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Experimental Study of Manufacturing of Precast Paver Blocks from Local Municipal Solid Waste

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Abstract: *The project aims to revolutionize paving block production by utilizing plastic waste instead of cement, potentially reducing costs compared to traditional concrete blocks. In India, where millions of tons of plastic waste are generated annually, finding ways to repurpose this waste into paving blocks could significantly decrease environmental plastic pollution. Our experimentation involved mixing plastic waste with quarry dust, coarse aggregate, and other materials to create the paving blocks. Through testing and analysis, we assessed the effectiveness of these blocks. Ultimately, our goal is to offer a practical solution to both mitigate plastic waste and make paving blocks more economically accessible. Plastic waste poses significant environmental challenges due to its non-biodegradable nature, causing pollution and harm to ecosystems. Despite efforts in plastic recycling, much of it still ends up in landfills or incinerators due to quality concerns with recycled materials. Similarly, construction and demolition waste (C&D Waste) contribute to landfill overflow, but it also holds potential for manufacturing precast paver blocks. It can even replace a portion of aggregates in concrete without compromising its strength. By exploring these avenues, we strive to address both plastic and construction waste issues while offering sustainable solutions in paving block production*

Keywords: block production

I. INTRODUCTION

PRESENT-DAYSCENARIO

Concrete

In today's world, the dependency on cement in concrete is profound and far-reaching. Everywhere you look, from towering skyscrapers to humble sidewalks, cement-based concrete structures dominate our urban landscapes. Cement is the glue that holds our modern infrastructure together, providing strength, durability, and versatility in construction projects of all sizes.

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As populations grow and urbanization accelerates, the demand for cement continues to skyrocket. Developing countries are investing heavily in infrastructure development, while even mature economies are constantly renovating and expanding their existing infrastructure. This relentless demand for cement drives not only construction activities but also the economies that rely on them

One area where cement's extensive use is particularly evident is in the production of paving blocks. Paver blocks, commonly used in sidewalks, driveways, and roads, are essential components of urban and suburban landscapes. These blocks provide stability and durability underfoot while also enhancing the aesthetic appeal of outdoor spaces.

Traditional paver blocks are primarily made of concrete, which means they rely heavily on cement as a key ingredient. As a result, the production of these blocks contributes significantly to the overall demand for cement. Given the widespread use of paver blocks in various construction projects, their reliance on cement underscores the pervasive influence of cement in modern construction practices.

However, with growing concerns about environmental sustainability and the carbon footprint of cement production, there is an increasing interest in exploring alternative materials and construction methods. One of the popular projects like the one aiming to replace cement with plastic waste in paver blocks represents a promising step towards reducing the dependency on cement and finding more eco-friendly solutions for construction needs.

Concrete is extensively employed as a fundamental construction material globally. Constituting essential elements such as cement, sand, and coarse aggregate, it has many applications in various structures. However, due to its popularity ease of use, and availability, the increasing demand for concrete has led to its depletion, prompting the exploration of substitute materials. We, civil engineers, are constantly in search of alternative materials for cement that can partially or completely replace it as a binding agent

PLASTIC:

The composition of waste is different in different areas of the world, waste management programs, and consumption patterns but the amount of plastic in the overall waste composition is high. The major constituents of plastic waste are polyethylene and polypropylene. There are several methods available to recycle and reuse these waste products effectively. Since plastic has a long service life, it can be recycled effectively.

Sadly, hardly 8 to 9 percent of it is recycled at the maximum and the rest either goes to landfill, to the ocean via rivers and streams, or incinerated in the name of creating sustainable energy. This negatively affects the environment to a great extent such as

Plastic in the present day is majorly disposed of in 4 ways -

Illegal landfill – leachate action takes place and it contaminates the underground water table or may directly flow in a nearby river

Ocean dumping/accumulation – the plastic flows in the ocean and accumulates or gets trapped in certain locations due to ocean currents and forms patches. These patches grow enormous in size as time goes by (larger than cities), these are known as the garbage patches. Currently, there are 7 known patches detected

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As plastic doesn't degrade, in only breaks down in smaller particles known as microplastic which may float in the ocean forever and will constantly be at risk of being eaten by fish which may be ultimately consumed by us

Incineration – as plastic is mostly fossil oil combined with gas molecules, it burns very effectively and easily. It also acts as a fuel to burn other materials and produce energy but generates a lot of pollution to the equation

As you can see, there is endless negative effects of plastic and very limited methods of recycling plastic but still not even 10 percent of the manufactured plastic is recycled. The primary reasons for this are

Recycled Plastic has a lower quality yet a higher cost compared to its virgin alternative.

Plastic degrades every time it melts and is reformed to create new products.

A good plastic product could be recycled a maximum of up to 3 times to obtain the desired quality and you still have to add new plastic at every cycle to compensate for the quality degradation

PROBLEM DEFINITION

Problem Statement

In India, concrete block paving is widely favored for its attractive appearance, functional versatility, and cost-effectiveness. However, despite its widespread use and generally satisfactory performance, there are persistent challenges that need to be addressed. One major concern is the occasional failure of paving blocks due to excessive surface wear, which not only compromises the aesthetics of the pavement but also raises safety issues. Another critical issue is the variability in block strength, leading to inconsistencies in performance and potentially compromising the durability of paved surfaces.

