DEVELOPMENT OF AN OPTIMUM MIX FOR PAVING BLOCKS, USING WASTE STEEL SLAG AND CRUSHED TILE WASTE AS PART REPLACEMENT OF AGGREGATES

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In contemporary construction practices, paving blocks are essential for creating durable and aesthetically pleasing surfaces in urban and suburban areas, such as pedestrian walkways, driveways, and plazas. However, traditional paving blocks are often associated with considerable weight and high production costs, which can limit their widespread use and contribute to environmental degradation due to the extensive use of natural aggregates. This research aims to address these challenges by developing a lightweight and cost-effective mix design for eco-friendly paving blocks.

The proposed design incorporates waste materials from the steel industry, specifically steel slag, as well as crushed tile waste from construction industry, both of which are typically discarded as industrial and construction waste. By repurposing these materials, the study seeks to minimize the environmental impact of paving block production while providing a sustainable and economical alternative to conventional paving blocks.

The experimental program involved replacing traditional fine aggregates in the paving block mix with steel slag at varying proportions of 10%, 20%, and 30% by volume. Additionally, coarse aggregates were partially substituted with 25% crushed tile waste. The mechanical performance of the various paving block mixes was thoroughly assessed through a series of standardized tests, including density, compressive strength, split tensile strength, and flexural strength. These tests were conducted to determine the structural integrity and suitability of the eco-friendly paving blocks for practical applications.

The results of the study revealed that the paving block mix containing 30% steel slag and 25% crushed tile waste achieved an optimal balance between weight reduction, cost efficiency, and mechanical performance. This mix exhibited a compressive strength of 16.6 MPa after 28 days, making it suitable for non-traffic areas such as walkways, garden paths, and recreational spaces. Although this strength is marginally lower than the compressive strength of 17.5 MPa observed in conventional paving blocks, the eco-friendly mix offers several advantages, including a significant reduction in weight and production costs.

Furthermore, a detailed cost analysis was performed to compare the economic feasibility of the eco-friendly paving block mix with that of traditional paving blocks. The analysis indicated that the use of waste materials such as steel slag and crushed tile waste not only reduces the consumption of natural resources but also results in considerable cost savings. The cost of paving blocks decreases with the substitution, showing a reduction rate of approximately 4.6% from Mix 01 to Mix 02, and continuing consistently up to Mix 05, making it economically feasible. In conclusion, this study contributes to the ongoing efforts to develop sustainable construction materials by demonstrating the viability of using industrial and construction waste in paving block production.

Keywords: Mechanical properties, Paving blocks, Steel slag, Tile waste

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INTRODUCTION

Managing industrial waste and preserving natural resources are critical challenges today. Concrete paving blocks, using recycled materials, provide an efficient and visually appealing solution for footpaths.

RELATED LITERATURE

Several researchers have reported that peak compressive strength is achieved with slag replacement ratios of natural river sand ranging from 15% to 30%.

METHODOLOGY

- **Material Collection**
- **Material Characterization**
- **Mix Design**
- **Testing**
- **Analysis**
- **Economic Assessment.**

OBJECTIVE

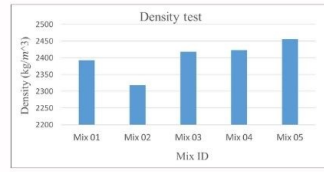
To analyze **steel industry waste materials for their suitability in paving block production**, evaluate the mechanical and physical properties of the developed blocks, and assess their economic viability compared to conventional paving blocks.

ANALYSIS

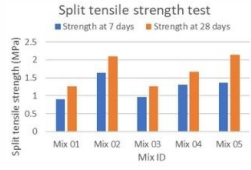
Materials selection included testing concrete for density, flexural strength, split tensile strength, and compressive strength, while aggregate underwent sieve analysis to determine particle size distribution.

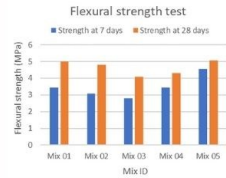
MIX ID	Cement (%)	Steel slag (%)	Fine Agg. (%)	Normal crushed Agg. (%)	Tile waste (%)
MIX1 (Control)	100	0	100	100	0
MIX2	100	0	100	75	25
MIX3	100	10	90	75	25
MIX4	100	20	80	75	25
MIX5	100	30	70	75	25

Mix Design



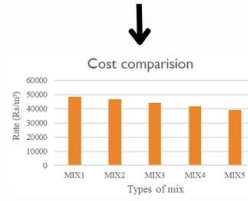
Density of varies mixes.





RESULTS/FINDINGS

- **Incorporating tile waste into the concrete mixture resulted in a 3.2% reduction in density. Conversely, the density increased by 2.93% with a 30% steel slag replacement.**
- **The compressive and flexural strength decreased by 8.3% and 9.6%, respectively, when 25% of the coarse aggregates were replaced with tile waste. However, strength increases with an increase in slag content.**
- **The tensile strength increased by 59.5% when 25% of the coarse aggregates were replaced with tile waste. Conversely, the strength increased by 64.6% with a 30% replacement of steel slag.**
- **The cost of paving blocks decreases with the substitution, showing a reduction rate of approximately 4.6% from Mix 01 to Mix 02, and continuing consistently up to Mix 05, making it economically feasible.**



CONCLUSION

Mix 05 is fixed as an optimum mix for this study, and it gave compressive strength of above 15 MPa after 28 days, split tensile strength and flexural strength were also found to be comparatively higher.