



International Journal of Innovative Research in Science Engineering and Technology (IJIRSET)

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)



Impact Factor: 8.524

Volume 14, Issue 1, January 2025

Experimental Investigation on Use of Marble Powder & Fly Ash as Partial Replacement of Fine Aggregate in Concrete

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ABSTRACT: Due to excess cost of transportation from natural sources natural sand is expensive & large-scale depletion of these sources creates environmental problems. A substitute or replacement product for concrete industry needs to be found because environment, transportation and other constraints make the availability and use of natural sand less feasible in mix design. Natural sand used as fine aggregates in production of concrete poses the problem of acute shortage in all parts of country. In this study, the possibility of using fly ash & marble powder in concrete production was examined by studying the effects of blending of fly ash & marble powder with natural sand on the performance of fresh and hardened concrete. This study represents the results of experimental investigation carried out to determine compressive strength and flexural strength of concrete mixes i.e. M25 & M30 in which natural sand was partially replaced with varying percentage of fly ash & marble powder in equal amount ranging from 2.5% to 15% of natural sand by weight. A total of eighteen trial mixes along with universal & compatibility mix were prepared for both grades of concrete. The tests for compressive strength and flexural strength were conducted for each mix at 7 & 28 days and 28 days respectively. Test results indicated significant increment in the strength of concrete with addition of fly ash & marble powder up to a certain percentage replacement of natural sand. However after further increasing the percentage of marble powder & fly ash, a drop in strength of concrete was noted. The concrete technology become advanced which wants to reduce the consumption of natural sources & to improve the quality of environment by using the waste generated from thermal plants & industries.

KEYWORDS: Marble Powder, Flyash, Natural Fine Aggregate, Cement, Concrete, Replacement

I. INTRODUCTION

Concrete is a material synonymous with strength and longevity. It has emerged as the dominant construction material for the infrastructure needs of the twenty-first century. In addition to being durable, concrete is easily prepared and fabricated from readily available constituents and is therefore widely used in all types of structural systems.

The challenge for the civil engineering community in the near future is to realize projects in harmony with the concept of sustainable development and this involves the use of high-performance material sand products manufactured at reasonable cost with the lowest possible environmental impact. Fly Ash & Marble Powder have advantages and disadvantages over natural sand. They are easily available and in cheaper rates remunerating a cost-effective project.

Paper is organized as follows. Section II describes automatic text detection using morphological operations, connected component analysis and set of selection or rejection criteria. The flow diagram represents the step of the algorithm. After detection of text, how text region is filled using an Inpainting technique that is given in Section III. Section IV presents experimental results showing results of images tested. Finally, Section V presents conclusion. Their use also protects delicate fluvial environments from disruption due to sand mining. Environmental limitation has restricted dredging of rivers beds for sand. According to IS 1489, fly ash is used up to 35% in place of Cement. A lot of research has already done on replacement of cement or sand by fly ash but there is very few research on replacement of cement or sand by marble powder. Fly Ash is more common in concrete structure work due to environmental problem.

The continuous reduction of natural resources and the environmental hazards posed by the disposal of fly ash has reached alarming proportion such that the use of fly ash in concrete manufacture is a necessity than a desire. The use of

fly ash in normal strength concrete is a new dimension in concrete mix design and if applied on large scale would revolutionize the construction industry, by economizing the construction cost and decreasing the ash content. Marble has been commonly used as a building material since the ancient times. Rajasthan produces over 95% of the marble produced in India. That is why Rajasthan is the State of India for stone based product. The industry's disposal of the marble powder material, consisting of very fine powder, today constitutes one of the environmental problems around the world.

II. LITERATURE SURVEY

T. Bakoshi, K. Kohno, S. Kawasaki, N. Yamaji (1998) used bottom ash in amounts of 10– 40% as replacement for fine aggregate in their practical work. Their test results indicate that the compressive strength and tensile strength of bottom ash concrete generally increases with the increase in replacement ratio of fine aggregate and curing age.

Rafat S. (2003) carried out a detailed investigation about mechanical properties of concrete mixtures in which fine aggregate was partially replaced with five percentages i.e.10%, 20%, 30%, 40%, and 50% with class F fly ash by weight. He has studied Compressive strength, splitting tensile strength, flexural strength, and modulus of elasticity.

Valeria Carinaldes, Giacomo Moriconi & Tarun R. Naik (2005) have studied on (i) mortar in which fine aggregate is partially replaced by marble powder (ii) mortar in which cement is partially replaced by marble powder, with or without admixture. To obtain the effect of marble powder on mechanical behaviour, different mortar mixture were prepared with sand to cement ratio of 3:1 at the same workability. Results obtained from tests show that 10% substitution of sand by the marble powder in the presence of a super-plasticizing admixture provided maximum compressive strength.

