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Partial Replacement of Cement with Marble Powder in Concrete

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ABSTRACT: Marble powder is one of the most active research areas that encompass several disciplines including civil engineering and construction materials. The marble industry inevitably produces waste, irrespective of the improvements introduced in manufacturing processes. In the marble industry, about 50 to 60% of production waste. This waste creates many environmental dust problems in now day-to-day society. It requires a suitable form of management to achieve sustainable development. This paper explained the behavior of concrete with partial replacement of cement with added percentage values of marble powder and attain the required strength. Partial replacement of marble powder in cement accordingly in the range of 10%, 20%, and 30%, by weight for M35 grade of concrete. With this experimental research work the problem of waste production management of this agro waste will be solved. It analyzed the research work the workability, and compressive strength values at 7, 14, and 28 days. The ability to use recycled waste material to form concrete brings a new dimension to construction and helps for the sustainability of the built environment.

KEYWORDS: Cement (53 grade), Marble powder, Fine aggregate (M-sand), Coarse aggregate (20mm size)

I. INTRODUCTION

This paper aims to focus on the possibilities of using waste materials from different manufacturing activities in the preparation of innovative mortar and concrete. The marble stone industry generates both solid waste and stone slurry. Leaving the waste materials to the environment directly can cause environmental problems. Advanced concrete technology can reduce the consumption of natural resources and energy sources, thereby less the burden of pollutants on the environment. We describe the feasibility of using marble sludge dust in concrete production as a partial replacement for cement. These materials, participate in the hydraulic reactions, contributing significantly to the composition and microstructure of hydrated products. Presently large amounts of marble dust are generated in natural stone processing plants with an important impact on the environment and humans. This project describes the feasibility of using the marble sludge dust in concrete production as a partial replacement of cement.

In INDIA, marble and granite stone processing is one of the most thriving industries the effects of varying marble dust contents on the physical and mechanical properties of fresh and hardened concrete have been investigated. The use of replacement materials offers cost reduction, energy savings, arguably superior products, and fewer hazards in the environment. In this project, our main objective is to study the influence of the partial replacement of cement with marble powder and to compare it with the compressive and tensile strength of ordinary M20 concrete. We are also trying to find the percentage of marble powder replaced in concrete that makes the strength of the concrete maximum. Nowadays marble powder has become a pollutant. So, by partially replacing cement with marble powder, we are proposing a method that can be of great use in reducing pollution to a great extent.

II. LITERATURE REVIEW

Gopi R. (2019) The analysis of the characteristics of concrete namely the workability, strength, and durability are made based on the fundamental study initiated to arrive at the feasibility and suitability of using marble powder as a partial replacement material by 0, 5, 10, 15, 20 and 25% weight of cement in M30 grade concrete. The compressive strength at 7, 14, and 28 days increases with the increase in the replacement level of cement with marble powder up to 15% replacement at which the compressive strength is 14.53% higher compared to conventional concrete.

M Ofuyatan, A M Olowofoyeku, J Obatokiand, J Oluwafemi (2015) The addition of waste marble dust as a constitutive material of concrete had a good slump of fresh concrete. At 25%, marble dust had a strength greater than the control at 56 days. However, the addition of waste marble dust increased the tensile strength by 17% at 25%. The addition of waste marble dust increased the compressive strength of concrete by 11% at 25% Marble dust content. The optimum percentage for the replacement of sand with Marble waste is 25% for both cubes and cylinders.

Dhanalakshmi, M. Shahul Hameed (2013) The use of leftover marble dust powder as a concrete constituent resulted in a satisfactory slump of fresh concrete. Marble dust had a strength of 15% larger than the control after 28 days. The addition of marble dust powder, on the other hand, enhanced the tensile strength by 15%. By adding 15% marble dust powder to the concrete, the compressive strength of the concrete was improved. For both cubes and cylinders, the optimal percentage for replacing sand with Marble waste is 15%. Because Marble Dust powder is inexpensive, this study proposed a simple and practical method for reducing concrete manufacturing costs. The effect of marble dust powder is responsible for enhancing compressive strength.

