



Experimental Utilization of Marble Dust Powder as Partial Replacement of Cement and Fine Aggregates in Concrete

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Abstract- The attention of the world towards the development is one of the major concerns from the few past years. This may be due to use of natural resources in large quantity in construction sector or any other industrial sector. This act of using large volume of natural aggregates in construction industry leads to the deficiency of natural aggregate in construction process. The latest trend in construction industry is to use alternate materials which can be best substitute of natural aggregates so that there is no compromise in terms of strength and durability considerations of structure. Reusing waste materials as an alternative to natural aggregates can help in reducing environmental problems, pollution, waste disposal and global warming. From the last few years, it has been found that the waste generated from demolition of construction site and old structures is increasing at more rapidly. Thus, reusing and recycling these wastes may reduce the usage of natural aggregates and thus contribute in reducing environmental hazards. India being the third (about 10%) top most exporter of marble in the world, every year million tons of marble waste form processing plants are released. Due to the availability of large quantity of waste produced in the marble factory, this project has been planned and preceded.

In the present experimental work, the natural fine aggregates are replaced by marble dust powder with replacement ratio of 0%, 25%, 50% and 100% and cement is replaced by marble dust with replacement ratio of 0%, 5% and 10%. Twelve different mixes are used in the present study with varying replacement percentage of recycled aggregates and marble dust. The different mixes are studied for mechanical and durability properties of M30 concrete. Concrete mixes with 25% recycled aggregates and 10% marble dust replacement gives compressive strength and split tensile strength almost equals to normal mix. In terms of durability, the abrasion resistance test is performed on different concrete mixes. Results shows that depth of wear increases with increasing percentage of recycled aggregates and decreases with increasing percentage of marble dust. Concrete mix with 25% recycled aggregates and 10% of marble dust has comparable results in terms of abrasion resistance test to the normal concrete.

Keywords- Waste marble powder, concrete, compressive strength, flexure strength, split-tensile strength.

1. INTRODUCTION

Concrete is one of the most widely used construction material in the world. It has been found that after water only this material is extensively used on earth. Basically concrete is the mixture of four major ingredients i.e cement, fine aggregates, coarse aggregates and water. It is similar to artificial stone which is composed of above ingredients. With the passage of time, concrete has found its application in almost every aspect in construction like buildings, ports, dams, retaining walls, roads, railways, skyscrapers, airports and many more. Concrete plays a vital role in the development of economy of any country due to its utilization in huge volumes. Its production consumes almost 20 billion tons of raw materials. The research group of Fredonia stated that the global consumption of aggregates in construction practices may exceed 26 billion tons by 2012. It has been estimated that the pace by which urbanization is increasing, the demand of aggregates would be two times more in the next two to three decades. India is in

one of the top ten leading countries that uses its natural resources.

2. LITERATURE REVIEW

Raj P. Singh Kushwah et al. (2015) [1], presented in his paper that the marble can be utilized in concrete mix by replacement of fine aggregates. Hassan A. Mohammedan (2012) [4], looks into the effect of marble powder and silica fume of different percentages as partial substitute for cement on mortar. S. Firat [11], indicates marble dust, fly ash & waste sand have properties of good additive materials, which enhances the material properties. According to Ali. A. Aliabdo et al. [12], studied the replacement of cement or sand by marble powder for improvement in concrete properties. It shows that sand replacement gives better results as compare to cement replacement. Also, Alireza Naji et al. [9], studied that average particle size of rice husk provides positive effect on compressive strength and water permeability of hardened concrete. Deepankar Kr. Ashish et al. (2015) [15-24]



recommended the new and innovative building materials and eco friendly technologies, covering waste material is the need of the hour.

In this experimental study we had experimental effect of marble waste powder on the concrete mix by partially replacing cement and sand with the marble powder waste. In this project, we check the effect on mechanical and physical properties of concrete mix with varying marble powder waste partially replaced in concrete mix.

3. RESEARCH SIGNIFICANCE

To study the influence of partial replacement of cement and fine comparable with conventional Concrete. Aggregates with marble dust powder and compare it with the compressive strength of the ordinary M20 concrete. This study has been carried out at 0%, 10%, 15%, 20% and 25%.

4. EXPERIMENTAL METHODOLOGY & INVESTIGATION

Concrete Mix Constituents

Cement

The cement use for the experimental studies was 43 grade OPC conforming to the specifications of Indian Standard Code IS: 8112-1989 shows in table 1. It was fresh and without any lumps.

