

Study on Mechanical Behaviour of Concrete with Steel Fiber and Marble Dust with Partial Replacement for Fine Aggregate

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ABSTRACT This paper presents a review of literature regarding the suitability of fiber reinforced concrete by partial replacement of marble dust powder and steel fiber. Concrete is one of the most vital and common materials used in the construction field. Marble dust powder MDP was waste product from marble industry, without proper disposal that'll affect the environment. The scope of this project is to Use the Marble Dust Powder as a replacement of Fine aggregate. Marble Dust Powder was added to concrete in manner without affecting the Mechanical properties of concrete. In addition to that, Steel Fibers was added to increase the Mechanical properties of concrete. when used with varying gradation and moisture content were studied.

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

I. INTRODUCTION

Fibre reinforced cement and concrete materials (FRC) have been developed progressively since the early work by Romualdi and Batson in the 1960s. By the 1990s, a wide range of fibre composites and FRC products were commercially available and novel manufacturing techniques were developed for use with high fibre content. Fibre reinforced concrete (FRC) is a composite material consisting of cement, sand, coarse aggregate, water and fibers. In this composite material, short discrete fibers are randomly distributed throughout the concrete mass. The behavioural efficiency of this composite material is far superior to that of plain concrete and many other construction materials of equal cost. Due to this benefit, the use of FRC has

steadily increased during the last two decades and its current field of application includes: airport and highway pavements, earthquake-resistant and explosive-resistant structures, mine and tunnel linings, bridge deck overlays, hydraulic structures, rock-slope stabilization, etc.,

1.1 Marble dust

Marble powder is one of the waste produces in marble industry. It is obtained during the processes of cutting, shaping and polishing. It is collected as slurry near the dumpsite of the industry. It mixes with the water and makes it unfit for reuse. Marble as a building material especially in palaces and monuments has been in use for ages. Thus, utilizing these marble waste in construction industry itself would help to protect the environment from dumpsites of marble and also limit the excessive mining of natural resources of sand.

1.2 Steel fiber

Steel fibers are filaments of wire, deformed and cut to lengths, for reinforcement of concrete, mortar and other composite materials. It is a cold drawn wire fibre with corrugated and flatted shape. The addition of steel fibers helps in converting the brittle characteristics to ductile ones. To faster the compressive strength without sacrificing the ductility, a strategy adopted is to add discrete steel fibers as reinforcement in concrete. It is obvious that the behaviour of HFRC depends on the orientations, distributions, aspect ratios, geometrical shapes and mechanical properties of fibers in concrete mixture.

II. LITERATURE REVIEW

Bhupendra Singh Kalchuri, Dr. Rajeev Chandak, R.K.Yadav (2015) explore the possibility of using marble powder waste as partial replacement of fine aggregate in concrete. In the study, Based on the Indian Standard (IS: 10262 – 1982), design mix for M30 grade of concrete was prepared by partially replacing fine aggregate with five different percentages by weight of marble powder (0%, 10%, 20%, 30%, and 40%,) and 150x150x150 mm concrete cubes were casting. The nine specimens of each mix were prepared. After 24hrs the specimens were removed from the mould subjected to water curing for 7, 28 and 90 days. After curing, the specimens were tested for compressive strength using a calibrated compression machine. The compressive strength of concrete with marble dust replacement of 0%, 10%, 20%, 30%, and 40%, at the curing period of 28 days correspondingly was 39.55N/mm², 40.59 N/mm², 41.04 N/mm², 36.15 N/mm², 33.48 N/mm². From this we conclude that, The compressive strength of concrete is increased when the percentage of marble powder waste is increased up to 20% and by further increasing the percentage of marble powder waste compressive strength gets reduced. They also indicates that the waste marble powder can be successfully utilized as partial replacement of fine aggregate in concrete production. Their use in concrete will alleviate the problem of their disposal and environmental pollution.

Mr. L.SATISH KUMAR and Mr.M.SRINIVASA RAO (2017) list out the possibilities of using Marble dust as a replacement for Fine aggregate. In this work, M25 grade concrete mix was developed using IS method of mix design. Specimens of dimension of 150 x 150 x 150mm cubes were cast for compressive strength of concrete specimens. The test results indicate that with the use of replacing Marble dust by fine aggregates in different percentages i.e. 0%, 5%, 10%, 15%, 20%, 25%, 30%, 30% and 40%. For evaluation of strength parameters each grade of concrete for each proportion in the form of cubes casted for testing at 3 days, 7days and 28 days periods. The compressive strength increases with the increase in percentage of Marble dust up to 30%. The maximum compressive strength of M25 grade concrete occurred at 30% replacement of fine aggregate was observed as 35.41 N/mm² which is higher when compared to compressive strength of normal concrete without replacement of marble dust powder i.e., 25N/mm². Based on this experimental investigation, it is found that Marble

dust can be used as an alternative material to the natural river sand in future.

