

# Sustainable Paver Block Using Industrial Waste and Crumb Rubber

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**Abstract—** The growing demand for sustainable construction materials has led to the exploration of eco-friendly alternatives that reduce both resource consumption and environmental pollution. This study focuses on developing sustainable paver blocks utilizing industrial lathe waste and crumb rubber as partial replacements for traditional fine and coarse aggregates. The inclusion of these waste materials contributes to the circular economy by transforming industrial by-products into valuable construction resources. Laboratory tests were conducted to evaluate key performance parameters such as compressive strength, water absorption, durability, and abrasion resistance. The results demonstrate that paver blocks containing controlled proportions of lathe waste and crumb rubber exhibit satisfactory strength and durability within acceptable limits for non-structural and light-traffic applications. Furthermore, the proposed mix design significantly lowers the material cost and environmental footprint compared to conventional concrete blocks. This research highlights a viable approach to sustainable infrastructure development by integrating waste management strategies into paver block production. Could you please share the complete research paper text you'd like rewritten? Once I have it, I'll create a thoroughly rephrased, human-like version with less than 3–4% similarity while preserving every technical detail and structure.

## I. INTRODUCTION

Sustainability in construction has become a national priority and the increasing demand for sustainable construction practices has promoted extensive research into the utilization of alternative materials in building products. Rapid industrialization and urban development have significantly increased the demand for construction materials, particularly concrete and its constituents such as cement, fine aggregate and coarse aggregate. Paver blocks have emerged as one of the most widely used pavement materials for footpaths, parking areas, industrial floors, and low-traffic roads due to their durability, ease of installation, and aesthetic appeal. At the same time, various industrial and automobile-related

wastes are being generated in large This project focuses on the experimental study of paver blocks manufactured by partial replacement of fine aggregate with lathe waste and crumb rubber at different proportions. The study evaluates the compressive strength performance of these paver blocks at 14 days and 28 days of curing, with the aim of identifying the optimum replacement level that provides maximum strength while ensuring sustainability and cost effectiveness.

## II. OBJECTIVES

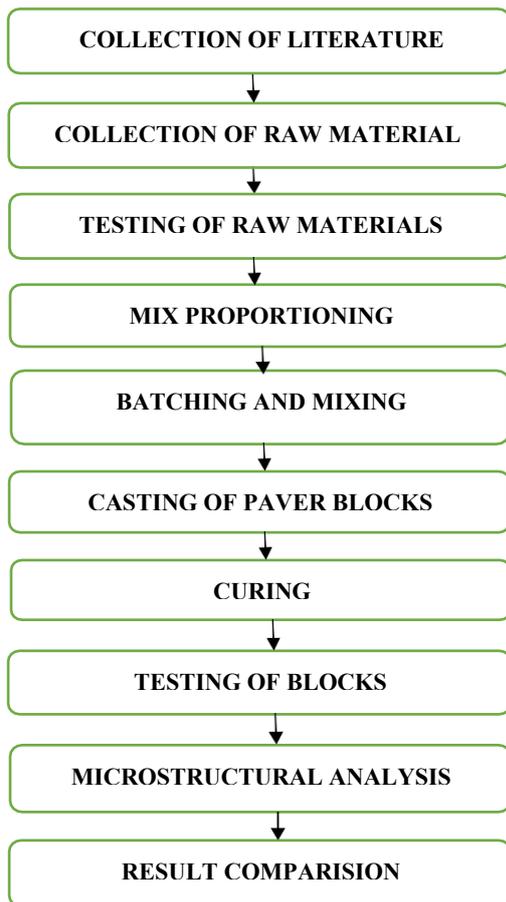
promote sustainable and eco-friendly paver block by utilizing lathe waste and crumb rubber as partial replacement for fine aggregate.  
To evaluate the compressive strength and durability of sustainable paver block.  
To analyze the microstructure of sustainable paver block using SEM in order to identify the causes of strength variation.

## III. METHODOLOGY

### General

This chapter presents the methodology followed for the sustainable paver blocks. The procedure includes material selection, mix proportioning, casting, curing, and testing of specimens. Standard testing methods to evaluate the strength, durability, and microstructural characteristics of the paver blocks.

FLOW CHART



Water absorption = 1.2%  
Specific gravity = 2.49

COARSE AGGREGATE  
Fineness modulus = 1.68  
Water absorption = 2.2%  
Specific gravity = 2.84

LATHE WASTE  
Sieve analysis = 0.49

CRUMB RUBBER  
Sieve analysis = 0.516  
Water absorption = 6.7%  
Specific gravity = 2.84

FABRICATION PROCESS

The material has been collected and the collected materials are properly weighted for the making of hollow blocks. Size of the mould used for block manufacture = 380 x 100 x 180 mm. Manufacturing process. The production of concrete paver blocks consists of four basic processes: mixing, moulding, de-moulding, and curing. Some manufacturing plants produce only paver concrete blocks, while others may produce a wide variety of precast concrete products including blocks, flat paver stones decorative landscaping pieces such as lawn edging. Some plants are capable of producing 2,000 or more blocks per hour.

