COMPARATIVE STUDY ON VARIOUS PROPERTIES OF PAVER BLOCK PRODUCED FROM MUNICIPAL PLASTIC WASTE

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Abstract. In order to lower the cost of paver blocks and use waste plastic bottles in the manufacturing process instead of using conventional concrete paver blocks, this study proposes to substitute coarse aggregates with plastic trash in paver blocks. The project's goals are to make paver blocks more affordable while also reducing environmental pollution and plastic waste in a beneficial way. For the experiment, three different types of nine paver blocks, each measuring 220 x 180 x 70 mm and 240 x 120 x 60 mm, were created. In this study, we combined various amounts of plastic trash with coarse gravel and sand. After the paver blocks were assembled and put through testing, the findings showed improved compressive strength and water absorption. Hydrocarbons, which can be obtained from a variety of sources including coal, oil, and certain minerals, are used to make plastic. There are many different types of plastic, such as Low Thickness Polyethylene (LDPE) and High Thickness Polyethylene (HDPE). These leftover polymers are then to be effectively utilized in the production of paver squares. To produce high-quality blocks with warm and sound protection qualities to deal with contamination and to lower the overall cost of development, low-thickness polyethylene is spotlessly mixed with the sand and aggregate at different rates. This is probably the most ideal approach to prevent the collection of plastic waste.

Keywords. Plastic waste, Paver Block, Sustainability.

1 Introduction

Paver blocks are a flexible and long-lasting material that can be utilized for any kind of building project. Their diverse range of forms, dimensions, and hues renders them ideal for a multitude of uses. In addition to being widely used for covering roadways, paver blocks can be used to build driveways, garage floors, and walkways. [1] Usually utilized for outdoor flooring, they are produced as tiles, bricks, and paving stones. The ability to elevate and replace each block is by far its greatest feature. One of the most often utilized building materials worldwide is paver blocks. Roads, pavements, and automobiles may be easily constructed with them since they are robust, long-lasting, affordable, weather-resistant, and fireproof.
The ability to readily reassemble concrete pavement blocks using a variety of building techniques allows them to be repurposed or rearranged in other forms or for different purposes, as opposed to being used once and then destroyed as is typically the case. This is one of the main benefits of using concrete paving blocks. Their quality is contingent upon the makeup of the base and sub-base layers, which need to be appropriately designed for diverse uses utilizing a Portland cement and water mixture mixed with different kinds of fine aggregates. Concrete paving blocks come in a variety of patterns, including basket-weave, stretcher bond, and herringbone [2]. The ASTM C1319 standard [1] states that concrete paving blocks' compressive strength must be more than 35 MPa and that their water absorption must be not more than 160 kg/m$^3$. The demand for concrete paving blocks is now rising, which is driving up cement usage. The manufacturing of cement has detrimental effects on the environment that are both direct and indirect. A ton of cement is made by heating the raw ingredients to about 1500 °C, which releases about 900 kg of carbon dioxide (CO$_2$) into the atmosphere and contributes significantly to global warming. Furthermore, a significant amount of dust is produced during the cement-making process, which has an impact on the environment and natural resources.

One by product of producing acetylene (C$_2$H$_2$) gas is calcium carbide residue (CCR). While acetylene (C$_2$H$_2$) gas is frequently utilized in industry for welding and in agriculture to ripen crops, CCR, or calcium hydroxide, is frequently dumped as factory waste due to its high alkalinity, which can negatively impact landfills and the surrounding environment. Demonstrates the quantity of CCR that an acetylene gas industry in the central part of Thailand disposed of in a landfill between 2004 and 2015. The amount of CCR sent to the disposal location is about 1.000 tons each month, or 12.000 tons annually. According to earlier studies, CCR can react with pozzolanic materials to create substances that have cementitious qualities. [3]. When built and installed properly, paver blocks are adaptable, aesthetically pleasing, practical, affordable, and require little to no maintenance. The majority of concrete block paving built in India has also operated well. the utilization of novel and unconventional materials as well as the recycling of waste products to make up for the depletion of natural resources and discover alternate strategies for environmental preservation. Using different ingredient mix percentage ratios, such as sand, ceramic waste, and coarse aggregate, we created three different types of paver blocks. We completed 24 plastic paver block samples. Using Survival for Pedestrians is quite simple. In addition, it exhibits better heat resistance than the concert paver block. Gardens, bike lanes, and pedestrian walkways can all use it.

