Journal of Infrastructural in Civil Engineering (JICE)
Vol. 07, No. 01, January 2026, pp: 102-109
available online at: https://publikasi.teknokrat.ac.id/index.php/jice

INNOVATIVE ECO-PAVING BLOCKS FOR SUSTAINABLE DEVELOPMENT OF THE POLINELA RESERVOIR

Vera Chania Putri [1*], Sekar Dwi Rizki [1] and Arlina Phelia[1]

[1]*Program Studi Teknik Sumberdaya Lahan dan Lingkungan, Jurusan Teknik, Politeknik Negeri Lampung, Bandar lampung, Indonesia*

*E-mail: verachaniaputri@polinela.ac.id

Received: 10 December 2025 **Accepted**: 1 January 2026 **Published**: 4 January 2026

Abstract

Recycling plastic waste, though a common practice, often results in low-value residual materials. Therefore, further efforts are required to manage plastic waste more effectively. One potential alternative is the production of eco-paving blocks, which are an innovative form of paving blocks manufactured using polyethylene terephthalate (PET) plastic bottle waste as a partial mixture. This eco-paving block innovation is expected to support jogging track facilities as part of the environmentally friendly development plan for the Polinela retention pond (Embung Polinela). This study aims to evaluate the mechanical performance of eco-paving blocks based on compressive strength and water absorption tests. In this study, paving blocks were produced by incorporating PET waste at proportions of 2%, 4%, 6%, 8%, and 10% by weight of the paving block. The results indicate that the maximum compressive strength was achieved with a 2% PET addition, resulting in a 17.39% increase in compressive strength and a 20.76% increase in water absorption compared to paving blocks without PET incorporation.

Keywords: *Eco-Paving Block, Polyethylene Terephthalate, Compressive Strength, Water Absorption*

To cite this article:
Vera Chania Putri et al., (2026). Innovative Eco-Paving Blocks for Sustainable Development of the Polinela Reservoir. *Jurnal of Infrastructural in Civil Engineering*. Vol (07), No. 01, pp 102-109

INTRODUCTION

One of the planned development projects at Lampung State Polytechnic (POLINELA) is the construction of the Polinela Retention Pond. Considering the important role of higher education institutions in promoting sustainable development, it is essential for Polinela to begin adopting environmentally friendly practices across the campus.

One of the environmental issues affecting the Polinela campus is the accumulation of plastic waste. Various efforts have been undertaken to manage plastic waste, including recycling. However, the recycling process often still generates residual waste that no longer has economic value. Therefore, further efforts are required to effectively manage plastic waste. One feasible alternative is the production of paving blocks incorporating plastic bottle packaging waste as an additive, commonly referred to as eco-paving blocks. Eco-paving blocks are construction products with characteristics similar to conventional paving blocks; however, they are manufactured by utilizing a mixture of plastic waste as one of their constituent materials[1].

Paving blocks are widely used as surface covering materials for pedestrian pathways, parking areas, parks, and public open spaces [2]. Paving blocks are defined as building materials composed of a mixture of Portland cement or other hydraulic binders, water, and aggregates, with or without additional materials that do not reduce the quality of the paving blocks. Paving blocks are classified into several quality grades based on their compressive strength and water absorption values, which determine their suitability for various applications. The classification of paving blocks is presented in Table 1 [3].

Table 1. Classification of Paving Blocks

Quality	Utility
A	Road
B	Parking Lot
C	Pedestrian
D	Parks and other Uses

Sourcer: National Standarization Body SNI 03-0691-1996

As a concrete-based material, the performance of paving blocks is strongly influenced by the characteristics of their constituent materials, particularly cement and aggregates. Portland cement serves as the primary binding material, while aggregates constitute the largest volume in the mixture and significantly affect the compressive strength and density of the material [4].

Eco-paving blocks are expected to reduce the consumption of natural resources, minimize waste generation, and support environmentally friendly construction practices that promote environmental sustainability [5]. Furthermore, eco-paving blocks are anticipated to serve as an innovative solution applicable to various development projects utilizing paving block construction, including jogging track areas.

