Utilization of Tyre Rubber in Concrete

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Abstract

The incorporation of waste Tyre rubber into concrete presents a novel approach to addressing both environmental sustainability and enhancing certain concrete properties. This research explores the feasibility, advantages, and challenges associated with the use of Tyre rubber as a partial replacement for conventional aggregates in concrete mixtures. The study investigates the effects of varying proportions of Tyre rubber on the mechanical properties, durability, and thermal performance of concrete. The findings suggest that while there are reductions in certain strength characteristics, Tyre rubber concrete exhibits enhanced flexibility, impact resistance, and thermal insulation properties, making it suitable for specific applications.

1. Introduction

1.1 Background

Concrete is one of the most widely used construction materials globally, characterized by its high compressive strength and durability. However, the production and disposal of concrete contributes significantly to environmental degradation. On the other hand, waste management, particularly of non-biodegradable materials such as used Tyres, poses a significant environmental challenge. Annually, millions of Tyres are discarded, leading to severe environmental issues. So, there is a need to take steps to find solutions or alternate disposal measures for these problems. Using Tyre waste in concrete can be a good alternate disposal method for Tyre waste, but other aspects such as behavior of concrete in terms of flexibility, strength, thermal expansion etc. should be studied in detail.

1.2 Objective

The primary objective of this research is to evaluate the potential of using waste Tyre rubber as a partial replacement for fine and coarse aggregates in concrete. The study aims to:

- Assess the mechanical properties of concrete containing Tyre rubber.
- Determine the durability and thermal performance of Tyre rubber concrete.
- Identify suitable applications for Tyre rubber concrete based on its properties.

2. Literature Review

2.1 Previous Research

Previous studies have demonstrated mixed results regarding the use of Tyre rubber in concrete. While some researchers have reported reductions in compressive strength, others have highlighted improvements in flexibility, toughness, and thermal insulation.

2.2 Benefits of Tyre Rubber in Concrete

- Environmental Impact: Reduces landfill waste and the need for natural aggregates.
- Flexibility and Toughness: Tyre rubber can enhance the toughness and impact resistance of concrete.
- Thermal Insulation: Rubber has low thermal conductivity, potentially improving the insulation properties of concrete.

2.3 Challenges

- Strength Reduction: Incorporating Tyre rubber often results in lower compressive and tensile strengths.
- Bonding Issues: Poor adhesion between rubber particles and cement matrix can affect concrete integrity.
- Workability: Rubber particles can alter the workability of the concrete mix, requiring adjustments in mix design.

3. Materials and Methods

3.1 Materials

- Cement: Ordinary Portland Cement (OPC).
- Aggregates: Natural fine and coarse aggregates.
- Tyre Rubber: Shredded waste Tyre rubber in varying sizes.
- Water: Potable water for mixing.

3.2 Mix Design

Different concrete mixtures were prepared with varying percentages of Tyre rubber (5%, 10%, 15%, 20%) replacing the natural aggregates by volume. A control mix with no Tyre rubber was also prepared for comparison.

3.3 Testing Procedures

- Compressive Strength: Measured using a universal testing machine at 7, 14, and 28 days.

- Flexural Strength: Determined using a three-point bending test.
- Impact Resistance: Evaluated using a drop weight test.
- Thermal Conductivity: Assessed using a thermal conductivity meter.

4. Results and Discussion

4.1 Compressive Strength

The results indicated a reduction in compressive strength with increasing Tyre rubber content. The 20% replacement mix exhibited the highest reduction, with a 30% decrease compared to the control.

4.2 Flexural Strength

Flexural strength tests showed that while the initial strength decreased, the post-cracking behavior improved, indicating enhanced toughness.

4.3 Impact Resistance

Concrete containing Tyre rubber demonstrated significantly higher impact resistance, with the 20% replacement mix showing a 50% improvement over the control.

4.4 Thermal Conductivity

The inclusion of Tyre rubber improved the thermal insulation properties of concrete. The 20% replacement mix showed a 25% reduction in thermal conductivity.

4.5 Durability

Durability tests, including freeze-thaw resistance and water absorption, indicated that Tyre rubber concrete had comparable performance to the control mix, suggesting good durability under typical environmental conditions.

5. Conclusion

5.1 Summary

The incorporation of Tyre rubber in concrete presents a viable method for recycling waste Tyres while producing concrete with unique properties. While there are some reductions in compressive and flexural strengths, the benefits in terms of toughness, impact resistance, and thermal insulation make Tyre rubber concrete suitable for specific applications.

5.2 Future Research

Further research is recommended to optimize the mix design and improve the bonding between Tyre rubber particles and the cement matrix. Additionally, long-term durability studies and the

development of standards for Tyre rubber concrete are essential for broader adoption in the construction industry.

References

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