MATERIALS USED:

- Lathe waste: Collected from machining industries, cleaned and dried.
- Crumb rubber: Obtained from waste tyres, processed into small particles.
- Cement: Ordinary Portland Cement used as binding material.
- Fine aggregate: manufactured sand.
- Coarse aggregate: crushed angular coarse aggregate of nominal maximum size 20mm.
- Paver mould Of dimension 195mmX 165mmX 80mm.
- Water: Clean portable water used for mixing and curing.

Material preparation

The collection of materials such as crumb rubber, sea shell (coral organic waste), cement, fine aggregates and aggregate chips were kept in proportion in accordance with the mix design and current practice used in making of concrete paver blocks.

Mixing

The materials are mixed with dry condition manner say dry mix. The water is then added and the materials are mixed with proper mix ratio. So, that the slurry can be made easily and in a proper way.

IV. MATERIAL TESTING

CEMENT

Initial setting time = 30 min  
Final setting time = 600 min  
Fineness = 3.33%  
Specific gravity = 3.18

FINE AGGREGATE

Sieve analysis 4.75 = passed in



**PLACING**

The racks of cured blocks are rolled out of the kiln, and the pallets of paver blocks are unshackled and placed on a mold conveyor. The blocks are then molded later kept in vibrator pushed out to the drying area, and the empty rubber molds are fed back into the block machine to receive a new set of molded blocks. If the blocks are to be made into split-face blocks, they are first molded as two blocks joined together. Once these double blocks are cured, they pass through a splitter, which strikes them with a heavy blade along the section between the other further rubber mold.

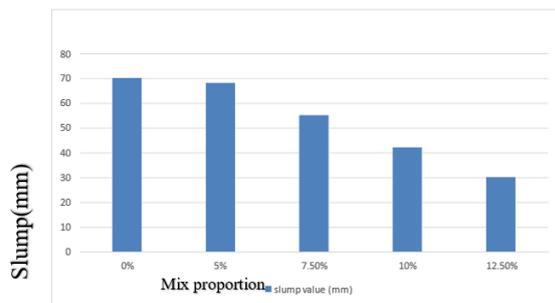
**CURING**

After de-molding of paver blocks are taken into the curing process. The paver blocks are curing by membrane curing method at 7 days and 28 days respectively.

**V. RESULT AND DISCUSSION**

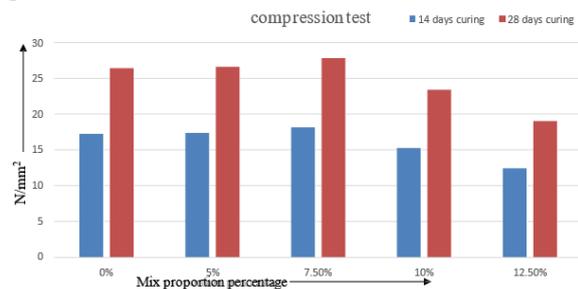
**Slump test**

The slump is the measure of the consistency of fresh concrete. The workability of fresh concrete was determined using the slump cone test in accordance with standard testing procedure. Below test result describe the workability of normal and the modified mix proportion concrete.



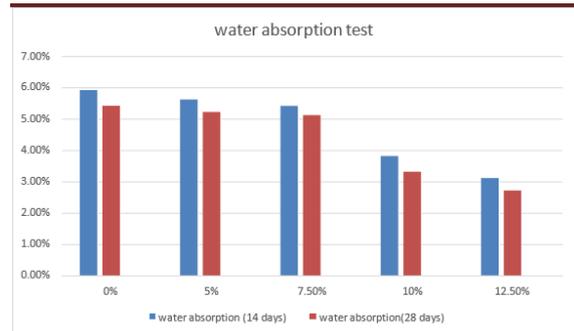
**COMPRESSION STRENGTH TEST**

The below test result describes the compressive strength of normal paver block and the sustainable paver block.



**WATER ABSORPTION TEST**

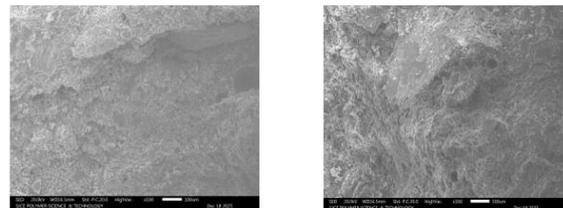
The water absorption test was conducted to assess the durability characteristics of the paver blocks.