Aggarwal P. and Aggarwal Y. (2007) have studied mechanical properties like compressive strength, split tensile strength and flexural strength at 7, 28, 56 & 90 days in which fine aggregate was partially replaced with five percentages i.e.10%, 20%, 30%, 40%, and 50% with bottom ash by weight.

Hameed and Sekar (2009) reported that marble dust can be used either to produce new products or as an admixture so that the natural sources are used more efficiently and the environment is saved from dumpsites of marble waste.

Hisyam, Mohd. S. and Fadhlhartini M. (2010) reported that Sieve analysis conducted on washed bottom ash is more suitable for mortar rather than concreting sand.

H.K. Kim and H.K. Lee (2011) detailed experimental investigation carried out to evaluate the effect of fine and coarse bottom ash on the flow characteristics and density of concrete mixture and found that both of fine and coarse bottom ash aggregates had more influence on flexural strength than compressive strength.

Jayesh Kumar Pitroda, Nutan Patel & Amit Raval (2013) used waste marble powder as replacement for fine aggregate in their practical work. They have designed M30 grade of concrete and then partially replacing fine aggregate with waste marble powder in range from 5 to 20%. They reported that the compressive strength of concrete mix with marble powder was 5- 10% higher than the reference concrete up to 15% replacement of fine aggregate by marble powder.

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Kirti Vardhan, Shweta Goyal & Rafat Siddique (2015), they have been studied on Mechanical properties and microstructural analysis of cement mortar incorporating marble powder as partial replacement of cement. In that paper the findings suggest that incorporating marble powder as a partial replacement for cement is a viable approach for enhancing sustainability in the construction industry. While up to 10% replacement yields promising results, further research is needed to optimize mix designs for higher replacement levels and evaluate long-term performance in diverse environmental conditions.

K.I. Syed Ahmed Kabeer & Ashok Kumar Vyas (2017), The study by K.I. Syed Ahmed Kabeer and Ashok Kumar Vyas investigates the use of marble powder as a substitute for river sand in mortar mixes. By evaluating parameters like workability, compressive strength, microstructural changes, and sustainability, the research aims to address environmental and resource conservation challenges. This study highlights the feasibility of using marble powder as a sustainable construction material. Replacing up to 20% of sand achieves better performance while reducing dependency on natural sand and addressing waste disposal issues.

Vishal Singhal, Ravindra Naga, & Vinay Agrawal (2020), The study by Vishal Singhal et al. evaluates the feasibility of using marble slurry powder (MSP) and fly ash (FA) as replacements for fine aggregate and cement, respectively, in concrete. The research focuses on the fresh properties, flexural strength, and permeability to assess the sustainability and performance of the concrete mixes. This research demonstrates the potential of MSP and FA for sustainable concrete production by reducing reliance on natural resources and addressing waste disposal challenges. The mix with 35% FA and 20% MSP substitution achieves a balance of enhanced durability, environmental benefits, and cost efficiency.

Cheng Wang, Xiao Zhao (2024), they have studied of waste incineration bottom ash as fine aggregate applied to green alkali-activated bottom ash-slag concrete. In this study they found that optimum performance was achieved by using 50% of bottom ash fine aggregate in place of natural fine aggregate for making alkali-activated bottom ash-slag concrete. Compressive strength better than natural concrete at 100% replacement of bottom ash fine aggregates. Flexural strength better than natural concrete at 75% replacement of bottom ash fine aggregates.

Saloua Filali, & A. Nasser (2024), They have been studied on evaluating the potential of fly ash (FA) and marble coarse aggregates (MCA) as eco-friendly substitutes in concrete, addressing the dual challenges of resource depletion and waste management. The research examines workability, compressive strength, split tensile strength, flexural strength, ultrasonic pulse velocity, and Schmidt hammer rebound values.

Anil Kumar, & Mr. Ushendra Kumar (2024), they comparative studied on the effects of partial replacement of fine aggregate with marble dust in concrete provides valuable insights into the potential benefits and challenges of utilizing marble dust as a sustainable alternative in construction materials. Through a thorough examination of various parameters including compressive strength, workability, durability, and environmental impact, it becomes evident that the incorporation of marble dust can significantly influence the properties of concrete.

