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TO EVALUATE THE PERFORMANCE OF DOLOMITE-BLENDED CONCRETE AGAINST CONVENTIONAL CONCRETE

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Abstract

The utilization of supplementary materials in concrete has emerged as an effective approach to improve performance, reduce environmental impact, and optimize construction costs. This study evaluates the performance of dolomite-blended concrete in comparison to conventional concrete by partially replacing cement and conventional aggregates with dolomite in varying proportions of 0%, 2%, 4%, 6%, 8%, and 10% by weight. Experimental investigations were conducted to determine fresh properties through slump tests and hardened properties through compressive, tensile, and flexural strength tests at 7, 14, and 28 days. The results indicate that the inclusion of dolomite up to an optimum level significantly enhances workability and mechanical strength, with peak performance observed at a 6% replacement level. Beyond this proportion, a marginal reduction in strength was recorded. The study concludes that dolomite can be effectively used as a partial replacement material in concrete to achieve improved performance, sustainability benefits, and potential cost savings without compromising structural integrity.

Key Words:- supplementary materials, dolomite-blended concrete, experimental investigations, compressive strength, tensile strength, flexural strength

Introduction

Concrete is the most widely used construction material in the world due to its versatility, durability, and relatively low cost. Traditionally, its composition relies heavily on Portland cement, natural aggregates, and water. However, the large-scale production of cement is associated with high energy consumption and significant carbon dioxide emissions, contributing to global environmental concerns. In addition, the depletion of high-quality natural aggregates has prompted researchers and the construction industry to explore alternative and supplementary materials that can partially replace cement or aggregates while maintaining or enhancing concrete performance.

One such promising material is dolomite, a carbonate mineral composed primarily of calcium magnesium carbonate ($CaMg(CO_3)_2$). Dolomite possesses a unique combination of physical and chemical properties, including high specific gravity, good hardness, and resistance to weathering, making it suitable for use in concrete production. Its fine particles can act as a filler, improving particle packing density, while its mineral composition can influence the hydration process and enhance certain mechanical and durability characteristics of concrete. The use of dolomite can also contribute to cost reduction, waste minimization, and sustainable construction practices.

Blending dolomite with conventional concrete constituents offers the potential to improve workability, compressive strength, tensile strength, and durability while reducing the overall cement content. Previous studies have reported that the incorporation of dolomite as either a partial replacement for cement, fine aggregate, or coarse aggregate can lead to significant changes in fresh and hardened properties, depending on replacement levels, particle size, and mix design. Furthermore, dolomite's alkaline nature may help in mitigating certain chemical attacks, potentially extending the service life of structures.

Given the growing demand for sustainable and high-performance construction materials, it is essential to evaluate the influence of dolomite on the behavior of concrete compared to conventional mixes. This involves systematic testing of fresh properties such as workability and setting time, as well as hardened properties including compressive strength, flexural strength, tensile strength, and durability parameters.

Therefore, the present study aims to evaluate the performance of dolomite-blended concrete against conventional concrete by analyzing its fresh and hardened characteristics at varying replacement levels. The research findings are expected to provide insights into the optimal proportion of dolomite for achieving enhanced performance, cost-effectiveness, and sustainability in concrete production, thereby contributing to eco-friendly construction practices and resource conservation.

Literature Review

Maisam Raza et al (2025) this experimental study investigates the partial replacement of cement with dolomite powder and fly ash in self-compacting concrete (SCC) to enhance sustainability and performance. Dolomite, an anhydrous material composed of calcium magnesium carbonate, was incorporated along with fly ash in varying replacement levels of 15%, 20%, 25%, 30%, 35%, 40%, 45%, and 50% of cement content. Fresh concrete tests assessed workability, while hardened concrete tests measured compressive and splitting tensile strengths at 7, 14, and 28 days of curing. Results showed that dolomite significantly contributed to early-age and improved strength development in SCC by refining the microstructure and filling internal pores, thereby increasing compressive strength. The replacement also promoted the formation of calcium silicate hydrate (CSH) gel, further enhancing mechanical properties. Overall, the combination of dolomite and fly ash not only achieved the required strength levels but also demonstrated potential for sustainable concrete production without compromising performance.

