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Effective use of marble powder and waste brick powder in concrete

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Abstract

Significant progress has been made in the worldwide building sector, mostly as a result of the application of novel materials and structural systems. Concrete is still a key component of contemporary construction among these materials. But because of worries about how it affects the environment, more sustainable options are being investigated. By examining the combined use of brick waste powder and marble powder as partial substitutes in concrete, this study seeks to support sustainable building practices. In particular, brick waste powder substitutes fine aggregate at 10%, 20%, 30%, and 40% levels, while marble powder replaces cement in various amounts of 3%, 6%, 9%, and 12%. In the study, M30 grade concrete was tested for compressive strength, split tensile strength, and flexural strength over seven and twenty-eight days of curing. The results showed that adding these waste materials to concrete significantly improved its qualities. While brick waste powder improved bonding by filling pores in the mix and increasing overall strength, marble powder contributed cementitious qualities.

Keywords: Cement, marble powder, brick powder, strength, concrete

1. Introduction

Concrete is a fundamental component of contemporary building techniques and is well-known for its strength, durability, and versatility. However, the traditional methods of producing concrete mostly depend on limited natural resources, including cement and sand, which present serious financial and environmental problems. In order to overcome these issues and improve the performance of concrete, researchers and engineers have focused more on substitute materials and processes. The construction industry has made extensive use of waste resources, and the outcomes have been superior to those of traditional methods. Concrete is made from a variety of waste products, including sawdust, fly ash, rice husk, and brick waste powder. Low-cost and environmentally friendly building materials have received a lot of attention in light of the aforementioned considerations. The most common kind of building material used worldwide is brick. The partial substitution of brick waste powder for sand and marble powder for cement in concrete formulations is one such potential strategy. Beyond just cost reductions and sustainability considerations, this creative approach offers a wide range of advantages. Furthermore, the foundation of this strategy is sustainability. By reducing the demand for natural resources, partial replacement preserves valuable sand deposits and lessens the environmental impact of sand extraction. Additionally, this method promotes economic principles by recycling resources that would otherwise add to landfill garbage by using waste materials like marble powder, which are obtained from industrial processes.

2. Literature Review

The search for environmentally friendly building materials has accelerated research into industrial waste as potential replacements for traditional concrete ingredients. The viability of replacing some of the cement with waste marble powder, a by-product of the stone processing industry, has been demonstrated by a substantial amount of research. According to studies by [1], the fine marble particles function as an efficient micro-filler at ideal concentrations of 10-15%, strengthening the interfacial transition zone and densifying the cement matrix to produce compressive strength that is on par with or even better[2-3]. However, the intrinsic inertness of calcium carbonate-based marble powder has been noted as a significant limitation throughout literature [4-5]; high-volume replacements beyond this ideal range frequently cause a dilution effect, lowering the cementitious compound content and jeopardizing long-term strength gain. At the same time, studies on substitute fine aggregates have confirmed the potential of Surkhi, or brick waste powder. Concrete's microstructure and durability can be enhanced over time by the chemical reaction of burnt clay powder, a pozzolanic substance, with calcium hydroxide from cement hydration to create more cementitious gel [5-6]. Notwithstanding this benefit, there are still issues, chiefly with its high water absorption and irregular p article shape, which might impair workability and necessitate careful mix design modifications [4,7]. There is a significant study void on the synergistic usage of these materials, despite the fact that many studies have examined them separately. The innovative emphasis of this inquiry is the combination use, where the chemical pozzolanicity of brick waste powder and the physical filler impact of marble powder could complement each other [8-9]. This application is still understudied. These days, mixing materials with different substitutions is widespread. The replacement of brick waste powder and marble powder in cement has been the subject of numerous studies. Numerous topics have been covered and determined in various experiments and trials [10]. By using the leftover brick and marble powder, this substitute can serve as a sustainable solution. Additionally, there hasn't been much research done on the combination of marble powder and brick waste powder, so this experiment's topic was chosen to learn more about it.