Innovations in the production of paving blocks using plastic waste have been widely explored. One type of plastic waste commonly utilized is PET plastic. PET plastic is typically used in the manufacture of packaging bottles. Polyethylene terephthalate (PET) exhibits high mechanical strength, transparency, non-toxicity, and does not affect taste, while also having very low permeability to carbon dioxide. In addition, PET demonstrates excellent tensile and impact strength, along with good chemical resistance, clarity, processability, colorability, and thermal stability[6]. The residual products from PET plastic waste processing are shown in Figure 1.

Figure 1. PET Waste

Several studies on the utilization of plastic waste have reported varying results, indicating changes in material properties after the incorporation of plastic additives. For example, plastic waste types such as PET, LDPE, and PP have been used as additional materials in paving block mixtures. Test results showed that the maximum compressive strength was achieved with the addition of the three types of plastic waste, resulting in a 17% increase compared to conventional paving blocks, along with a 14% increase in water absorption values relative to normal paving blocks. These values satisfy the requirements for Class B paving blocks, indicating their suitability for parking areas[7].

Other studies utilizing plastic waste as an additive in paving block production have also demonstrated significant improvements in the tensile strength of paving blocks [8]. In addition, the effects of incorporating plastic bottle waste and variations in fly ash content in paving block mixtures have been investigated by assuming a specimen weight of 2.5 kg and applying variations of 10%, 20%, 30%, 40%, and 50% of the cement weight. The results indicated that the paving blocks met Class D quality standards, which are intended for use in urban parks [9].

Further studies on the utilization of plastic waste in paving blocks have shown that paving blocks made with plastic waste exhibit better quality than conventional paving blocks. Moreover, from an economic perspective, plastic waste–based paving blocks are considered more cost-efficient than normal paving blocks [10].

Based on the findings of previous studies, although the utilization of plastic waste as an additive in paving blocks has demonstrated potential improvements in mechanical performance and cost efficiency, variations in plastic types, mixture proportions, and manufacturing methods still result in significant differences in quality. Therefore, further investigation is required to specifically evaluate the effects of polyethylene terephthalate (PET) plastic bottle waste on the physical properties of paving blocks, particularly for targeted applications.

Based on that background, this research will discuss how the physical properties of eco-paving blocks made from a mixture of PET plastic bottle waste can meet the quality standard criteria for soil cover construction for jogging tracks according to the SNI Concrete Paving Block. This study aims to determine the strength of eco-paving blocks as assessed by the compressive strength test and the water absorption capacity of the paving blocks. Test samples were made with different concentrations of mixed plastic waste materials. The final result of this research is to determine the optimum concentration of plastic waste so that it can be used to produce paving blocks for jogging track areas.

RESEARCH METHODOLOGY

This research was conducted in the Soil and Water Engineering (TTA) laboratory of Politeknik Negeri Lampung for 6 (six) months, from April to September 2024. The materials used in this research include Cement (PCC), fine aggregate (sand), coarse aggregate (screening stone), plastic waste, and water. Meanwhile, the equipment required includes a set of paving block mold-making tools, a compressive strength machine (CTM), and a laboratory oven used for testing the compressive strength and absorption of paving blocks. The eco-paving block samples were made in the size of 21 cm x 10.5 cm x 6 cm. The cement: aggregate mix ratio was 1 pc: 4 ps, and plastic fibers were added with concentrations of 0%, 2%, 4%, 6%, 8%, and 10% of the paving block's cement volume. Each type of paving block mixture is made in 3 (three) sample units. The test sample is presented in Table 2.

The amount of PET plastic waste mixture to be used is determined by multiplying the percentage of plastic waste content defined by the assumed weight of the fabricated paving block. From the weighing results of the existing paving blocks, it is known that one paving block weighs 2600 grams. The paving blocks are cured using the curing method for 28 days,

after which tests on the absorption, and compressive strength of the concrete is conducted according to the SNI 03-0691-1996 standards, see Table 3 [3]. The amount of plastic waste in the mixture can be seen in Table 4.

