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Experimental Investigation On Partial Replacement of Cement by Marble Powder

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Abstract: *The rapid growth of the construction industry has led to increased cement consumption, resulting in high carbon dioxide emissions and environmental concerns. Simultaneously, marble industries generate a significant quantity of marble waste powder during cutting and polishing processes, creating disposal and pollution issues. The partial replacement of cement with marble powder in concrete offers a sustainable solution by reducing cement usage and recycling industrial waste. This review paper summarizes experimental studies on concrete incorporating marble powder as a partial cement replacement. The effects on workability, compressive strength, tensile strength, and durability properties are discussed. Research findings indicate that replacing cement with marble powder up to 10–20% can enhance strength characteristics and improve sustainability without compromising performance.*

Keywords: *Marble Powder, Cement Replacement, Sustainable Concrete, Waste Utilization, Green Construction*

INTRODUCTION

Cement is a key ingredient in concrete and a major contributor to carbon dioxide emissions due to its energy-intensive manufacturing process. The increasing demand for infrastructure has resulted in excessive cement consumption, raising serious environmental concerns.

At the same time, marble processing industries produce large quantities of waste marble powder during cutting and polishing operations. Improper disposal of this waste causes land pollution, dust problems, and environmental hazards. Utilizing marble powder as a partial replacement for cement in concrete presents an eco-friendly approach to waste management and sustainable construction.

This review focuses on experimental investigations where cement is partially replaced with marble powder at varying percentages (5%, 10%, 15%, and 20%). The influence of marble powder on workability, strength, and durability of concrete is analyzed. Although marble powder improves particle packing and filler effects, excessive replacement may reduce strength due to reduced cement content. Therefore, optimizing replacement levels is essential.

LITERATURE REVIEW

- **Binici et al. (2007) – Construction and Building Materials**
  - Studied the use of marble and limestone dust in concrete. Results showed improved compressive strength at lower replacement levels due to filler effect and better particle packing.
- Corinaldesi et al. (2010) – Cement and Concrete Composites
  - Investigated marble powder as cement replacement and observed increased early-age

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strength up to 10% replacement**.**

- Alyamac & Ince (2009) – Construction and Building Materials
  - Reported that marble powder improves workability and surface finish of concrete. Strength reduction occurred beyond 20% replacement.
- Singh et al. (2015) – International Journal of Civil Engineering
  - Found that 10–15% marble powder replacement produced optimum compressive and tensile strength**.**
- Vardhan et al. (2019) – Journal of Cleaner Production
  - Highlighted environmental benefits such as reduced CO_2 emissions and landfill waste through marble powder utilization.
- Ergun (2011) – Materials and Structures
  - Studied durability properties and found reduced permeability at lower replacement levels.
- Raman et al. (2020) – Materials Today: Proceedings
  - Observed improved workability and comparable strength up to 15% cement replacement.
- Aliabdo et al. (2014) – Construction and Building Materials
  - Reported that marble powder acts as a micro-filler, enhancing concrete density and mechanical performance.
- Kumar et al. (2022) – Materials
  - Confirmed that marble powder replacement up to 20% is suitable for non-structural and low-load applications.
- Patel et al. (2024) – Innovations in Civil Engineering
  - Concluded that marble powder contributes to sustainable concrete with reduced cement content and acceptable durability.

OBSERVATION

Based on the reviewed literature:

- Marble powder improves workability due to fine particle size.
- Optimum cement replacement lies between **10–15%**.
- Compressive and tensile strength improve at lower replacement levels.
- Replacement beyond **20%** may lead to strength reduction.
- Environmental benefits include reduced cement consumption and waste disposal.

CONCLUSIONS

Marble powder generated from marble processing industries can be effectively utilized as a partial replacement for cement in concrete. Experimental studies indicate that cement replacement levels of 10–15% provide optimum mechanical and durability performance. The use of marble powder not only improves sustainability but also reduces environmental pollution and construction costs. Wider adoption of marble powder–based concrete can contribute significantly to eco-friendly and resource-efficient construction practices.

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