N. Gurumoorthy (2014) The Compressive strength, Split Tensile strength, and Flexural strength are increased with the addition of waste marble dust up to 25% replaced by the weight of cement. Further any addition of waste marble dust the compressive strength, Split Tensile strength, and Flexural strength are decreased. Therefore, we conclude that the most suitable percentage replacement of marble dust in concrete is 25%. Thus, we found out the optimum percentage for the replacement of marble dust with cement and it is almost 25% cement for cubes, cylinders, and prisms. The result of this investigation is that marble dust could be conveniently used in making good-quality concrete.

Ms. Ruchi Chandrakar, Mr. Avinash Singh (2015) Replacing cement with marble dust powder increases the consistency of cement, leading to higher water consumption in concrete and potential bleeding. This replacement also prolongs the initial setting times of cement, consequently decreasing final setting times, which can compromise concrete strength. Moreover, exceeding a 10% replacement threshold diminishes compressive strength. Graphically, up to 10% replacement enhances compressive strength, but exceeding this threshold leads to a decline. Thus, in M-20 grade concrete, replacing up to 10% of cement with marble powder boosts compressive strength, beyond which strength diminishes.

III. PROPOSED METHODOLOGY AND DISCUSSION

In this project, our main objective is to study the influence of partial replacement of cement with MDP. The compressive strength of ordinary M35-grade concrete is obtained. Similarly, compressive strength, tensile strength & flexural strength were obtained for 10%, 20%, & 35% replacement of cement with MDP by weight. The water cement ratio (0.41) kept constant throughout the investigation of this project work.

1. To study the physical properties of Marble dust powder
2. To characterize the particle size of Marble dust powder
3. MDP as a replacement of cement material.
4. To study the effect of MDP inclusion on the properties of concrete

The evaluation of marble powder which is used as a replacement for cement material begins with concrete testing. With the conventional concrete 10%, 20%, and 30% of the marble powder was replaced with cement. weight batching is done by volume, but most specifications require that batching be done by mass rather than volume. Cement: 53 grade (OPC), Content=478kg/m³.

Combination material mix proportion: (M35 grade) is 10262- 2009.



- **Batching and mixing of materials:**
Batching of materials was done by weight. The percentage replacements of Ordinary Portland cement (OPC) by marble powder were, 10%, 20%, and 30%.
- **Concrete Mix Design:**
The concrete used in this research work was made using Binder, Sand, and Gravel. The concrete mix proportion was 1:1.42:2.44 by weight.
- **Test specimens:**
Test specimens consisting of 150×150×150 mm cubes for Compressive strength, for M35 grade of concrete mix were cast and tested as per IS: 516 and 1199.
- **Curing of concrete:**
Casting of concrete after the completion of 24 hours mould will be removed and then cured by using portable Water. The specimen is fully immersed in potable water for specific ages of 7, 14, and 28 days. After the Completion of curing, it will be tested.

In this study, ordinary Portland cement 53 (OPC 53) was employed, characterized by a specific gravity of 3.15, with initial and final setting times recorded at 140 minutes and 250 minutes, respectively. The standard consistency of cement was determined as 30.5%. Fine aggregate consisted of artificial sand, possessing a specific gravity of 2.84 and a fineness modulus of 3.3. Coarse aggregates, sourced locally, were of 20mm size, with a specific gravity of 2.98 and a flakiness index of 6.7, featuring fine angular sharpened edges. Potable water, essential for mixing and curing, adhered to a water-cement ratio (W/C) of 0.41 (41%), falling within the range of 6 to 7.5 parts per million (PPM). Marble dust, procured from Nero marbles, exhibited a specific gravity matching that of the fine aggregate at 2.84, with a corresponding fineness of 3.3

