International Journal of Engineering Technology and Management Sciences
Website: ijetms.in Issue: 3 Volume No.9 May - June – 2025
DOI:10.46647/ijetms.2025.v09i03.023 ISSN: 2581-4621

# PERFORMANCE ANALYSIS OF PAVER BLOCKS MADE WITH RECYCLED PLASTIC AND FINE AGGREGATES

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**Abstract**
Nowadays in India, usage of paver blocks has become important as it is durable and if they are interlocked perfectly, they can sustain the huge vehicular load for about 20-25 years. India generates 9.46 million tons of plastic waste annually in which nearly 40% of the waste remains uncollected. This waste piles up in landfills, rivers, drains, further flows into sea, leaches into soil and ground water. The generation of rubber waste which is second largest waste generated in India and directly dumped into the landfill. To address this issue, concrete paver block was designed using plastic, M sand with the partial replacement of crushed stones. variations were made to the ratio 1:1,1:2 and 1:3. Paver blocks were evaluated for their compressive strength and water absorption at different ratios. Ratio 1:2 gives the optimum result by enhancing compressive strength by 54.4MPA and decreasing water absorption by 1.025%. This research has produced eco-friendly paver blocks by removing cement and replacing it with plastic waste, which will benefit the environment, Economical, reduce carbon foot print and be suitable for low-traffic areas, all of which contribute to sustainable development.
**Keywords:** Paver Block, Plastic Waste, Compressive strength, Water absorption, M-Sand.

## 1. INTRODUCTION
Annually the world generates 2.01 billion tons of solid waste, in which 33% of that is not managed in a safe manner. The waste generated worldwide per person per day averages about 0.74 kilogram but ranges widely, from 0.11 to 4.54 kilograms. According to the recent study the production of the waste can grow up to 3.40 billion tones by the year 2050(Avinash, G. B et.al 2019), more than double the population growth over the same period.
Plastic and its waste have significant impacts on the environment and climate. Plastic has become a serious challenge for the natural world. Plastic waste is not being handled in a suitable manner as the world is not being serious and showing interests towards it. From the research the economic growth of the world, the speed of urbanization affects the consumption and waste generation at the same rate (Meghana B S et.al 2021, Tulashie, S. K et.al 2020).
To overcome this problem wastes is utilized in different proportions in interlocking paver block to reduce harmful, hazardous and adverse effect on the environment, ecosystem and human health (Giri J P et.al 2024, Shanmugavalli, B et.al 2017).
Similarly, the rising production of cement in general and the release of carbon dioxide ($CO_2$) in particular pose another serious threat to the environment that environmentalists are concerned about. To safeguard the environment, it is necessary to minimize cement use, since cement production creates an equivalent amount of $CO_2$ (Ghuge J et.al 2019).
To lower the carbon footprint and related health issues, it is possible to substitute PW for cement as a binding medium; this will also aid in the elimination of PW. Several research and reviews on the usage of PW in the construction sector have been studied in recent years, and the findings have been promising.
The main objective of the experimental program was to obtain the best replacement level of plastic, M-sand paver blocks instead of concrete paver blocks without affecting the strength properties such

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as compression strength, water absorption, split tensile and heat resistance. The experimental work is carried out on different ratios of plastic and M-sand in the paver block to find the effect of these materials on various mechanical properties (Uvarajan T et.al 2021, Gungat, L et.al 2021).

## 2. MATERIALS AND METHODOLOGY

Materials Plastic HDPE is used having density of 0.94-0.96 g/mm$^2$ and melting point of 120-140°C. Fine Aggregates M-sand having 4.75mm is used as fine aggregates. The test made on fine aggregates are Specific gravity – 2.64% and Water absorption test – 0.32%.