3. Materials and Method

Marble powder was used in percentages of 3%, 6%, 9%, and 12% to replace the cement, while brick waste powder was used in percentages of 10% to 40% to replace the sand. A total of sixteen proportional combinations were developed and cast. These dimensions, along with certain cube, beam, and cylinder shapes, were cast and subsequently tested for strength over seven and twenty-eight days. Compressive strength, split tensile strength, and flexural strength were tested. The typical supplies and methods used to achieve the intended outcomes are listed below: Ultratech 53 grade Ordinary Portland Cement used. Marble powder was purchased from local marble vendor. Brick was ground into a fine powder after passing through a 75 micron filter. IS 3182 (1986) was satisfied by the brick waste powder that was utilized. Sieve analysis for fine aggregate provided in Table 1.

Table 1: Sieve analysis of fine aggregate

Sieve size	10(mm)	4.75(mm)	2.36(mm)	1.18(mm)	0.6(mm)	0.3(mm)	0.15(mm)
% passing	100	96.20	80.30	44.20	21.3	1.30	0

4. Result

The results of compressive strength are presented in Figure 1 and the split strength development are presented in Figure 2. The flexural strength development results plotted in figure 3.

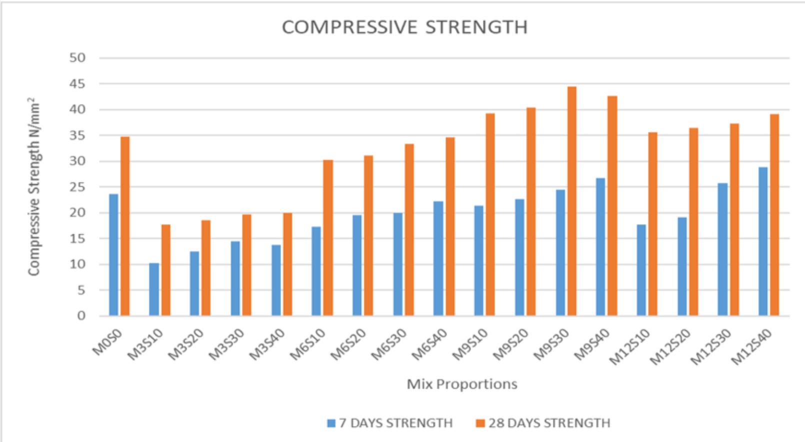

Figure 1: 7 and 28 days of maturity, the compressive strength development

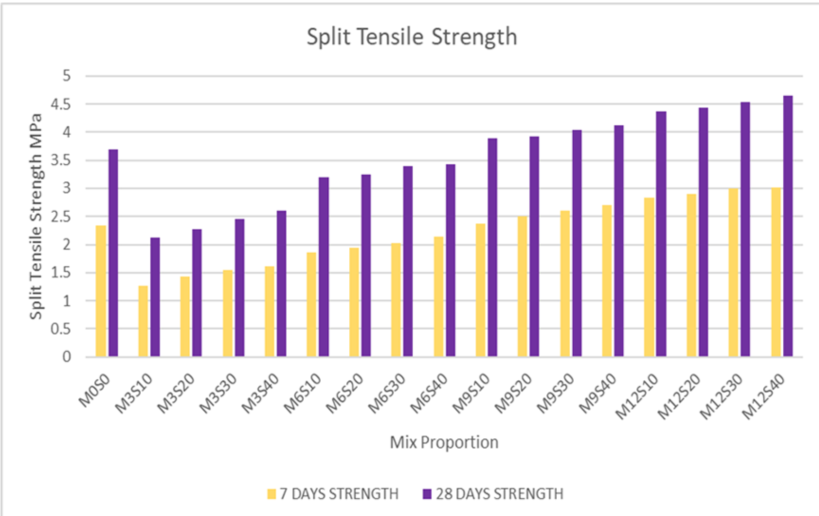

Figure 2: 7 and 28 days of maturity, the split strength development

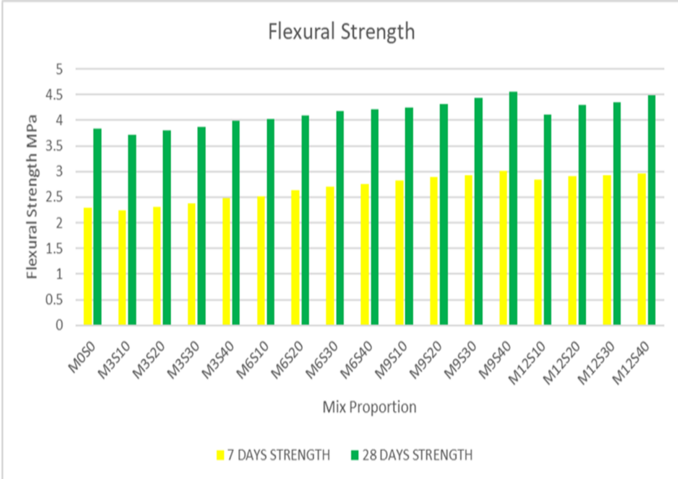

Figure 3: 7 and 28 days of maturity, the flexural strength development

5. Conclusion

For both 7 and 28 days, it was found that the compressive strength increased gradually when sand was replaced with 10%, 20%, 30%, and 40% brick waste powder and cement with 3%, 6%, and 9% marble powder. When 10%, 20%, 30%, and 40% of the marble powder and brick waste powder were replaced, respectively, this pattern was not seen. Although the strength significantly decreased in this modification, the maximum strength was increased. The highest strength was achieved by substituting 9% marble powder and 30% brick waste powder for cement. 44.44 N/mm^2 was the strength that was attained.