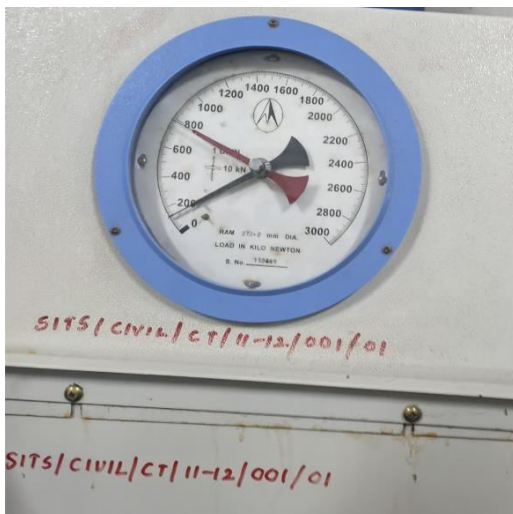
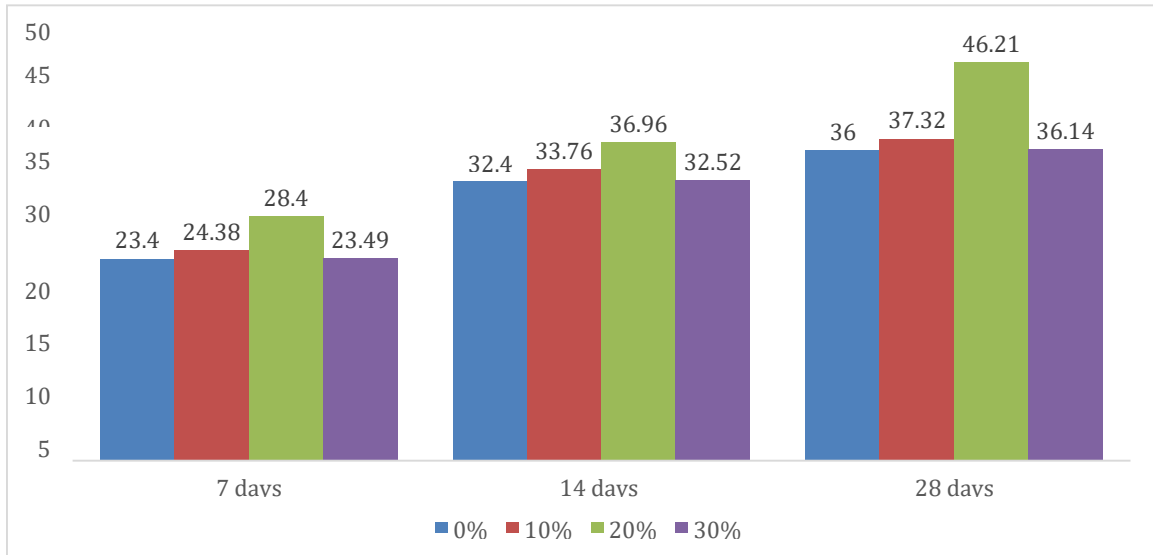
IV. RESULT

Compressive Strength Tests on Concrete Cubes:

The test results are also presented in Table 1. By increasing the marble dust the compressive strength values of concrete tends to increase at each curing age. This trend can be attributed to the fact that marble dusts possess cementing properties. It is also as much effective in enhancing cohesiveness due to lower fineness modulus of the marble powder. Furthermore, the mean strength of concrete mixes with marble dust was 15-20% higher than the reference concretes. However, there is a slight decrease in compressive strength value concrete mix when 30% marble dust is used as compared with that of 25% marble dust mix.

Table 1: Compressive Strength of Concrete Cubes with various percentages of marble powder:

No. of days	0%	10%	20%	30%
7 Days	23.4 MPa	24.38 MPa	28.4 Mpa	23.49 MPa
14 Days	32.4 Mpa	33.76 Mpa	36.94 Mpa	32.52 Mpa
28 Days	36 Mpa	37.32 Mpa	46.21 Mpa	36.14 Mpa



V. CONCLUSION

Due to marble dust, it proved to be very effective in assuring very good cohesiveness of mortar and concrete. From the above study, it is concluded that marble dust can be used as a replacement material for cement; and 20% replacement of marble dust gives an excellent result in strength aspect and quality aspect. The results showed that the substitution of 20% of the cement content by marble stone dust induced higher compressive strength and improvement of properties related to durability. Test results show that this industrial waste is capable of improving hardened concrete performance by up to 20%, enhancing fresh concrete behavior, and can be used in plain concrete

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