Humans produce trash on a regular basis, and they throw away plastic regardless of the situation, thus solid waste management is outdated. [5-10]. The quantity and use of plastic have changed, as has the disposal process and the reduction of pollution from polythene bags. Plastic is being used in more and more ways because of its conventional uses and low cost. Because of that specific reason, the work of disposing of plastic has become more difficult. Even while plastic is appropriate for a wider range of applications, it is acknowledged that finding a replacement method for getting rid of the enormous amounts of waste filling is a serious challenge. Because plastic is so abundant and has a very low biodegradability, it is thought to be a huge challenge to dispose of it in the environment.

Plastic is a material that is both extremely helpful and dangerous. Plastic is not biodegradable when it comes to emergencies and can linger as a dangerous substance for hundreds or even thousands of years. Municipal Solid garbage (MSW) contains an increasing amount of plastic garbage [12]. The rate of expansion is thought to double every ten years. This is because of the population's rapid increase, urbanization, development, and changes in lifestyle that have resulted in a lot of littering on the landscape. In addition to not degrading after 4500 years,
studies have discovered that plastic materials are non-biodegradable. About 40 million tons of municipal solid garbage are produced in India each year, and this amount is estimated to be growing at a pace of 1.5 to 2% annually.

2 Objectives & Literature Review

1. To assess the various properties and strength of paver blocks using various municipal plastic wastes.
2. To compare the results obtained by various tests on paver blocks.
3. To produce paving blocks by using collected HDPE plastic wastes (plastic bottle).
4. Concrete pavements are widely used to carry heavy load and provide long-lasting solution in highways, airports, and bridge decks.
5. The initiative aims to establish environment-friendly plastic waste disposal solution.

This chapter reviews the literature on the use of municipal waste, and waste plastic in various studies to create sustainable building materials. It also includes issues that have not been resolved or handled in earlier research.

The literature review discusses the following.

➢ Based on industrial waste
➢ Based on municipal waste
  o PET Plastic waste
  o HDPE Plastic waste

S. F. Wong, et al. (2010) This paper “Use of Recycled Plastics in a Pavement System” Examine the possibility of substituting some of the aggregate ingredients with recycled plastics, with an emphasis on creating a pavement system for use in infrastructure. Low-density polyethylene (LDPE), polystyrene (PS), high-density polyethylene (HDPE), and polypropylene (PP) are the types of recycled plastics utilized in that. To increase the workability 0%, a chemical admixture was added at a dose of 0.73% by weight of OPC, and 25% of the volume of total aggregates was replaced with recycled plastics. 8 mix proportions in all were used: P1, P2, P3, P4, P5, P6, P7, and P8. The results of tests conducted on pavement materials using LDPE (P1) type plastic show that after 28 days of curing, the material's strength reaches its optimum, along with physical attributes such water absorption of 4.10% and hardened density of 2158 kg/m³.

Kewal, et al. (2015) This paper “Development of Paver Block by Using Foundry Sand Based Geopolymer Concrete” Examine how foundry sand can be used to substitute fine aggregate in geopolymer paver blocks at different percentages, such as 0%, 20%, 40%, 60%, 80%, and 100%, to see how this affects the paver blocks' compressive strength. Research confirms that employing leftover foundry sand to partially substitute fine aggregate in geopolymer concrete paver blocks is appropriate. In the current project, paver blocks are constructed using a standard cement concrete mix design for M50 grade. The design mix was created using IS 10262:2009 (Concrete Mix Proportioning Guideline), and several experiments were conducted to determine the molarity of the alkaline.