Declaration of Conflicting Interests

The authors declare no potential conflicts of interest with respect to the research, authorship and publication of this article.

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References

[1] Aliabdo, A. A., Elmoaty, A. E. M. A., & Auda, E. M. (2014). Re-use of waste marble dust in the production of cement and concrete. Construction and Building Materials, 50, 28–41.
[2] Ashish, D. K. (2019). Concrete made with waste marble powder and supplementary cementitious material for sustainable development. Journal of Cleaner Production, 211, 716–729.
[3] Bektas, F., Wang, K., & Ceylan, H. (2009). Effects of crushed clay brick aggregate on mortar durability. Construction and Building Materials, 23(5), 1909–1914.
[4] Debbarma, S., Ransinchung, G. D., & Singh, S. (2020). Utilizing recycled ceramic aggregates in sustainable concrete: A review. Journal of Cleaner Production, 266, 121984.
[5] Dhanapandian, S., & Gnanavel, B. (2019). Properties of concrete with marble powder as a partial replacement of cement. International Journal of Engineering and Advanced Technology, 8(6), 3804–3811.
[6] Kannan, D. M., Aboubakr, S. H., El-Dieb, A. S., & Reda Taha, M. M. (2017). High performance concrete incorporating ceramic waste powder as a supplementary cementitious material. Construction and Building Materials, 144, 408–417.
[7] Rana, A., Kalla, P., & Csetenyi, L. J. (2015). Sustainable use of marble slurry in concrete. Journal of Cleaner Production, 94, 304–311.
[8] Senthamarai, R. M., & Manoharan, P. D. (2005). Concrete with ceramic waste aggregate. *Cement and Concrete Composites, 27(9-10), 910–913.
[9] Siddique, R. (Ed.). (2008). Waste materials and by-products in concrete. Springer Science & Business Media.
[10] Singh, M., Srivastava, A., & Bhunia, D. (2017). An investigation on effect of partial replacement of cement by waste marble slurry. Construction and Building Materials, 134, 471–488.