Aggregate

Normal river sand which is locally available in the market and confirming to Zone II as per IS 383 1970 as shown in table 2 and specific gravity of fine sand is 2.614 and coarse aggregates were used in this

S.No .	Characteristics	Specified value as per IS:8112-1989	Experimental value
1	Consistency of cement (%)	---	30.5
2	Specific gravity	3.15	3.00
3	Initial setting time (minutes)	>30	35
4	Final setting time (minutes)	<600	370
5	Compressive strength (N/mm ²) (i) 3 days (ii) 7 days (iii) 28 days	>23 >33 >43	22.10 34 46.10
6	Soundness (mm)	10	6.05
7	Fineness of Cement (gm)	10	1.25

Table 1.Characteristics Properties of Cement

Experiment whose fineness modulus is 2.65. Coarse aggregate used as 20 mm down size. The lumps of clay and other foreign materials were separated out carefully. Sand was washed and dried before testing. The coarse aggregates were washed to remove dirt, dust and then dried to surface dry conditions.

Table 2. Physical Properties of Fine and Coarse Aggregates

Sr.No .	Physical Properties	Fine Aggregates	Coarse Aggregates
1	Specific Gravity	2.60	2.63
2	Free Moisture Content	2%	-
3	Water Absorption	1.80%	1.06%
4.	Fineness Modulus	2.70	7.70

Table 3.Physical Properties of Marble Powder

Sr.No.	Physical Properties	Values
1	Specific Gravity	2.60
2	Water Absorption	0.80%
3	Bulk Density(kg/m ³)	1118
4.	Fineness Modulus	2.03

• Supplementary Cementations Materials

The marble powder was obtained by crushing marble powder forms in a marble industry. The bulk density was 1118.01 kg/m³ and fineness modulus is 2.03 and has specific gravity of 2.21.0

• Concrete Mixture Proportion

In this experimental study, the mix design is taken as M30. Water binder ratio is taken as 0.43. Different mixes was prepared by using a different percentage of marble powder (0%, 10%, 10%, 15%, 15%, 20% and 30%) namely MX0, MX1, MX2, MX4, MX5 & MX6 as a partial replacement in the cement sand mix, where MX0 is control mix with no marble powder dust, MX1 with 10% marble powder as partial replacement of sand, MX2 with 10% marble powder dust as partial replacement of cement and MX5 with 20% marble powder dust as partial replacement of cement and sand together and also MX3 with 15% marble powder as partial replacement of sand, MX4 with 15% marble powder dust as partial replacement of cement and MX6 with 30% marble powder dust as partial replacement of cement and sand together.

5. EXPERIMENTAL TEST RESULT & DISCUSSION

• Workability

Slump values of concrete sample have been tested for different sample of mix with different percentages of marble powder as replacement of cement and sand in a mix. The result showed that the workability of a concrete mix was decreases with increase in the marble powder dust content.

• Strength

Compressive Strength

It can be noted that when cement is partially replaced by the marble powder upto 10% then the compressive strength of the mix after 7 days increased upto 9% and after 28 days it increase upto 9.3% and when partially replace it with sand then again compressive strength after 7 days increased upto 10% after 28 days it increase upto 11% but when marble powder dust is partially replaced by cement (15%), compressive strength after 7 & 28 days increases slightly 1.7% and 0.9% respectively and when partially replaces it with sand then it increases up to 2.45% & 2% after 7 & 28 days respectively also when together replaces by 20%(10%+10%) by marble powder then its compressive strength after 7 & 28 days decreased upto 8.8%& 9% respectively and 11.5% & 11.33% when partially replaces both cement and sand by 30%(15%+15%) marble waste. Hence result shows that marble powder when mixes with sand and cement upto 10% has high compressive strength and thereafter its strength decreases.

