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Performance Based Analysis of Concrete and Plastic Paver Blocks Under Dynamic Conditions

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ABSTRACT

This study provides dynamic comparison between concrete paver blocks and plastic paver blocks in terms of mechanical performance, durability, environmental impact, and economic feasibility. Since traditional concrete pavers are commonly utilised for infrastructure, they carry issues like heavy weight, fragility, and high environmental cost from cement usage. An innovative alternative to concrete paver blocks is the use of paver blocks made from recycled polymers or plastic and have shown potential in the areas of sustainability, flexibility, and durability.

Key parameters like compressive strength, water absorption, wear resistance, and resistance to repeated cycles of wetting and drying were measured by laboratory tests. Whereas despite high initial compressive strength of concrete blocks, notable cyclic exposure degradation was observed. Though they have less initial strength than their concrete counterparts, the plastic paver blocks were far superior as of moisture resistance, recovery from deformation, and long-term performance in dynamic environmental conditions.

However, prices of plastic paver production depend upon demand and availability of raw plastics. But there are long term benefits in lower maintenance, a longer operational life. Plastic pavers are more environmentally friendly than traditional counterparts, whereas they have a lower carbon footprint, even consume non-biodegradable waste and require less water and energy in the whole process of production fulfilling the objective of Circular economy.

Study finds that the plastic paver blocks are cost effective, sustainable and durable alternative, which are especially effective in areas that suffer from lot of plastic wastage. It will need to be standardized and field-tested further to be used more widely. This study highlights role of novel use of material for sustainable environmental conservation.

Keywords: Paving Blocks , Lightweight Construction, Sustainability, Environmental Impact

I. INTRODUCTION

Paver blocks are widely used in modern construction, either for driveways, walkways, parking lots, or other outdoor applications because of their structural durability, aesthetic value, low maintenance, and simple installation process. There are various materials available but the industry has traditionally gone ahead with concrete paver blocks due to reasons like high compressive strength, cost economy, availability of material, and already existing manufacturing standards.

Hence, the construction industry is undergoing a paradigm shift towards sustainable development, propelled by the necessity to mitigate carbon emissions, decrease resource depletion, and embrace sustainable practices. One of the major challenges facing the world today is the way in which the alarming amounts of plastic waste negatively affect terrestrial and marine environments. Using recycled plastic materials in construction has shown potential in providing an environmental sanitization solution that aligns with circular economy initiatives.

In recent years, plastic paver blocks, made from post-consumer plastic waste or plastic composites, have emerged as a novel and environmentally responsible substitute for traditional concrete blocks. The blocks exhibit potential benefits, including reduced environmental impact, low density, cost-effectiveness, and durability under specific loads and environmental conditions.

Now comparing mechanical performance, dynamic behaviour-based durability, economic viability, sustainability parameters, and benefits of life cycle assessment and waste management for concrete and plastic paver blocks. Its purpose is to explore the possibility of replacing new plastic pavements with recycled ones in building projects as a sustainable replacement.

II. LITERATURE REVIEW

Introduction

A literature review is important to understand previous studies, their methodologies, materials used and performance metrics utilised to compare concrete paver blocks with plastic paver blocks. This chapter provides review of previous studies upon concrete and plastic paver blocks and their material and manufacturing methods as well as performance indicators and identifies gaps in existing research.

Historical Background of Paver Blocks

Paver blocks have been around since ancient times, with origins traceable to Roman roads with stone pavers. Modern concrete pavers were developed in Europe in the early 20th century and quickly became prevalent for their interlocking capability and structural strength. Plastic paver blocks is a fairly new development that emerged due to necessity to control plastic pollution.

Concrete Paver Blocks: Review of Past Studies

concrete paver block uses a combination of cement and aggregates, sand and water, poured into molds with vibration and compression. Mechanical properties of these modified composites have been studied extensively and found to have high compressive strength, durability, and resistance to weathering.

- Patel et al. (2017) observed as M30 grade concrete paver blocks were found to give good structural integrity and were suitable for lighter to medium traffic Loads.
- Singh et al. (2019) investigated addition of fiber reinforcement in concrete paver blocks for improving crack resistance in addition to flexural strength.
- IS 15658:2006 IS gives the specifications for concrete paver blocks for design and performance in India.

Plastic Paver Blocks: Review of Past Studies

•Typically, plastic paver blocks are produced from recycled thermoplastics, possibly with additives such as sand, fly ash, or quarry dust.

•Rajan et al. (2020) performed experiments upon use of LDPE and PET waste in formulation of paver blocks and attained satisfactory compressive strength with reduced water absorption.

•According to Nath and Das (2021), plastic blocks offer thermal resistance and light weight, making it suitablefor pedestrian pathways.

•Gawande et al. (2012) noted, utilising plastic waste in construction could reduce landfill use as well as environmental pollution.

Comparative Studies

There have been only a handful of studies directly comparing concrete and plastic paver blocks:

•Kumar & Verma (2022) discovered plastic pavers to outperform concrete blocks in terms of water resistance and environmental sustainability, whereas concrete blocks held an advantage in their compressive strength.

•Joshi et al. observed by making use of locally available plastic wastes plastic paver blocks were found to be 12% less in structural strength as shown in (2021) but found that plastic paver blocks are more sustainable and cheaper comparing with other available options.