III. METHODOLOGY

Experimental Program

Material for Experimental Investigation

Coarse Aggregate

In this experimental program two size of coarse aggregate is used

- a) 20mm coarse aggregate
- b) 10 mm coarse aggregate.

Fine Aggregate

There is four grading zone of fine aggregate as per Table 4 of IS-383:1970 i.e. Grading Zone I, Grading Zone II, Grading Zone III & Grading Zone IV. This grading zone classified as per percentage passing material from 600 micron sieve.

Cement

Cement used in the experimental procedure was a Ordinary Portland Cement 43-Grade as per IS-8112. The brand name of cement is Shree Cement.

Fly Ash

The fly ash is taken as Per IS-1489 code recommendation from Min. 15% to Max. 35% which includes pulverized coal fly ash from Kota Thermal Power Plant. In Rajasthan Class I & II type is available. In this study the sample from Kota Thermal Power Plant is taken and by passing 45 micron sieve it was found residue percentage lies in range of 12% to 15% which is in limit.

Marble Powder

Rajasthan is known for marble stone based products. The major sources of environmental degradation in the areas where marble quarries and marble processing units are located are solid marble waste, powder and slurry. The marble powder used in this work is taken from makrana. Ten type of marble is available on the basis of color.

Chemical Admixtures

As per specification of IS code, the various types of admixture are there like water reducing, retarder and water reducing and retarding admixture. When used in large dosage, it can have a negative effect on setting times.

IV. RESULT

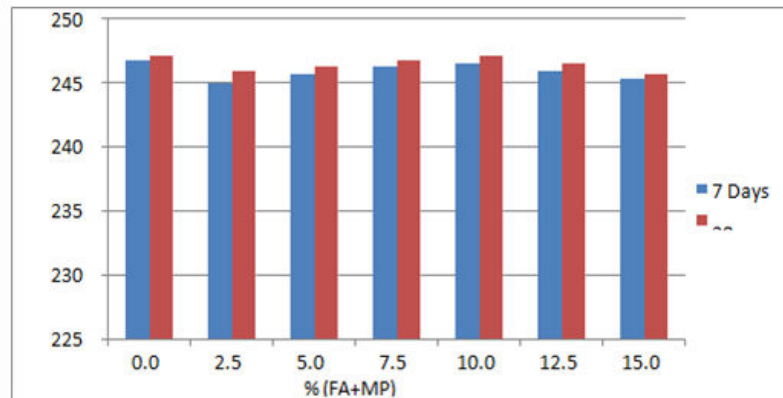


Figure 1 Effect of Fly Ash & Marble Powder on Density of Hardened Concrete of M-25 grade with age

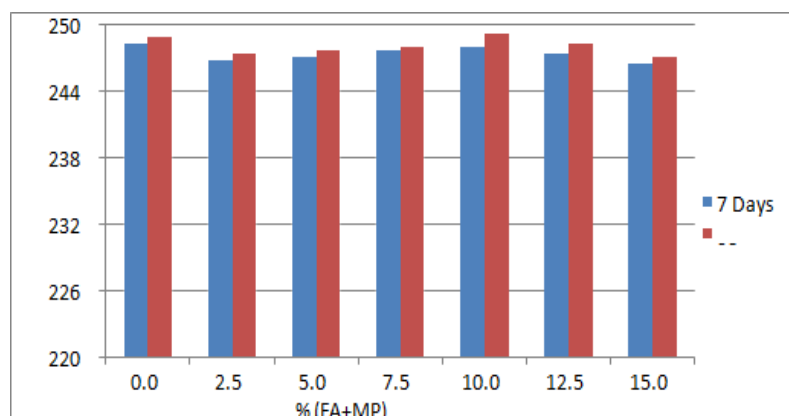


Figure 2 Effect of Fly Ash & Marble Powder on Density of Hardened Concrete of M-30 grade with age

V. CONCLUSION

1. The compressive strength of blended concrete mix is increased upto 10 % replacement of natural sand with equal amount of fly ash & marble powder and after that compressive strength was decreased.
2. The flexural strength was increased up to 10% replacement of natural sand with equal amount of fly ash & marble powder as compared to controlled concrete & after that it was decreased. The beam specimen of size 150 mm × 150 mm × 700 mm was tested for single point load at the midpoint under the UTM of capacity 100 ton.
3. Environment friendly approach is most important aspect and is touched due to understanding of earth life balance along with pollution free society.
4. The surface finish of cube and beam manufactured by blended concrete mix is better than the surface finish of cube and beam manufactured by control mix.
5. The slump of blended concrete mix is increased up to 7.5% replacement of natural sand and after that it will decrease.

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