The process begins with the collection of plastic waste, which is carefully separated from other types of waste. If the plastic waste is wet or contains moisture, it must be thoroughly dried before use, as only dry plastic is suitable for the next steps. Once dried, the plastic waste is crushed into small particles using a crushing machine and further processed into fine-sized particles. The plastic is then combined with M sand in a ratio of 1:1,1:2 and 1:3. These are the ratio which represents the plastic, M-sand respectively. The fine plastic particles are then heated in a furnace (commonly referred to as a Bhatti) until they melt into a liquid form. This mixture is then thoroughly blended to form a uniform mix. The final mix is poured into molds and allowed to set. After setting, the mold is left to dry, and the product is demolded the next day. Paver blocks of Size 200mm x 60mm x 60mm was obtained as shown in Fig1.

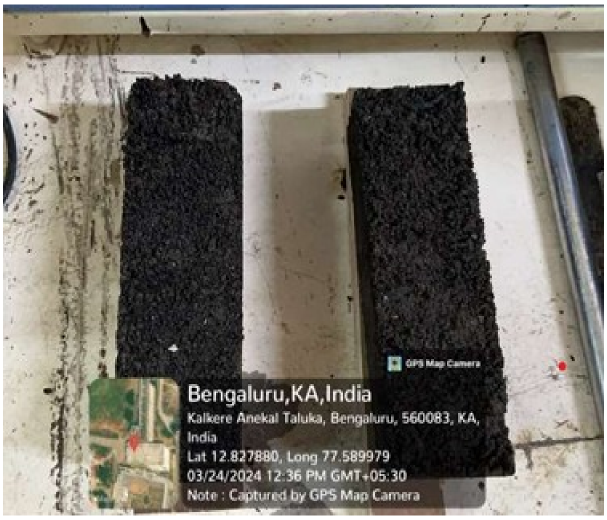


**Fig.1. Paver Block after demolding**

## 3 RESULTS AND DISCUSSIONS

### 3.1Compression Strength Test

In this test, according to BS 5628 standards the cubical block specimen is placed in the compression strength testing machine. After placing it we will apply the load on the brick without any shock. The load will be increased at a rate of 140kg/cm$^2$/min continuously till the specimen's resistance to increasing load breaks down and it cannot withstand any greater load further. Recording the maximum load applied to the brick specimen and the appearance and type of failure is also noted along with any unusual features. Table1 shows the comparative study of compressive strength of paver block for different plastic sand ratio. Compression test on paver block conduced is shown in Fig2.

In the test results, the 1:2 mix ratio proved to be the most optimal, yielding the highest compressive strength among the three. This is because it offers a well-balanced proportion of Plastic to aggregates, ensuring adequate bonding, proper compaction, and good workability. On the other hand, the 1:3 mix is too lean, containing insufficient plastic to effectively bind the aggregates, which results in weaker paver blocks with lower compressive strength. Conversely, the 1:1 mix, although rich in plastic, may suffer from issues such as shrinkage, reduced workability, and

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difficulties in compaction, which can negatively impact the overall strength of the block despite the higher plastic content.

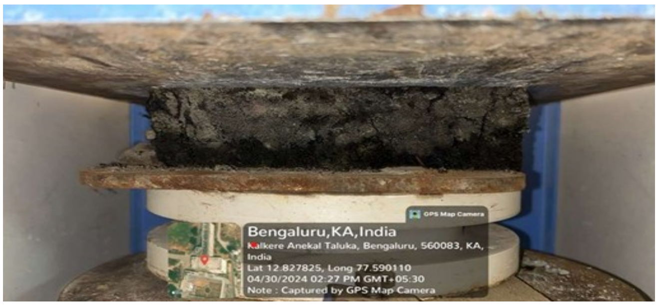


**Fig.2. Compression test on paver block**

**Table.1. compressive strength of paver block for different plastic, sand ratio.**

| Paver Block | Specimen | Obtained Compressive Strength (N/mm$^2$) |
|---|---|---|
| 1.1 Ratio | 1 | 32.6 |
| | 2 | 33.1 |
| | 3 | 32.9 |
| 1.2 Ratio | 1 | 54.4 |
| | 2 | 54.2 |
| | 3 | 54 |
| 1.3 Ratio | 1 | 20.28 |
| | 2 | 20.24 |
| | 3 | 21.1 |

**3.2 Water Absorption Test**

In this test at first the blocks are weighed in total dry conditions. Then they will be allowed to be dipped in fresh water for about 24 hours in a container. The blocks are taken out of the water after 24 hours and are wiped with a cloth. The wet block is weighed using a weighing machine. For the calculation of water absorption, the difference between wet block and dry block is done. The difference is the amount of water absorbed by the block. After that the percentage of water absorption is calculated using the data. Table2 shows the comparative study of water absorption test conducted on paver block for different plastic sand ratio.

