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Investigation into the Mechanical Properties of Concrete Using Steel Fiber and Marble Dust with Partially Replacing Fine Aggregate

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Abstract- The appropriateness of fiber-reinforced concrete by partially substituting steel fiber and marble dust powder is reviewed in this research. Concrete is one of the most important and widely utilized materials in the building industry. Marble dust powder MDP was a waste product from the marble industry that would harm the environment if it wasn't disposed of properly.The project's objective is to replace fine aggregate with marble dust powder. The addition of marble dust powder to concrete was done without compromising the material's mechanical qualities. Furthermore, steel fibers were included to improve the concrete's mechanical qualities.were examined in relation to different moisture contents and grades.

Key Words: Concrete, Marble Dust, Steel Fiber, Fiber Reinforced Concrete, Compressive Strength, Plain cement concrete.

I. INTRODUCTION

Since the early research done in the 1960s by Romualdi and Batson, fiber reinforced cement and concrete materials (FRC) have undergone a gradual development. By the 1990s, new manufacturing processes with high fiber content were created, and a variety of fiber composites and FRC products were on the market. The composite material known as fiber reinforced concrete (FRC) is made up of fibers, water, coarse aggregate, sand, and cement. Throughout the concrete bulk of this composite material, short, distinct threads are dispersed at random. The behavioral efficiency of this composite material is significantly higher than that of several other construction materials of comparable cost as well as plain concrete. This advantage has led to a steady increase in the use of FRC over the past 20 years. Its current applications include rock-slope stabilization, bridge deck overlays, mine and tunnel linings, earthquake and explosive resistant structures, airport and highway pavements, and hydraulic structures.,

Marble dust

One of the waste products of the marble industry is marble powder. It is acquired by the cutting, shaping, and polishing procedures. It is gathered as slurry close to the industry's disposal site. It combines with the water and renders it unusable. Marble has long been used as a building material, particularly for palaces and monuments.Therefore, using these marble wastes in the construction sector itself will reduce the overexploitation of sand natural resources and safeguard the environment from marble dumpsites.

Steel fiber

Steel fibers are wire filaments that have been bent and cut to length for use as reinforcement in composite materials like mortar and concrete. It is a corrugated, flattened wire fiber that is cold pulled.

Steel fibers are added to help change the brittle properties into ductile ones. Adding discrete steel fibers as reinforcement to concrete is one tactic used to increase compressive strength more quickly without compromising ductility.It is clear that the orientations, distributions, aspect ratios, geometrical forms, and mechanical characteristics of the fibers in the concrete mixture affect how HFRC behaves.

II. LITERATURE REVIEW

Dr. Rajeev Chandak, R.K. Yadav, and Bhupendra Singh Kalchuri (2015) investigate the potential of using leftover marble powder as a partial substitute for fine aggregate in concrete. In the investigation, 150x150x150 mm concrete cubes were cast using a design mix for M30 grade concrete that was developed in accordance with the Indian Standard (IS: 10262–1982). This mix was made by partially substituting fine aggregate with five different percentages by weight of marble powder (0%, 10%, 20%, 30%, and 40%). Each mix's nine specimens were made. The specimens were taken out of the mold after 24 hours and allowed to cure in water for 7, 28, and 90 days.

A calibrated compression machine was used to measure the specimens' compressive strength after they had cured. At 28 days of curing, the compressive strengths of concrete with 0%, 10%, 20%, 30%, and 40% marble dust replacement were 39.55 N/mm2, 40.59 N/mm2, 41.04 N/mm2, 36.15 N/mm2, and 33.48 N/mm2, respectively. From this, we deduce that when the percentage of marble powder waste is raised to 20%, the compressive strength of concrete increases, and when the percentage of marble powder waste is further increased, the compressive strength decreases. Additionally, they show that leftover marble powder can be effectively used to partially substitute fine aggregate in the manufacturing of concrete. The issue of their disposal and environmental contamination will be lessened by their use in concrete.

According to Mr. L. Satish Kumar and Mr. M. Srinivasa Rao (2017), marble dust can be used in place of fine aggregate. Using the IS method of mix design, an M25 grade concrete mix was created for this project. Concrete specimens measuring 150 x 150 x 150 mm cubes were used to test the specimens' compressive strength. According to the test results, fine aggregates can be used in varying amounts to replace marble dust, including 0%, 5%, 10%, 15%, 20%, 25%, 30%, 30%, and 40%. Each concrete grade for each proportion is tested as cubes over three, seven, and twenty-eight days in order to evaluate the strength criteria. hich is 25 N/mm2. According to the results of this experimental study, Marble In the future, dust may be utilized as a substitute for natural river sand.