Akshith Mahajan, R. S. Bansal, Arjun Kumar and Kanav Mehta (2018) The aim of their study is to relatively improve the tensile and flexural strength of concrete along with its compressive strength using Marble Dust Powder (MDP) and steel fibers in standard concrete. In this the Marble dust powder was replaced by 5%, 10%, 15% and 20% to the weight of cement, and steel fibres was added in volume fraction of concrete at 0.5%, 1% and 1.5% volume of concrete. In this study the M25 grade concrete with w/c of 0.45 is used and controlled workability is observed without using any admixtures. the cube specimen of size (150X150X150) mm and cylindrical specimens of size (150X300) was made and tested in CTM to obtain the compressive strength of masses. the beam specimens of size (100X100X500)mm were made and tested under the two point static flexural loading machine. 7 and 28 day strength to find the Flexural strength and admixture concrete mass. It is observed that when MDP is replaced with cement by 10% of its weight then it provides much better properties of concrete. This study also reveals that MDP and fiber mixed concrete provide much better properties in improving all strength as above and use of fibers provide better properties in controlling cracks and high strengths. Hence the optimum mix for this has been worked out to be MDP 15% and HE steel fibers 1% in concrete improving the properties of concrete. Further on increasing MDP beyond 15% , the strengths started to falling due to slight extra brittleness than using cement and also on increasing fiber beyond 1% the fall in strengths observed probably due to non-cohesiveness of concrete particles to each other. The maximum increase in compressive strength, split tensile strength and flexural strength at optimum has been worked out to be after 28 days is 36.9MPa, 4.24MPa, 5.46 respectively from initial values 32.8MPa, 3.24MPa, 4.34 MPa. From this they conclude that the MDP was replaced upto 15% with Hooked End steel fibres proportion of 1% of concrete volume, to enhance the overall performance of concrete.

Birbal Kumar, Prof. Kapil Soni (2019) they utilized Waste marble powder and steel fibers in this study and analyzed the strength of concrete. For achieve this objective they partially replaced the cement with waste marble powder as partial replacement of cement incorporating with steel fibers. In this research, steel binding wires were used as steel fibers which are locally available at very cheap cost. Steel fibers were added in

different percentage i.e. 0 %, 0.5 %, 1 %, 1.5 % and 2 %, with addition to waste marble powder. In this work M20 grade with mix ratio of 1:1.5:3 and w/c ratio of 0.45 was adopted. In this with Marble dust replacement at range of 0%, 5%, 10%, 15%, 20%, the corresponding compressive strength after 28 days of curing are 24.80 N/mm², 25.45 N/mm², 26.10 N/mm², 28.95 N/mm², 24.30 N/mm². This shows further increasing at 20% of marble dust the compressive strength was decreased so it is safe to adopt marble dust replacement as 15%. The result of compressive strength of different mix with 15% marble powder corresponding to the different percentage of Steel fibre at 0%, 0.5%, 1.0%, 1.5%, 2.0% was 28.95 N/mm², 29.65 N/mm², 30.90 N/mm², 28.80 N/mm², 28.65 N/mm². Similarly the corresponding Split tensile strength with 15% of marble dust and 1% of steel fibre 2.98 N/mm² was higher than other proportions, 0%- 2.69 N/mm², 0.5%-2.78 N/mm², 1.5%-2.63 N/mm², 2.0%-2.55 N/mm². The flexural strength of concrete with 15% of marble dust in addition with 1% of steel fibre 6.67 N/mm², was higher when compared to other proportional values 0%- 6.35 N/mm², 0.5%- 6.41 N/mm², 1.5%- 6.31 N/mm², 2.0%-6.28 N/mm². On the basis of those result obtained that 1% steel fibre in addition with partial replacement of 15 % marble powder shows better results in all the aspects. Concrete mix with 15 percent marble dust as replacement of cement is the optimum level as it has been observed to show a significant increase in compressive strength, Flexural strength and Split tensile strength at 28 days when compared with nominal mix. From this study we conclude that the marble dust in addition to steel fibres on concrete increase the properties of the concrete and also marble dust was suitable replacement for the Cement as well as Fine aggregate.

Vasudev R, Dr. B G Vishnuram at (2013) In this paper they made a comparative study between ordinary reinforced concrete and steel fibre reinforced concrete. In this study the fibres which were used was the turn fibres. They were the scraps from the lathe shops. The concrete mix adopted were M20 and M30 with varying percentage of fibres ranging from 0, 0.25, 0.5, 0.75 & 1%. In this study the results are compared with the Available steel fibres and Turn steel fibres. Nominal concrete cubes (15 cm x 15 cm x 15 cm), concrete cylinders (15 cm diameter and 30 cm long). A mixture of irregular and crimped shaped fibres (3cm - 4cm length) were mixed with the aggregate while casting the specimens, it was made sure that fibres were uniformly distributed throughout the mix. For conducting the tests of compressive strength, two sets of ten cubes each of