The variation in water absorption across different paver block mix ratios is primarily due to differences in porosity and density caused by the plastic-to-fin aggregate ratio. The 1:2 and 1:1 mixes exhibit lower water absorption because the higher plastic content leads to a denser, less porous structure that resists water penetration. In contrast, the 1:3 mix has significantly higher water absorption due to its lean composition, which results in poor bonding, more voids, and increased porosity. This indicates that mixes with balanced or higher plastic content produce more compact and durable blocks with lower water absorption.

**Table.2. Water Absorption of paver block for different plastic, sand ratio.**

| Paver block | Specimen | Obtained Water Absorption (in %) |
|---|---|---|
| 1.1 Ratio | 1 | 1.02 |

| | | |
|---|---|---|
| | 2 | 1.029 |
| | 3 | 1.025 |
| 1.2 Ratio | 1 | 1.029 |
| | 2 | 1.033 |
| | 3 | 1.011 |
| 1.3 Ratio | 1 | 1.14 |
| | 2 | 1.115 |
| | 3 | 1.14 |

**3.3 Heat Resistance Test**

The standard used for the test is BIS 3809 1979. The plastic alone is readily susceptible if not flammable to elevated temperatures and in case of fire, the sand and plastic mixture may with stand temperatures that plastics alone usually cannot.

It has been observed that the structural integrity of the block holds very well up to 100 degrees. In this test we will first heat and maintain the brick at the standard testing temperature in the oven and then we will do the compressive strength test to check whether the properties change or not. Fig 3 shows the specimen kept in oven and there is no deformation.

The paver blocks did not undergo visible changes during the heat resistance test likely because of their strong and stable composition.

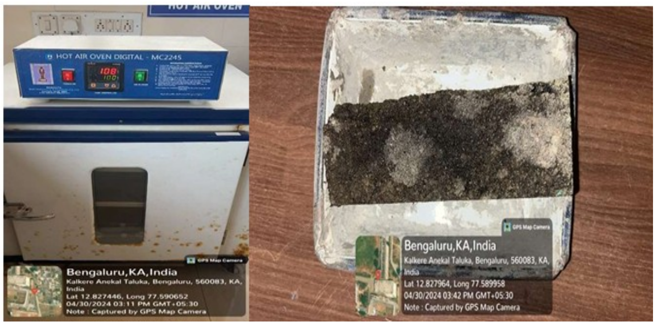


**Fig.3. Specimen kept in Oven & Specimen with no deformation.**

**3.4 Split tensile test**

The split tensile test is an indirect way of evaluating the tensile test of concrete. In this test, a standard cylindrical specimen is laid horizontally, and the force is applied on the cylinder radially on the surface which causes the formation of a vertical crack in the specimen along its diameter. Table 3 shows the split tensile strength of paver block for 1:2 ratio of plastic, sand.

**Table.3. Split tensile test of paver block for 1:2 ratio of plastic, sand.**

| Split Tensile Test | Minimum Tensile Strength (N/mm2) | Obtained Tensile Strength (N/mm2) |
|---|---|---|
| 1:2 Ratio | 15 | 24 |

**4. CONCLUSION**

1.The optimal mix ratio 1:2 plastic-to-aggregate gave the highest compressive strength. This is due to a well-balanced composition that ensures strong bonding, good workability, and effective compaction.

2.In water absorption 1:2 and 1:1 mixes had lower water absorption, indicating a denser, less porous structure. The 1:3 mix absorbed more water due to its lean nature and higher porosity.