Arjun Kumar, Kanav Mehta, R. S. Bansal, and Akshit Mahajan (2018) Their study's objective is to use steel fibers and marble dust powder (MDP) in regular concrete to comparatively increase the material's tensile and flexural strengths in addition to its compressive strength. Steel fibers were added to the volume fraction of concrete at 0.5%, 1%, and 1.5%, and the powdered marble dust was substituted with 5%, 10%, 15%, and 20% of the cement's weight. Without the addition of any admixtures, controlled workability is demonstrated in this investigation utilizing M25 grade concrete with a w/c of 0.45. To determine the compressive strength of masses, 150X150X150 mm cube specimens and 150X300 mm cylinder specimens were created and tested in CTM.

The two point static flexural loading machine was used to create and test the beam specimens, which had dimensions of 100 x 100 x 500 mm. Flexural strength and admixture concrete mass are determined after 7 and 28 days. It has been found that concrete's qualities improve significantly when 10% of MDP is substituted with cement. According to this study, MDP and fiber-mixed concrete offer significantly higher qualities in terms of enhancing all strength as mentioned above, and the usage of fibers offers superior qualities in terms of crack management and high strengths. Therefore, the best combination for this has been determined to be 15% MDP and 1% HE steel fibers in concrete, which improves the concrete's qualities. Strengths began to decline as MDP was increased above 15% because of a modest increase in brittleness compared to utilizing cement. Additionally, a decrease in strengths was noted when fiber was increased over 1%, most likely as a result of the concrete particles' inability to adhere to one another. It has been determined that after 28 days, the maximum increase in compressive strength, split tensile strength, and flexural strength at optimal is 36.9 MPa, 4.24 MPa, and 5.46 MPa, respectively, from the original values of 32.8 MPa, 3.24 MPa, and 4.34 MPa. They draw the conclusion that, in order to improve the overall performance of concrete, Hooked End steel fibers, which make up 1% of the volume of concrete, were used to replace up to 15% of the MDP.

cement, which was mixed with steel fibers. Steel binding wires, which are inexpensive and readily available locally, were employed as steel fibers in this study. Steel fibers were incorporated into
varying proportions, such as 0%, 0.5%, 1%, 1.5%, and 2%, in addition to leftover marble powder. In this work M20 grade with mix ratio of 1:1.5:3 and w/c ratio of 0.45 was adopted. After 28 days of curing, the corresponding compressive strengths are 24.80 N/mm2, 25.45 N/mm2, 26.10 N/mm2, 28.95 N/mm2, and 24.30 N/mm2, with marble dust replacement ranging from 0% to 5%, 10%, 15%, and 20%.

This indicates that the compressive strength dropped with an additional 20% of marble dust, making it safe to replace 15% of marble dust. When varying the proportion of steel fiber at 0%, 0.5%, 1.0%, 1.5%, and 2.0%, the compressive strength of various mixes with 15% marble powder was 28.95 N/mm2, 29.65 N/mm2, 30.90 N/mm2, 28.80 N/mm2, and 28.65 N/mm2.The equivalent split tensile strength, which was 2.98 N/mm2 when 15% marble dust and 1% steel fiber were added, was also higher than when these proportions were used: 0%–2.69 N/mm2, 0.5%–2.78 N/mm2, 1.5%–2.63 N/mm2, and 2.0%–2.55 N/mm2. Concrete containing 15% marble dust and 1% steel fiber had a higher flexural strength (6.67 N/mm2) than concrete with other proportionate values (0%–6.35 N/mm2, 0.5%–6.41 N/mm2, 1.5%–6.31 N/mm2, 2.0%–6.28 N/mm2).
Based on those findings, 1% steel fiber combined with a 15% marble powder substitution partially yields superior outcomes in every category. The best concrete mix is one that contains 15% marble dust instead of cement since, at 28 days, it has been found to significantly boost the concrete's compressive, flexural, and split tensile strengths when compared to a nominal mix. This investigation leads us to the conclusion that adding marble dust to concrete along with steel fibers improves the concrete's qualities and that marble dust can be used in place of cement and fine aggregate.

Dr. B G Vishnuram and Vasudev R at (2013) A comparison between regular reinforced concrete and steel fiber reinforced concrete was conducted in this paper. Turn fibers were the fibers employed in this investigation. They were leftovers from stores that sold lathes. With different percentages of fibers ranging from 0, 0.25, 0.5, 0.75, and 1%, the concrete mixes M20 and M30 were used. The findings of this investigation are contrasted with those of turn steel fibers and available steel fibers. Concrete cylinders (15 cm in diameter and 30 cm in length) and nominal concrete cubes (15 cm by 15 cm by 15 cm). egular and crimped-shaped fibers (3 cm to 4 cm in length) were mixed with the aggregate, and it was ensured that the fibers were evenly dispersed throughout the mixture.