Moreover, as the world grapples with the depletion of natural resources, the construction industry faces the dual challenge of meeting escalating demand while minimizing environmental impact. This challenge is exacerbated by the substantial increase in waste generation from industrial and residential sectors, further straining resources and exacerbating environmental degradation.

sTherefore, the primary objective of this study is to develop a comprehensive solution that addresses the aforementioned challenges associated with concrete block paving in India. This solution will aim to enhance the attractiveness, functionality, and cost-effectiveness of paving blocks while minimizing maintenance requirements. By incorporating non-conventional materials and promoting efficient waste recycling, the project seeks to establish a sustainable paradigm for concrete block paving that not only conserves natural resources but also mitigates environmental impact. Through collaborative efforts and innovative approaches, we aspire to revolutionize the construction industry, paving the way for a more sustainable and environmentally conscious future.

PROJECT INTRODUCTION

The plastic used in this project was collected from nearby areas, showing our commitment to tackling environmental problems head-on. Right now, India is facing a big issue with getting rid of around 56 lakh tonnes of plastic waste every year. This waste causes serious harm to our environment and affects both animals and people.

To deal with this problem, it's really important to find smart ways to use plastic waste instead of just throwing it away. By using plastic waste instead of traditional materials like cement, we can help the environment and even save money.

Our project focuses on finding out if we can make strong and eco-friendly paving blocks using things like pulverized fuel ash (PFA), artificial sand, and recycled plastic. We're doing experiments to figure out the best mix of recycled plastic, sand, and fly ash to make these blocks tough and good for the environment.

This research is important because it could give us a way to solve two big problems at once: reducing plastic waste and finding better materials for building things. By using recycled plastic and other alternative materials, we can cut down on how much we rely on natural resources and lessen the impact of construction on the environment.

OBJECTIVE -

- In this project the waste plastic is used as building material instead of cement to produce Paver blocks and bricks.
- Here cement, as a binding material is completely replaced by adding waste plastic in different proportions with sand and possibly other waste materials.

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- this project aims to use plastic waste as building material instead of cement in the manufacture of Paver blocks and bricks.
- Thus, reducing the various problems associated with waste plastic disposal.
- And also eliminate the environmental and social impacts caused by the cement industries.

II. METHODOLOGY

Material Procurement and Selection: PET plastic is sourced from various sources such as hotels, waste markets, and recycling centers. Careful selection ensures a variety of plastic materials while keeping costs low. After collection, meticulous sorting is conducted to ensure consistency in quality for long-lasting paver blocks.

Thorough Cleaning and Washing: The collected PET plastic undergoes thorough cleaning to remove dirt, dust, and oils. Washing and rinsing ensure the plastic is clean and suitable for producing strong and durable paver blocks.

Cutting and Shredding: Clean plastic is cut or shredded into smaller pieces for better handling and processing. Uniformity in size and shape enhances efficiency and consistency in the manufacturing process, resulting in high-quality paver blocks.

Optimization of Sand Properties: The sand used in the mixture is optimized by measuring its weight after drying and heating. Proper heating removes moisture and ensures the sand is at the right temperature for mixing with other materials. This process prevents premature hardening of the mixture and ensures smooth and uniform mixing.

Mold Preparation and Maintenance: Molds play a crucial role in shaping the plastic mixture into blocks. Molds are designed to open completely for easy removal of blocks and are inspected for smooth internal surfaces. Proper maintenance, including cleaning and inspection, ensures the molds produce consistent and high-quality blocks.

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Melting Process: The plastic is melted carefully to ensure smooth and even melting. Controlled temperature and gradual addition of plastic ensure optimal melting without overheating or forming lumps, resulting in a uniform mixture.


Homogeneous Mixing and Sand Incorporation: The melted plastic is mixed with warm, dry sand and fly ash to create a homogeneous mixture. Mixing is done carefully to ensure even distribution of materials, resulting in strong and visually appealing blocks.


Casting and Molding: The mixture is poured into molds placed on oiled surfaces. Multiple pours and tapping ensure proper compaction and smooth surfaces. Vibration-assisted consolidation further improves block strength and quality.


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Gradual Cooling and suring: Blocks are allowed to cool slowly in the molds to prevent stress and maintain size and shape. Patience during the cooling process ensures strong and durable blocks the blocks are at least cured for 28- 48 hours to harden and solidify completely.

III. RESULTS

COMPRESION TEST

We made plastic paver blocks shaped like cubes, each measuring 100x100x100 millimeters. Then, we tested how much weight each block could hold before it broke. We noted down the highest weight each block could withstand. To figure out how strong they are on average, we used the following formula to calculate the strength of our block

Compressive strength (N/mm2) = (Ultimate load in N / Area of cross section (mm2))

Model	Plastic percentage (%)	Compressive stress (N/mm²)
M1	10	-
M2	20	16.3
M3	30	15.1
M4	40	10.8
M5	50	10.3
M6	70	3.8
M7	95	4.4

WATER ABSORBTION

SR.	Plastic (%)	Weight before test	Weight after test	Water absorption (%)
1	20	2035	2098	3.01
2	30	1948	2004	2.87
3	40	1870	1892	1.2
4	50	1792	1808	0.9

IV. CONCLUSION

Following conclusion were concluded from the above experiment -

Repurposing waste plastic into paver blocks offers an effective solution for managing plastic waste. This approach not only reduces environmental pollution but also provides cost savings compared to traditional concrete blocks.

Plastic paver blocks are visually appealing, with a durable finish and effective interlocking system. However, as the plastic content increases, there's a gradual decrease in compressive strength.

Despite this, plastic paver blocks remain a practical and sustainable option for various construction projects, balancing cost-effectiveness with environmental responsibility.

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