3.All paver blocks remained unchanged during heat testing, suggesting a thermally stable and

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durable composition. This implies suitability for use in environments with moderate thermal exposure.
4.The 1:2 mix ratio is optimal for achieving both high strength and low water absorption, making it the most suitable for durable and reliable paver block production.

**5. ACKNOWLEDGEMENTS**
This study did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors. The authors report there are no competing interests to declare.

**6. REFERENCES**
[1]. Avinash, G. B., Roja, A. P., Santosh, M. R., & Puneetha Kumari, H. M. (2019). Utilisation of waste plastic in manufacturing of paver blocks. *International Journal of Innovative Research in Science, Engineering and Technology*, *8*(6), 6674-6680.
[2]. Meghana, B. S., & Suhas, R. EXPERIMENTAL STUDY ON USAGE OF WASTE IN PAVER BLOCKS.
[3]. Giri, J. P., & Priyadarshini, M. (2024). Innovative utilization of waste plastic in paving blocks: A paradigm shift. *Journal of Building Pathology and Rehabilitation*, *9*(1), 11.
[4]. Ghuge, J., Surale, S., Patil, B. M., & Bhutekar, S. B. (2019). Utilization of waste plastic in manufacturing of paver blocks. *System*, *6*(04), 1967-1970.
[5]. Asif, U., & Javed, M. F. (2024). Optimizing plastic waste inclusion in paver blocks: Balancing performance, environmental impact, and cost through LCA and economic analysis. *Journal of Cleaner Production*, *478*, 143901.
[6]. Ghuge, J., Surale, S., Patil, B. M., & Bhutekar, S. B. (2019). Utilization of waste plastic in manufacturing of paver blocks. *System*, *6*(04), 1967-1970.
[7]. Agyeman, S., Obeng-Ahenkora, N. K., Assiamah, S., & Twumasi, G. (2019). Exploiting recycled plastic waste as an alternative binder for paving blocks production. *Case Studies in Construction Materials*, *11*, e00246.
[8]. Gungat, L., Anthony, F., Mirasa, A. K., Asrah, H., Bolong, N., Ispal, N. A., & Matlan, S. J. (2021, May). Development of paver block containing recycled plastic. In *IOP Conference Series: Materials Science and Engineering* (Vol. 1144, No. 1, p. 012094). IOP Publishing.
[9]. Goyal, H., Kumar, R., & Mondal, P. (2023). Life cycle analysis of paver block production using waste plastics: Comparative assessment with concrete paver blocks. *Journal of Cleaner Production*, *402*, 136857.
[10]. Shanmugavalli, B., Gowtham, K., Nalwin, P. J., & Moorthy, B. E. (2017). Reuse of plastic waste in paver blocks. *International Journal of Engineering Research And, V6*, *2*, 313-315.
[11]. Iftikhar, B., Alih, S. C., Vafaei, M., Ali, M., Javed, M. F., Asif, U., ... & Amran, M. (2023). Experimental study on the eco-friendly plastic-sand paver blocks by utilising plastic waste and basalt fibers. *Heliyon*, *9*(6).
[12]. Awodiji, C. T. G., Sule, S., & Oguguo, C. V. (2021). Comparative study on the strength properties of paving blocks produced from municipal plastic waste. *Nigerian Journal of Technology*, *40*(5), 762-770.
[13]. Suchithra, S., Oviya, S., Rethinam, S. R., & Monisha, P. (2022). Production of paver block using construction demolition waste and plastic waste–a critical review. *Materials Today: Proceedings*, *65*, 1133-1137.
[14]. Uvarajan, T., Gani, P., Chuan, N. C., & Zulkernain, N. H. (2022). Reusing plastic waste in the production of bricks and paving blocks: a review. *European Journal of Environmental and Civil Engineering*, *26*(14), 6941-6974.
[15]. Tulashie, S. K., Boadu, E. K., Kotoka, F., & Mensah, D. (2020). Plastic wastes to pavement blocks: A significant alternative way to reducing plastic wastes generation and accumulation in Ghana. *Construction and Building Materials*, *241*, 118044.