sig		
	0,45	**0,50**	**0,55**
0,45	**-**	**0,180**	**0,072**
0,50	**0,180**	**-**	**0,868**
0,55	**0,072**	**0,868**	**-**

From table 4.4 above, differences in HDPE plastic composition variations based on the compressive strength test can be seen from the Tukey test results. Seen in table 4.4, the results of the analysis show differences in PET plastic variations of 0.45%, 0.50%, and 0.55% (p-value = 0.00, 0.447, and 0.002, where for the p-value results for plastic with an amount of HDPE of 0, 45% and HDPE 0.55% lower than 0.005.



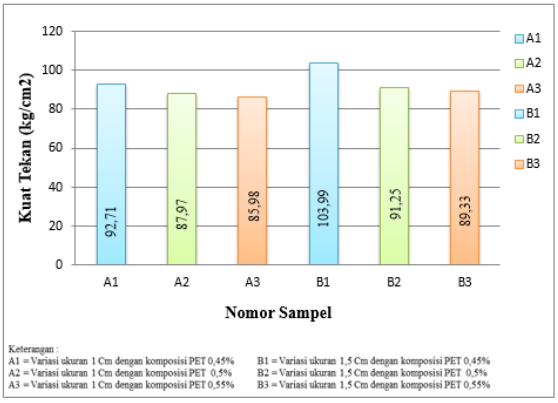
Graph 1 Effect of Composition on Compressive Strength Test

From the graph above, it can be seen that the influence of composition on the compressive strength test. With the addition of each composition variation, the compressive strength decreases. Where with a composition of 0.45% the results are 98.35 kg/cm2. Then there was a decrease at the 0.50% composition amounting to 8.74 kg/cm2, and at the 0.55% composition the results were 87.65 kg/cm2.



Graph 2 Effect of Size Variations on Compressive Strength Tests

From the graph above, it can be seen that the influence of size variations on the compressive strength test. As the size variation increases, the compressive strength decreases. Where with a variation in size of 1 cm the results are 88.88 kg/cm2. Then there was a decrease in the 1.5 cm size variation amounting to 94.85 kg/cm2.



Graph 3 Average Number of Compressive Strength Tests

From the graph above, it can be seen that the average compressive strength test experienced a decrease in compressive strength from sample numbers A1 to A3, as well as samples B1 to B3 also experienced a decrease in compressive strength, although the decrease that occurred was not too significant.

DISCUSSION

This research aims to determine the effect on making paving blocks by using the addition of shredded HDPE plastic waste composition of 0.00%, 0.45%, 0.5%, 0.55% and variations in the size of 1 cm and 1.5 cm plastic shreds on the strength test. Press on paving blocks. In this research, chopped HDPE (High Density Polyethylene) plastic was used. In the chopping process, plastic waste is cleaned first and then cut into pieces of 1 cm and 1.5 cm using scissors. In the process of making paving blocks there are 2 treatments with 3 repetitions. Mixing sand concrete and chopped plastic using a mixer and printing using a hydraulic press machine. The paving block samples were left for 10 days. After that, the compressive strength test is carried out using a Compression Testing Machine by applying the load gradually until the test object is destroyed. The research location was carried out at the Tanjung Karang Health Polytechnic Workshop, Department of Environmental Sanitation and carried out compressive strength tests at the Materials and Construction Laboratory, Faculty of Civil Engineering, University of Lampung.

The effect of size on the compressive strength test based on table 4.3 shows a p-value = 0.000 < 0.05, so it can be concluded that there is a difference in the compressive strength test results of paving blocks based on the number of chopped HDPE used. The effect of HDPE chopped size on the compressive strength test was obtained by a p-value = 0.218 > 0.05, so it can be concluded that there is no difference in the compressive strength test results of paving blocks based on the HDPE chopped size. The influence of the size and number of HDPE pieces used on the compressive strength test obtained a p-value = 0.421 > 0.05, so it can be concluded that there is no difference/interaction between the size and number of HDPE pieces in the results of the paving block compressive strength test.

The use of shredded HDPE plastic waste as an additional mixture in making paving blocks produces maximum compressive strength at a composition of 0.45% with a variation in chopped plastic waste of 1 cm. The quality of paving in terms of compressive strength falls into quality D, used for gardens and other uses. From the results of research that has been carried out, the maximum strength of paving blocks in this study is in treatment B1 with a composition of 0.45% HDPE plastic addition and a variation of 1.5 cm HDPE plastic pieces, namely 103.99 kg/cm2 and the lowest compressive strength value. found in treatment A3 with a value of 85.98 kg/cm2 which occurred when using chopped 0.55% PET plastic waste and with a cutting variation of 1 cm. The results show that each addition of shredded HDPE plastic waste causes a decrease in the pressure on the paving block. With the above results, paving blocks with the highest pressure strength, namely 103.99 kg/cm2, become grade D paving blocks which are intended for parks and other uses. Meanwhile, paving blocks with A3 treatment which have a value of 85.98 kg/cm2 have a grade below D, in accordance with SNI03-0691-1996 concerning paving block quality standards.