Schuter et al. (2018) highlight that self-compacting concrete (SCC) offers significant advantages in terms of flow ability, reduced water demand, and improved workability without compromising strength or durability. This is achieved through the use of admixtures that act as effective water reducers, enabling lower water-to-cementations material ratios while still maintaining the high fluidity needed for SCC placement, thus minimizing issues like segregation and bleeding. Additionally, these materials facilitate better hydration reactions, which in turn enhance the concrete's long-term strength and durability. From a sustainability perspective, SCC can reduce the environmental footprint of construction by decreasing the reliance on Portland cement—which is energy-intensive to produce—and incorporating supplementary cementations materials such as fly ash, a waste byproduct, thereby promoting resource efficiency and reducing carbon emissions.

Methodology

The methodology for evaluating the performance of dolomite-blended concrete against conventional concrete involved a systematic experimental approach comprising material selection, mix proportioning, specimen preparation, curing, and testing. Ordinary Portland Cement (OPC) of 43 grade, natural fine and coarse aggregates, potable water, and dolomite powder were used, with dolomite partially replacing cement at varying percentages (0%, 2%, 4%, 6%, 8%, and 10%) by weight. Concrete mix design was carried out for M30 grade as per IS 10262:2019, maintaining a constant water-cement ratio. Fresh concrete properties such as workability were assessed using the slump cone test. Standard cube (150 mm), cylinder (150 mm × 300 mm), and prism (100 mm × 100 mm × 500 mm) specimens were cast for compressive, split tensile, and flexural strength tests, respectively. All specimens were demoded after 24 hours and cured in water for 7, 14, and 28 days. Mechanical properties were evaluated according to IS 516:2018 and IS 5816:1999, and results of dolomite-blended concrete were compared with those of conventional concrete to determine the optimal replacement level for enhanced performance.

Result and Discussion

The experimental investigation assessed the effect of partial replacement of cement and conventional aggregates with dolomite at proportions of 0%, 2%, 4%, 6%, 8%, and 10% on the fresh and hardened properties of M30 grade concrete. The results are discussed in terms of workability, compressive strength, split tensile strength, and flexural strength at curing periods of 7, 14, and 28 days.

Workability (Slump Test)

The slump values indicated that the inclusion of dolomite improved the workability of the mix up to 6% replacement. This is attributed to the finer particle size and smooth surface texture of dolomite, which enhances lubrication between particles. Beyond 6% replacement, a slight reduction in slump was observed, likely due to increased water demand caused by the higher surface area of the added dolomite particles. Optimum workability was achieved at 6% replacement.

Compressive Strength

The compressive strength increased progressively with dolomite content up to 6%, after which it decreased. At 28 days, the control mix (0% dolomite) achieved 38.12 MPa, whereas the 6% replacement mix reached the maximum value of 42.19 MPa, representing an improvement of approximately 10.68%. The enhancement is due to dolomite's filler effect, which densities the microstructure and contributes to better bonding in the cement paste. The decline beyond 6% may be attributed to dilution of cementations material, reducing the hydration product formation.

Conclusion

In conclusion, the experimental evaluation of dolomite-blended concrete against conventional concrete demonstrates that partial replacement of cement with dolomite can enhance certain performance parameters, particularly workability, compressive strength, and durability, when used in optimal proportions. The incorporation of dolomite, due to its fine particle size and filler effect, improves the packing density of the mix, leading to reduced porosity and better hydration, while also contributing to sustainable construction by lowering cement consumption and associated CO_2 emissions. However, excessive replacement levels may result in a decline in mechanical properties, indicating that there is an optimal replacement percentage beyond which the benefits diminish. Overall, dolomite-blended concrete offers a viable, cost-effective, and eco-friendly alternative to conventional concrete, provided that the mix design is carefully optimized to balance strength, durability, and sustainability.

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