Table 2. Variation of Test Mixtures for Paving Blocks

Concentration of PET	The number of test samples
0%	6
2%	6
4%	6
6%	6
8%	6
10%	6
Total of sample tests	36

Table 2. The physical properties

Quality	Compressive Strength (Mpa)		Water Absorption Max
	Average	Min.	Average (%)
A	40	35	3
B	20	17,0	6
C	15	12,5	8
D	10	8,5	10

Sourcer: National Standarization Body SNI 03-0691-1996

Table 3. Mix Modification for Paving Block Testing

No	Concentration of PET (%)	Weight (gr)
1	0	0
2	2	52
3	4	104
4	6	156
5	8	208
6	10	260

The compressive strength test of paving blocks with a mixture of PET plastic waste is conducted to determine the compressive strength value of the paving blocks that have reached 28 days of age. The paving blocks that are ready for the compressive strength test, according to SNI 03-0691-1996, are first cut into cube shapes. The size of the paving blocks used as samples for the compressive strength test is 6 x 6 x 6 cm. The compressive strength of the paving blocks is obtained using the following formula:

$$f'c = \frac{P}{A} \quad (1)$$

Where:

f'c = compressive streng of paving blocks

P = maximum compressive load (N or kN)

A = area of the paving block (mm^2)

The water absorption test of paving blocks is conducted to determine the extent of water absorption through their pores. The water absorption test of paving blocks is undertaken by comparing the weight of the paving blocks in dry and wet conditions. The dry condition refers to the condition of the test specimen that has been oven-dried at ± 100° for 24 hours, while the damp condition refers to the condition of the test specimen after being soaked for 24 hours. The water absorption value of the paving blocks according to SNI 03-0691-1996 is calculated as follows[3]:

$$\text{Water absorption} = \left\{\frac{A-B}{B} X\ 100\%\right\} \quad (2)$$

Where:

A = weight of wet paving blocks (gr)

B = dry paving block weight (gr)

RESULTS AND DISCUSSION

Compressive Strength Test

The results of the compressive strength test of paving blocks with a mixture of PET plastic waste with three repetitions showed varying but insignificant results (Table 5). In the control treatment, the average compressive strength value of the paving blocks reached the highest result of 12.54 MPa with a PET waste content of 2%, while the lowest compressive strength value was 4,6 MPa with a PET waste content of 10% (Figure 2).

Table 4. Results of the Compressive Strength Test of Paving Blocks

Composition of PET	Sample	Weight (g)	Age (day)	Compressive Strength (Mpa)	Average of Compressive Strength (Mpa)
0%	$P_0$1	448,4	28	10,90	10,36
	$P_0$2	424,2	28	9,81	
	$P_0$3	445,3	28	10,36	
2%	$P_1$1	441,6	28	11,45	12,54
	$P_1$2	441,9	28	12,81	
	$P_1$3	434,2	28	13,35	
4%	$P_2$1	476,8	28	11,17	11,51
	$P_2$2	456,9	28	11,45	
	$P_2$3	434,9	28	11,90	
6%	$P_3$1	400,3	28	6,27	6,70
	$P_3$2	407,6	28	7,09	
	$P_3$3	417	28	6,72	
8%	$P_4$1	361,8	28	4,91	4,85
	$P_4$2	377,6	28	4,91	
	$P_4$3	405,5	28	4,72	
10%	$P_5$1	418,5	28	4,63	4,60