Nivetha C., et al. (2016) This paper “Production of Plastic Paver Block from the Solid Waste (Quarry Dust, fly ash, Pet)” intends to investigate the viability of replacing cement in the production of paver blocks with plastic waste as a binding element. The study focuses on polymers based on polyethylene terephthalate. Carrying plastic waste to melt, it is combined
with different amounts of solid waste fly ash and quarry dust (weight percentages: PET 25–35 percent, fly ash 25 percent, and quarry dust 40–50 percent). For the experimental work, concrete cubes measuring 70.6 x 70.6 x 70.6 mm and conforming to IS: 516:1964 were cast to measure compressive strength. The moulds were removed after two hours and allowed to cool for three hours at room temperature. The average compressive strength of three specimens was calculated and crushing loads were recorded.

**Dinesh S., et al. (2016)** In this paper “Utilization of Waste Plastic in Manufacturing of Bricks and Paver Blocks” Examine how high-density polyethylene (HDPE) and polyethylene (PE) bags are cleaned, then mixed with sand and gravel in different proportions to create bricks with great strength and the ability to insulate against heat and sound, which helps to minimize pollution and the overall cost of building. River sand, leftover plastic, and red oxide (ferric oxide) were the materials utilized to make paver blocks. The ratios of the mix percentage were (1:2, 1:3, 1:4, 1:5, 1:6), which stand for plastic and river sand, respectively. The first phase involves gathering trash plastic bags, sorting out polyethylene bags, and securely disposing of the remaining bags. After the gathered waste bags are cleansed with water and allowed to dry to eliminate any remaining moisture, the plastics are burned.

### 3 Materials & Methods

#### 3.1. Properties of the Plastic

1. The properties of plastic are numerous.
2. Plastic is a synthetic material create organic.
3. Plastics are lightweight with a high strength to weight ratio.
4. Plastic can be manufactured inexpensively, and mass produced.
5. Water resistant.
6. Shock resistant.
7. Thermally and electrically insulating.

#### 3.2. Method of Plastic Paver Block:
3.3. Materials selection

To create a concrete that has the required strength, durability, and workability as cheaply as possible, the right elements are chosen. The materials for the experiment are,

➢ Cement
➢ Aggregates
➢ Fine aggregate
➢ Plastic
➢ Water, and
➢ Admixtures

Collection of Plastic Material:

Waste plastic that is used to make paver blocks was gathered from the neighbourhood.

![HDPE & PET Plastic](image)

**Fig 1. HDPE & PET Plastic**

**Burning of plastic waste:**

After completion batching the plastic waste was taken for burning in which the plastic bags are drop one by one into the container and allowed to melt. These would be done in closed vessel because to prevent the toxic gases released into atmosphere. These will be at the temperature of 120-150 degrees centigrade.

**Cement:**

In concrete, cement serves as a tie-up material, binding the other ingredients together to form a dense mass. OPC is typically utilized for all construction and structural projects. OPC is available in grades 33, 43, and 53. Because M sand has an equal strength to cement, we use it in this research to achieve the properties of cement without adding any form of cement.

<table>
<thead>
<tr>
<th>Properties</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fineness of cement</td>
<td>7.2%</td>
</tr>
<tr>
<td>Specific Gravity</td>
<td>2.9</td>
</tr>
<tr>
<td>Normal Consistency</td>
<td>29.5%</td>
</tr>
</tbody>
</table>

**Table 1** Properties of cement

**Sand:**

The synthetic sand is known as M sand. It is made from crushed hard granite and is an alternative to regular sand for use in all types of build.

<table>
<thead>
<tr>
<th>PROPERTIES</th>
<th>VALUE</th>
</tr>
</thead>
</table>

**Table 2** Properties of M Sand
Coarse Aggregate:
Solid plastics and MSA 8- and 10-mm coarse aggregate were used, in accordance with IS 383-1970. IS methods were applied to ascertain the properties of the materials.

Water:
Water is necessary for any construction project; even if we don't use it for ours, we do use it to cure the plastic paver blocks. For curing paver blocks, water with a pH of 5.5–6.5 is the least suited. The hydrogen potential that is lowest in the range of 6 (pH 6).