M20 & M30 mix were cast without fibres. The Compressive strength of M20 grade concrete cubes at 28 days of curing with turn steel fibre content ratio as 0%, 0.25%, 0.5% and 0.75%, are 25.84 N/mm², 20.58 N/mm², 24.84 N/mm², 24.71 N/mm², and the compressive strength of M30 cube with fibre content ratio as 0%, 0.25%, 0.5% and 0.75% after 28 days of curing are 39.36 N/mm², 35.9 N/mm², 37.57 N/mm², 36.67 N/mm², from this study it is clear that there is no significant increase in compressive strength by adding Turn steel fibres in case of both M20 & M30 grade of concrete. For testing of the split tensile strength, the cylinders were cast in the cylindrical mould of size 15 cm diameter and 30cm height. The split tensile strength with fibre content ratio as 0%, 0.25%, 0.5%, 0.75% & 1% after 28 days of curing are 2.373 N/mm², 2.476 N/mm², 2.844 N/mm², 2.637 N/mm², 2.419 N/mm². And for the M30 mix The split tensile strength with fibre content ratio as 0%, 0.25%, 0.5%, 0.75% & 1% after 28 days of curing are 2.6 N/mm², 2.87 N/mm², 3.17 N/mm², 2.8 N/mm², 2.68 N/mm². In this the Split Tensile strength was increased by adding fibres of 0.5% on both the grades of concrete. From this study we conclude that the Significant increase in compressive strength was not obtained by the addition of turn steel fibres in concrete. The splitting tensile strength of plain concrete is improved by 20% for M20 concrete and 22% for M30 concrete by the addition of turn steel fibres. This study was a true example of sustainable development as the recycling of scraps. From this study it is clear that we can use Steel fibres instead of turned fibres for increasing Tensile strength compressive strength, Toughness of the concrete.

Aalok D.Sakalkal e, G. D. Dhawale, R. S. Kedar at (2014) in their "Experimental Study on Use of Waste Marble Dust in Concrete" analyzed the replacement of fine aggregate by marble dust at proportion 0%, 25%, 50% and 100% and its effect on properties of concrete were investigated. In order to determine the effect of the marble dust with respect to the curing age, standard mechanical properties of concrete are to be analyzed at the curing ages of 3, 7, 28 days. The Marble Dust Powder (MDP) was replaced accordingly to the weight of fine aggregate. In their study the compressive strength was compared with the proportion of marble dust powder the resultant values are mentioned on 3, 7 and 28 days curing period. With the Marble dust at 0% the compressive strength was 31.73 N/mm² at 28 days of curing. The compressive strength of 33.11 N/mm² was obtained at 25% of marble dust after 28 days curing. The compressive strength

with 50% of MDP is 35.54N/mm² after 28 days curing period. For MDP of 100% the compressive strength was 21.32N/mm². It is observed that 50 % MDP mix is the maximum optimum % of MDP and again further increasing the MDP% the compressive strength is gradually decreases. In case of split tensile strength, after 28 days curing, The maximum tensile strength is obtained at 0% MDP mix i.e, 8.12N/mm². when compared to the mix of 25%-7.93N/mm², for 50%-6.91N/mm², and for 100%-3.82N/mm². However, the tensile strength at 25% MDP mix is coming nearly equal to the tensile strength at 0% MDP. Thus, 25% MDP mix can also give better tensile strength. For the Flexural strength with MDP of 0%, 25%, 50% and 100% the corresponding Flexural strength are 4.43 N/mm², 4.70 N/mm², 5.10 N/mm², 3.51 N/mm². The maximum flexural strength is achieved at 50% MDP mix, at all the curing ages. Thus, 50% MDP mix gives the optimum percentage of MDP. The compressive strength of concrete is increased with addition of waste marble powder up to 50% by weight in place of sand and further any addition of waste marble powder the compressive strength decreases. The split tensile strength of cylinders is decreased with addition of waste marble powder, from control mix to 100% replacement of sand. However, the tensile strength at 25% replacement of sand is coming nearly equal to the tensile strength at control mix. Thus, 25% sand replacement with MDP can also give better tensile strength. The flexural strength of beams is also increased with addition of waste marble powder up to 50% sand replacement and then gradually decreases. From their study we found out the optimum percentage for replacement of sand with marble powder in concrete is almost 50%, this proportion of replacement was added in concrete for better efficiency.

III. CONCLUSIONS

From the study the following conclusions are described as follows:

- With the increase in steel fiber content, the mechanical properties such as compression strength, flexural strength, and splitting tensile strength improve gradually, especially for flexural strength and splitting tensile strength, the steel fiber reinforcement effect is obvious.
- Marble Dust Powder was a suitable replacement for Fine aggregate in concrete for various grades of concrete.
- From this study, Marble dust powder was partially replaced up to 20-30% to that of Fine aggregate, which shows better efficiency on mechanical properties of concrete, and by

addition of Steel fibres on concrete shows significant effect in overall strength, and ductility of concrete.

- The Experimental investigation on Partial replacement of the Marble dust Powder (MDP) as Fine aggregate in addition with Steel Fibres at varying proportions will be carried on the Project in future.

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