$P_5$2	397,2	28	4,36
$P_5$3	355,4	28	4,81

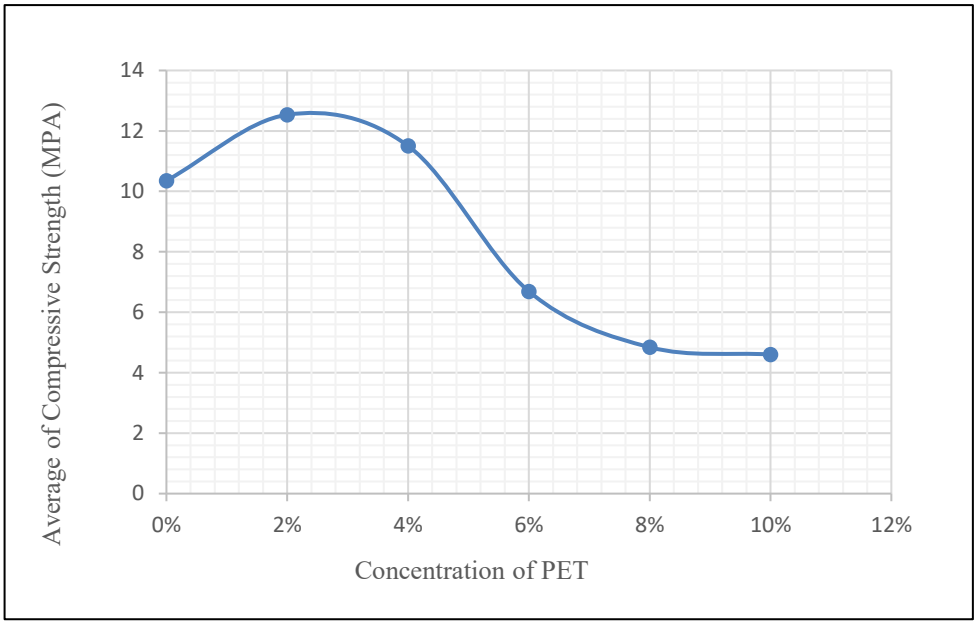

Figure 2. Graph of the compressive strength of paving blocks

Based on the compressive strength test results and the comparison of mixture ratios, it shows that adding 2% PET waste can increase the compressive strength of the paving block by 17.39%. This means that the addition of PET can improve the quality of the paving block. It was previously known that the compressive strength test results of the paving block without PET mixture fell into quality D, while by adding 2% PET waste into the paving block mixture, the quality of the paving block can reach quality C.

Water Absorption Test

Table 6 presents the results of the water absorption for the paving blocks. The absorption test results show that the average lowest absorption rate, which is 6.67%, is found in the paving block with a 2% mixture percentage (P1). In comparison, the paving block without PET mixture (P0) has an average absorption test result of 8.42%. However, the paving blocks with the addition of PET at 4%, 6%, 8%, and 10% show an increase in water absorption. The water absorption test graph can be seen in Figure 3.

Table 5. Results of The Water Absorption Test of Paving Blocks

Composition of PET	Sample	Wet Sample Weight (g)	Dry Sample Weight (g)	Precentage of Absorption Test (%)	Average Precentage of Absorption Test (%)
0%	P01	2687,4	2493	7,80	8,42
	P02	2680	2469,3	8,53	
	P03	2640,8	2424,5	8,92	
2%	P11	2701,2	2522,8	7,07	6,67
	P12	2706,2	2540,6	6,52	

Composition of PET	Sample	Wet Sample Weight (g)	Dry Sample Weight (g)	Precentage of Absorption Test (%)	Average Precentage of Absorption Test (%)
	P13	2696,9	2534,2	6,42	
	P21	2625,7	2448,8	7,22	
4%	P22	2627,6	2457,3	6,93	6,95
	P23	2655,5	2488,8	6,70	
	P31	2498,6	2304,9	8,40	
6%	P32	2492,5	2283,3	9,16	8,83
	P33	2509,5	2303,7	8,93	
	P41	2458,4	2227,6	10,36	
8%	P42	2463,1	2246,6	9,64	9,12
	P43	2442,4	2274,9	7,36	
	P51	2386,2	2132,6	11,89	
10%	P52	2325,9	2137,7	8,80	9,80
	P53	2261,3	2080,3	8,70	