From the results of the two way ANOVA test with the SPSS program, the addition of HDPE composition variations had an influence on the compressive strength of the paving blocks, but variations in the size of the HDPE plastic pieces had no effect on the compressive strength test. However, if you look at the test results in the laboratory, the resulting compressive strength varies with a maximum average compressive strength of 103.99 kg/cm2 and the lowest compressive strength, namely 85.98 kg/cm2.

The weakness of this research is that it does not have a control sample or a sample with the addition of 0% plastic composition. It is possible that several factors also greatly influenced the results, starting from the uneven mixing process in each sample, the drying process which was not the same in each sample, the water content in each sample may not be the same between sample A1 and the other samples.

LIMITATION OF THE STUDY

Utilization of plastic waste as an addition to making paving blocks to reduce environmental pollution

CONCLUSIONS AND SUGGESTIONS

CONCLUSIONS

From the results of research that has been carried out, the maximum strength of paving blocks in this study is at sample number B1 with a composition of 0.45% HDPE plastic addition and a variation of 1.5 cm PET plastic pieces, namely 103.99 kg/cm2 and a compressive strength value

The lowest was in sample number A3 with a value of 85.98 kg/cm2 which occurred when using a chopped composition of 0.55% PET plastic waste and with a cut variation of 1 cm.
Procedure for making paving blocks:

1. Prepare HDPE plastic with dimensions of 1 cm and 1.5 cm.
2. Then prepare a mixture of cement and sand in a ratio of 1:6 (1 cement : 6 sand).
3. The cement and sand mixture was made into 4 groups and added to each group of HDPE plastic mixture in varying amounts:
   e. 0.00% (Mixture of cement and sand without HDPE plastic),
   f. 0.45 % (0.45/100 X sample weight (6kg) = 0.027 kg HDPE plastic),
   g. 0.5 % (0.5/100 X sample weight (6kg)= 0.03 kg HDPE plastic)
   h. 0.55 %. (0.55/100 X sample weight (6kg) = 0.033 kg HDPE plastic),
4. Then mix the 4 variations and after 20 days
5. Carry out a compressive strength test using a Compression Testing Machine.

With the above results, the paving block has the highest pressure strength, namely 103.99 kg/cm2 with a composition of 0.45% chopped HDPE plastic waste and a variation in the size of the pieces of 1.5 cm. In accordance with SNI03-0691-1996 regarding quality standards for paving blocks, the paving blocks in sample B1 have grade D which is intended for parks and other uses, and can reduce piles of plastic waste with large covers. Making 1 paving block requires 0.027 kg, while using 1 m2 of paving blocks requires 25 paving blocks, so in 1 m2 of land area 0.675 kg of HDPE plastic waste is used.

SUGGESTIONS

With so much HDPE plastic waste being used while human resources for separating and collecting plastic waste are inadequate, researchers also recommend finding out more about plastic, because the position of plastic horizontally or vertically greatly influences the strength of paving blocks that use chopped waste. plastic.

A review is needed regarding manufacturing with a larger volume of plastic waste so that it can absorb more plastic waste and get a better grade from this research.

Acknowledgment
Technical assistance and advice can be described at the end of the text. Then the names of individuals that are included in this section, the author is responsible for the written consent of every person who communicates personally or recognized by the individual in the text.

ETHICAL CONSIDERATIONS

Data was obtained from the results of previous research and the results of field research as well as statutory and other regulations scientific reference. As a rule of research ethics, researchers maintain research confidentiality. Thus, this study did not require ethical approval to conduct it put information into the public domain.

Conflict of Interest Statement

The high burden of plastic waste in the environment is only carried out by the process of transporting it from the place where the HDPE type plastic waste is generated to the final disposal site, such as moving the problem from one place to another, so that in the long term it can cause an even greater level of pollution in the environment caused by plastic waste in particular. HDPE

plastic type. Therefore, researchers read from several journals (Sudarno, 2021), ((Kusuma, at all 2019), (Gusniar, et all 2018), (Ariansyah, 2020), (Supriyanto et al., 2019) that the use of plastic waste types PP has been widely carried out, while for HDPE there have been several studies as an additional material for making paving blocks, only the previous results of the compressive strength test of paving blocks do not meet the requirements according to SNI 03-0691 concerning the physical manufacture of paving blocks.

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