III. METHODOLOGY

This methodology was empirically formulated to enable systematic and objective comparisons among concrete and plastic paver blocks as different types. The assessment was performed according to five profiles: mechanical action, water takeup, surface quality, cost investigation, and environmental impact. Both were tested under the same conditions using the same procedures.

1. Sample Preparation

Thirty specimens of each type (concrete and plastic paver blocks) were prepared by using standard molds and curing methods. Concrete pavers were made via traditional mix design and curing, while plastic blocks were produced using shredded post-consumer plastic mixed with sand and heated.

2. Testing and Data Recording

IS and ASTM standards were followed for the tests. The parameters that were examined included:

Table 1: Compressive Strength (MPa)

Block Type	Sample Size	Average Strength (MPa)	Standard Deviation
Concrete Pavers	30	32.5	1.8
Plastic Pavers	30	26.4	2.1

Table 2: Water Absorption (% by weight)

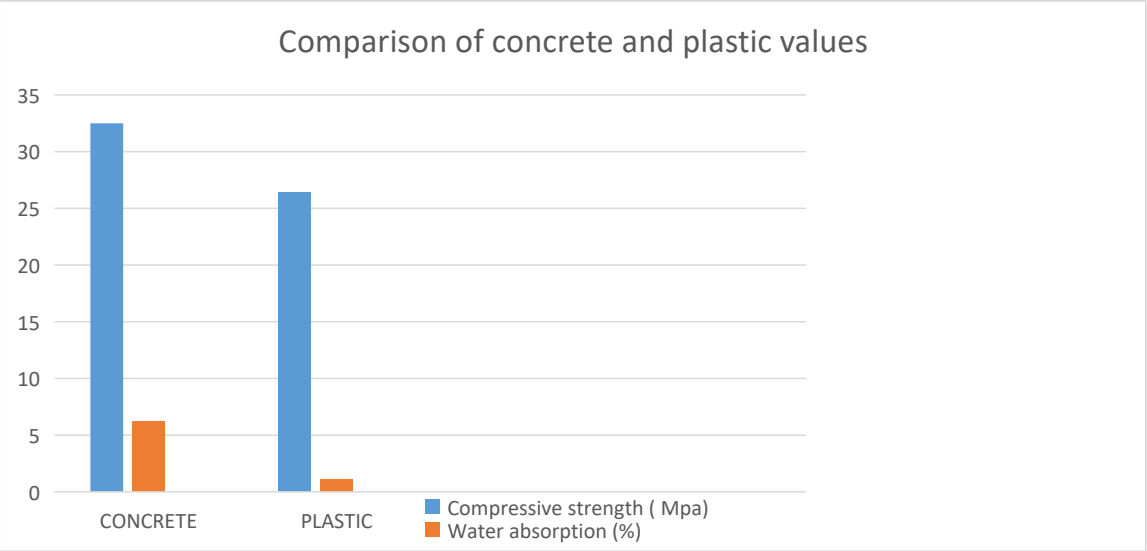
Block Type	Sample Size	Average Absorption (%)	Standard Deviation
Concrete Pavers	30	6.2	0.5
Plastic Pavers	30	1.1	0.2

Table 3: Visual Inspection Summary

Criteria	Concrete Blocks	Plastic Blocks
Surface Cracks	Moderate (20%)	Minimal (3%)
Edge Defects	Noticeable (15%)	Minor (5%)
Color Uniformity	Good	Excellent

3. Graphical Representation

Bar Graph 1: Comparison of Compressive Strength and Water Absorption



	Compressive Strength (MPa)	Water Absorption (%)
Concrete	32.5	6.2
Plastic	26.4	1.1

4. Cost Estimation

Table 4: Estimated Cost per Block (in INR)

Cost Category	Concrete Pavers	Plastic Pavers
Material Cost	₹20	₹15
Energy Cost	₹5	₹8
Labor	₹10	₹8
Total Cost	**₹35**	**₹31**

5. Environmental Impact Assessment

Secondary data was used to compare the environmental performance.

Table 5: Sustainability Comparison

Parameter	Concrete Pavers	Plastic Pavers
Carbon Footprint (kg CO_2/block)	3.2	1.1

Parameter	Concrete Pavers	Plastic Pavers
Recyclability (%)	Low (20%)	High (90%)
Waste Utilization	None	High

IV.CONCLUSIONS

Tackling plastic pollution demands a comprehensive response that encompasses sound policy, strategic foresight and engagement by all sectors of society. This is where policymakers and planners come in to help frame regulations, foster sustainability and enforce initiatives that help make difference. With collaboration, creative solutions, and commitment to environmental responsibility, such inner workings can reduce the negative impact of plastic waste and build upon a circular economy.

Integrating the utilisation of plastic paver blocks in local building codes and standards. IS 15658:2021 is specification for Precast Concrete Paver Blocks dated 19 Jan 2022 at Bureau of Indian Standards, India & mentions the dimensional requirements, compressive strength, and durability. To ensure quality and performance, similar standards for plastic paver blocks should also be adopted. Paver Block Manufacturers Association (PBMA) suggests guidelines, general types of paver block and applications which might guide in terms of ultimately leading to the standards being developed for plastic alternative products. Such specifications will promote the use of plastic paver blocks and thereby enhance environmental sustainability through the use of recycled material in construction.

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