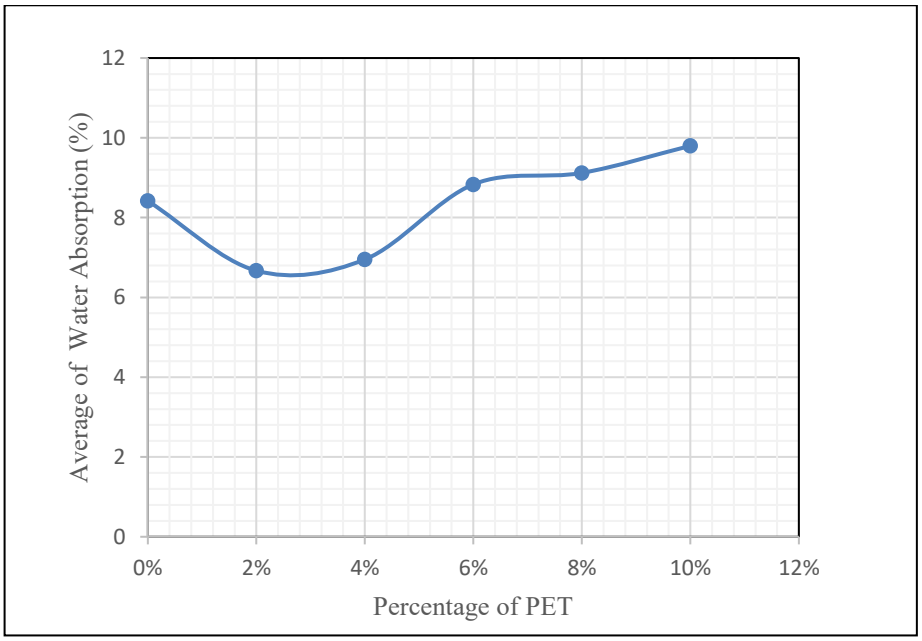

Figure 3. Graph of water absorption capacity of paving blocks

From the graph, it is known that there is a decrease in water absorption in the paving block with an addition of 2% PET waste mixture. This decrease in water absorption occurs by 20.76% from the water absorption produced by the paving block without adding PET waste mixture. The increase in water absorption in the paving block with a 4% - 10% mixture aligns with the compressive strength test results of the paving block. This may be caused by the lack of density in the paving block with that mixture, making the paving block structure more hollow and lighter. The voids in the paving block create more empty spaces, thereby increasing water absorption. Lighter and less dense materials tend to have higher water absorption because there is more space for water to enter.

CONCLUSION

From the results of the compressive strength and water absorption tests, the eco-paving block reaches its optimum value with the addition of a 2% plastic waste mixture. The compressive strength value obtained is 12.54, and the water absorption test result is 6.67. The test results for compressive strength and water absorption show that adding 2% PET waste can increase the compressive strength of the paving block by 17.39% and reduce the water absorption by 20.76% compared to paving blocks without PET mixture. According to SNI 03-0691-1996, the compressive strength and water absorption test results for the eco paving block indicate that the eco paving block with 2% PET mixture falls into the C quality paving block category, where paving blocks of this quality can be used for jogging track paths.

AKNOWLEDGEMENT

The author would like to thank the Lampung State Polytechnic as The Institution the funded this research through the Lampung State Polytechnic DIPA fund.

REFERENCES

[1] A. S. Pradipta, A. F. Jilan, and M. Rahmi, "Pemanfaatan sampah plastik menjadi eco paving block di Desa Karyawangi," *Madaniya*, vol. 5, no. 3, pp. 1051–1057.

[2] A. H. Andriati, "Penelitian pemanfaatan semen abu terbang untuk bahan komponen bangunan," *Jurnal Litbang*, vol. 11, no. 1–2, 1990.

[3] Badan Standarisasi Nasional, *SNI 03-0691-1996: Bata Beton (Paving Block)*. Jakarta, Indonesia, 1996.

[4] K. Tjokrodimulyo, *Pengetahuan Dasar Teknologi Beton dan Ilmu Teknik*. Yogyakarta, Indonesia: Universitas Gadjah Mada, 1996.

[5] I. Aldo, R. Bagas, I. Widiasanti, and E. Septiandini, "Limbah sebagai bahan pembuatan paving block," 2024, vol. 8, pp. 1176–1182.

[6] S. Arafah *et al*., "Kajian paving block campuran limbah plastik PET terhadap kuat tekan dengan standar SNI 03-0691-1996," *Malikussaleh Journal of Mechanical Science and Technology*, vol. 7, no. 2, p. 115, 2023, doi: 10.29103/mjmst.v7i2.13657.

[7] R. N. R. Dya Ayu, Sahara, and A. Wahyuni, "Pengaruh penambahan limbah plastik jenis polyethylene terephthalate, low density polyethylene dan polypropylene terhadap nilai kuat tekan dan daya serap air paving block," *Jurnal Fisika dan Terapannya*, vol. 8, pp. 32–39, 2021, doi: 10.24252/jft.v8i2.23442.

[8] L. S. Hadi, "Pemanfaatan limbah plastik polyethylene terephthalate (PET) untuk bahan tambahan pembuatan paving block," *Jurnal Universitas Mataram*, vol. 1, no. 1, p. 4, 2018.

[9] D. Anita and F. Subaidillah, "Pelatihan tentang pemanfaatan limbah botol plastik sebagai bahan campuran paving block ramah lingkungan," *Jurnal Abdiraja*, vol. 2, no. 2, pp. 1–5, 2019.

[10] S. Sudarno, "Pemanfaatan limbah plastik untuk pembuatan paving block," *Jurnal Teknik Sipil Terapan*, vol. 3, no. 2, p. 101, 2021, doi: 10.47600/jtst.v3i2.290.