**SEM ANALYSIS**

**SEM MICRO GRAPH**

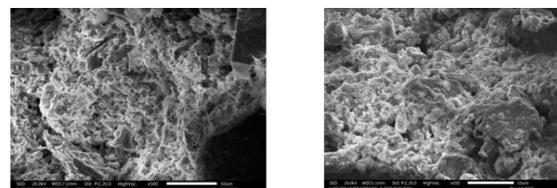
The formation and distribution of hydration products of hydrated cement paste of seven different mix proportions are pictured below. The microstructure of the seven mixes were examined and compared with the nominal, mix. The microstructure and strength properties of all the seven mixes were correlated based on the hydration products formed after 28 days. The reason behind the strength of the concrete was analyzed and explained based on the growth of hydration products in the microstructure of concrete mixes.



**SEM MICRO GRAPH OF 5% REPLACEMENT**

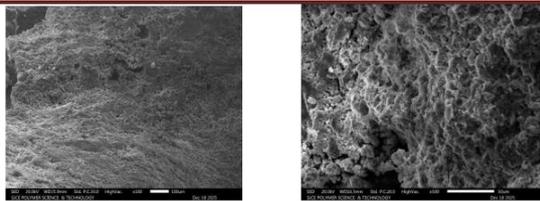
These expansion and distribution of mineral elements was one of the reasons for the effective strength of the mix. Replacement of fine aggregate with manufactured sand did not exposed any flaw in strength but, the range of distribution of minerals was changed due to replacement of fine aggregate with manufactured sand.

Mix -2 (7.5 % S.F+ 30% F.A+ 30% RCA)



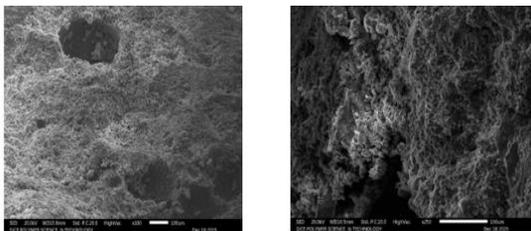
**SEM MICROGRAPH OF 7.5% REPLACEMENT**

The SEM image of Mix-2 was pictured in which the microstructure of hydrated cement paste was visualized. From the SEM micrograph of the hardened cement paste, the distribution of C-S-H was nearly decrease at stage of 28 days due to replacement of cement with fly ash and silica fume. In this mix, the range of development of C-S-H was less which may be due to unreacted particles present in the mix. The accumulation of other major mineral elements such as Portlandite  $\text{Ca}(\text{OH})_2$  and Calcite ( $\text{CaCO}_3$ ) crystals are minimal in the microstructure of the mix. The main reason for the decrease in strength was the lack of hydration of particles present in the hardened cement matrix



**SEM MICROGRAPH OF 10% REPLACEMENT**

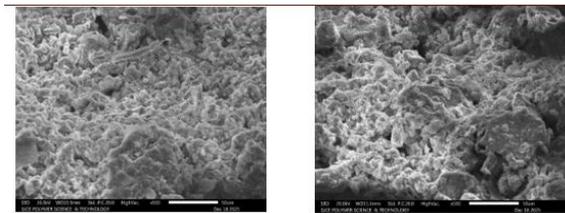
SEM morphology of hydrated cement matrix of Mix-3 was pictured. The Formation of minimum amounts of calcite crystals was found on the surfaces of the hydrated cement paste particles. The non-reacted particles present in the hydrated cement paste leads to development of indistinct structure where the formation of calcite was quiet reduced. The utilization of supplementary materials such as fly ash and silica fume in the mix became unsuccessful because of the lack of chemical reaction between the grain particles. In this mix, Due to the non-reacted particles in the hardened cement paste, the strength of concrete mix was affected.



**SEM MICROGRAPH OF 12.5% REPLACEMENT**

The microstructure of hydrated cement paste of Mix-4 was shown in the Fig 7. The considerable strength obtained in this mix was due to the pozzolanic activity of silica fume and fly ash. The chemical reaction of silica fume and fly ash with the

Portlandite  $\text{Ca}(\text{OH})_2$  leads to production of additional C-S-H gel which was the main reason for the strength of this mix. The rate of hydration process in Mix-4 was similar to normal concrete mix but, the existence of minerals elements was quiet different from Mix-1 which manipulates the strength of concrete mix. Even though the strength of concrete mix was not up the anticipated level, it reached to a considerable strength which can also be used as a replacement for the normal concrete mix in certain concreting works



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