<table>
<thead>
<tr>
<th>TABLE 3</th>
<th>Properties of Water</th>
</tr>
</thead>
<tbody>
<tr>
<td>S.NO</td>
<td>PARAMETERS</td>
</tr>
<tr>
<td>1</td>
<td>pH</td>
</tr>
<tr>
<td>2</td>
<td>Alkalinity</td>
</tr>
<tr>
<td>3</td>
<td>Hardness</td>
</tr>
<tr>
<td>4</td>
<td>Iron</td>
</tr>
<tr>
<td>5</td>
<td>Total dissolved solids</td>
</tr>
<tr>
<td>6</td>
<td>Chloride</td>
</tr>
<tr>
<td>7</td>
<td>Sulphate</td>
</tr>
</tbody>
</table>

Mould:
The mould is manufactured in the same way as concrete floor tile moulds, so you may make it any form you like. Nevertheless, the material will adhere to the sides of the mould and not come out properly if the walls are thicker than 4 cm.

![I shape mould](image1.png)

I shape mould
DIM (240*120*60) In mm

![Zig Zag shape mould](image2.png)

Zig Zag shape mould
DIM (220*180*70) in mm
4 RESULTS AND DISCUSSIONS

4.1. Compressive strength of paver block

Strength is the primary factor to be considered when introducing a new material into the building industry. Utilizing a Compressive Testing Machine (CTM), a compressive strength test must be performed to determine this plastic paver's resistance to compression. Paver block strength shall be specified in terms of 28 days compressive strength. In case the compressive strength of paver blocks is determined for ages other than 28 days, the actual age at testing shall be reported. The average 28 days compressive strength of paver blocks shall meet the specified requirement. Individual paver block strength shall not be less than 85 percent of the specified strength.

Fig 3. Compressive strength of plastic paver block

4.2. Water Absorption Test

Paving blocks are weighed in dry conditions and then submerged in fresh water for a whole day as part of this test. After being submerged in water for a whole day, those are removed and cleaned with a cloth. The block was cooled to room temperature and its weight (W1) obtained. The block was completely immersed in clean water at a temperature of 27+2°C for 24 hours. After 24 hours, the block was removed and wiped out with damp cloth and the block weight (W2) obtained after it removed from water. Water absorption % by mass, after 24 hours immersion in cold water as shown in equation 1.

\[ M = \frac{W2 - W1}{W1} \times 100 \]

Were,

\( W1 \) = Room temperature and its weight (W1)

\( W2 \) = After 24 hours, the block was removed from water (W2)
Zig Zag Paver Block:

\[
M = 4.100 - 3.870 \\
3.870 \times 100 \\
= 5.943 \% \text{ absorption in 24 hr}
\]

I Shape Paver Block:

\[
M_1 = 4.424 - 4.152 \\
4.152 \times 100 \\
= 6.55 \% \text{ absorption in 24 hr}
\]

Above demonstrates that a typical pavement absorbs 5.94\% and 6.55\% of water, while a plastic paver block absorbs 2.0\% of water. According to test results, plastic paver blocks outperform regular paver blocks in terms of their ability to resist water absorption.

**Fig 4. Water Absorption % of plastic paver block**

### 5 CONCLUSIONS

It has been found that adding more plastic to a plastic paver block increases its compressive strength. It has been noted that plastic paver blocks have a higher compressive strength than concrete paver blocks. The water absorption capacity of plastic paver blocks is limited. When weighed against concrete paver blocks, plastic paver blocks are less expensive. Because it doesn't absorb water, there is virtually no chance of developing algae or fungus. Paver blocks made of plastic don't need to cure. [14-17] The plastic paver block offers us hope and a means of pursuing plastic-related innovation as well as the creation of novel materials.

In addition to improving human life for the management of plastic wastes in the future, this attempt to turn plastic waste into paving blocks has been madoto lessen the degradation of plastic waste into "Eco-Friendly" paving blocks. Engineering that will likely have a
significant impact on the industry. When compared to concrete paver blocks, plastic paver blocks are also better at withstanding moisture. The plastic paver block offers us hope and a means of pursuing plastic-related innovation as well as the creation of novel materials for civil engineering that will likely have a significant impact on the industry in the future. The water absorption capacity of plastic paver blocks is limited. When weighed against concrete paver blocks, plastic paver blocks are less expensive. Because it doesn't absorb water, there is virtually no chance of developing algae or fungus. Paver blocks made of plastic don't need to cure.

References