Two sets of ten cubes each of the M20 and M30 mixes were cast without fibers in order to perform the compressive strength testing. When concrete cubes of M20 grade with turn steel fiber content ratios of 0%, 0.25%, 0.5%, and 0.75% are cured for 28 days, their compressive strengths are 25.84 N/mm2, 20.58 N/mm2, 24.84 N/mm2, and 24.71 N/mm2, and when M30 cubes are cured for 28 days, their compressive strengths are 39.36 N/mm2, 35.9 N/mm2, 37.57 N/mm2, and 36.67 N/mm2, It is evident from this investigation that adding turn steel fibers to concrete of the M20 and M30 grades does not significantly boost compressive strength. The cylinders were placed in a cylindrical mold that measured 15 cm in diameter and 30 cm in height in order to evaluate the split tensile strength. After 28 days of curing, the split tensile strength with fiber content ratios of 0%, 0.25%, 0.5%, 0.75%, and 1% is 2.373 N/mm2, 2.476 N/mm2, 2.844 N/mm2, 2.637 N/mm2, and 2.419 N/mm2.In addition, the M30 mix After 28 days of curing, the split tensile strength with fiber content ratios of 0%, 0.25, 0.75, 0.75%, and 1%

is 2.6 N/mm2, 2.87 N/mm2, 3.17 N/mm2, 2.8 N/mm2, and 2.68 N/mm2. By adding 0.5% fibers to both concrete grades, the split tensile strength was raised. We draw the conclusion from this investigation that adding turn steel fibers to concrete did not result in a significant increase in compressive strength. The addition of turn steel fibers to plain concrete increases its splitting tensile strength by 20% for M20 concrete and 22% for M30 concrete. The recycling of waste in this study was a perfect illustration of sustainable development. It is evident from this study that steel fibers can be used in place of turned fibers to increase the concrete's tensile, compressive, and toughness strengths.

In their "Experimental Study on Use of Waste Marble Dust in Concrete," Aalok D. Sakalkale, G. D. Dhawale, and R. S. Kedar (2014) examined the effects of replacing fine aggregate with marble dust at proportions of 0%, 25%, 50%, and 100% on the characteristics of concrete.

The typical mechanical properties of concrete must be examined at 3, 7, and 28-day curing ages in order to ascertain the impact of the marble dust on the curing age. The weight of the fine aggregate was taken into account while replacing the Marble Dust Powder (MDP). e of marble dust powder were evaluated in their investigation; the results are shown for curing times of 3, 7, and 28 days. After 28 days of curing, the compressive strength was 31.73N/mm2 with the marble dust at 0%. After 28 days of curing, a compressive strength of 33.11N/mm2 was achieved at 25% marble dust. The strength of compression 35.54N/mm2 following a 28-day curing time with 50% MDP. The compressive strength was 21.32N/mm2 at 100% MDP. It has been found that 50% MDP mix is the most ideal percentage of MDP, and that as MDP% is increased further, compressive strength steadily declines. After 28 days of curing, the greatest tensile strength for split tensile strength is achieved at 0% MDP mix, or 8.12N/mm2, in contrast to mixes of 25%-7.93N/mm2, 50%-6.91N/mm2, and 100%-3.82N/mm2. However, with 0% MDP, the tensile strength is roughly the same as at 25% MDP mix. Better tensile strength can therefore be obtained with a 25% MDP mix. The equivalent flexural strengths for MDPs of 0%, 25%, 50%, and 100% are 4.43 N/mm2, 4.70 N/mm2, 5.10 N/mm2, and 3.51 N/mm2. At all curing ages, the highest flexural strength is attained at 50% MDP mix. Therefore, the ideal MDP proportion is obtained with a 50% MDP mix. When discarded marble powder is added to concrete up to 50% by weight in place of sand, the concrete's compressive strength increases; however, the compressive strength falls with each additional addition. From a control mix to a complete replacement of sand, the inclusion of discarded marble powder reduces the split tensile strength of cylinders. But when 25% of the sand is replaced, the tensile strength is almost comparable to that of the control mix. Better tensile strength can therefore be obtained by replacing 25% of the sand with MDP. By replacing 50% of the sand with waste marble powder, the flexural strength of beams is also boosted before progressively declining. According to their research, the ideal percentage of marble powder to replace sand in concrete is about 50%; this replacement percentage was added to concrete to increase its efficiency.

III. CONCLUSIONS

From the study the following conclusions are described as follows:

- Mechanical qualities like compression strength, flexural strength, and splitting tensile strength rapidly improve as the amount of steel fiber increases. The reinforcement effect of steel fiber is particularly noticeable for flexural and splitting tensile strength.
- For different concrete classes, marble dust powder worked well as a substitute for fine aggregate.
- According to this study, adding steel fibers to concrete significantly improves its overall strength and ductility, and replacing some of the fine aggregate with marble dust powder by 20–30% improved the concrete's mechanical qualities.
- In the future, the project will conduct an experimental inquiry on the partial substitution of marble dust powder (MDP) as fine aggregate with steel fibers in different proportions.

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