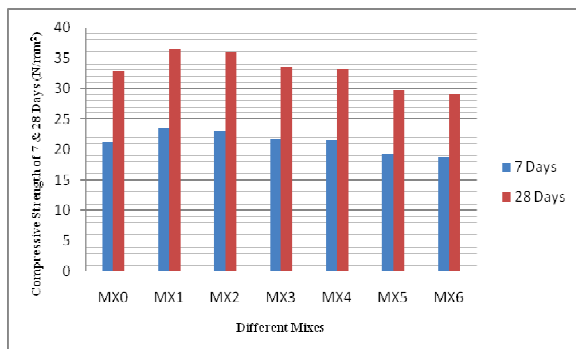


Figure 3. Graph between Different Mixes and Compressive Strength of 7 & 28 Days

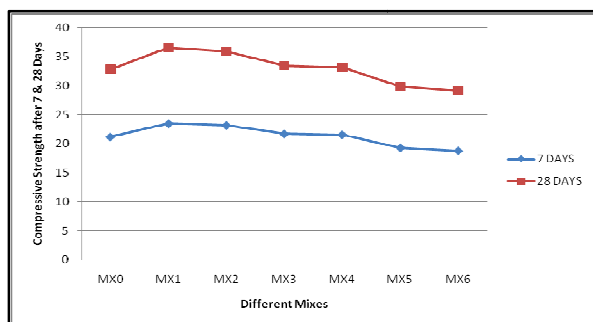


Figure 4. Comparison of Different Mixes of Compressive Strength after 7 & 28 Days

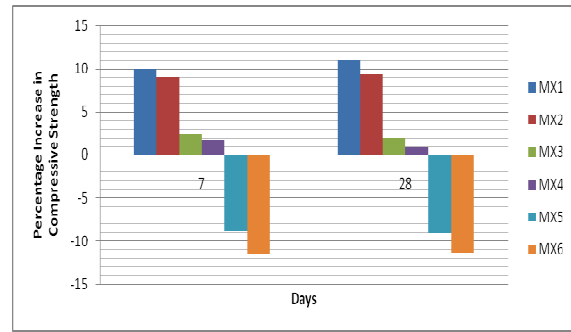


Figure 5. Percentage (%) increase in Compressive Strength by using marble waste

• Split Tensile Strength

It can be noted that the split tensile strength for concrete mix increased with 7% & 7.5% when partially replaced by 10% marble powder dust against cement in 7 & 28 days respectively and also increased by 11% & 11% as in the partial replacement with sand having 10% marble dust powder in 7 & 28 days respectively. But the split tensile strength increased slightly for the mix which contains 15 %marble powder dust against cement by 1.4%& 1.3% in 7 & 28 days respectively and 2% & 2.4% when partially replaces with 15% sand in 7 & 28 days respectively. Also when sand and cement together partially replaces upto 20%and 30% they have low split strength as compare to the replacement of marble waste in cement and sand individually.

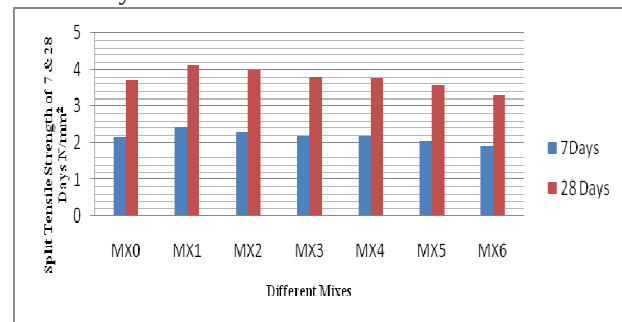


Figure 6. Graph between Different Mixes and Split Tensile Strength of 7 & 28 Days

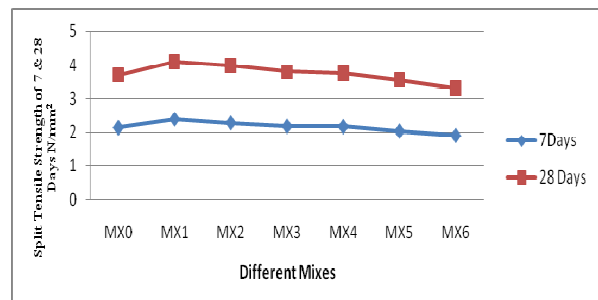


Figure 7. Comparison of Different Mixes of Split Tensile Strength after 7 & 28 Days

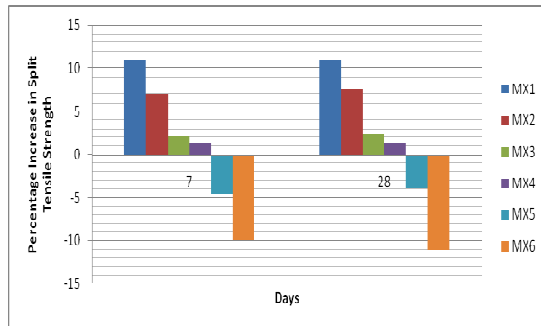


Figure 8. Percentage (%) increase in Split Tensile Strength by using marble waste

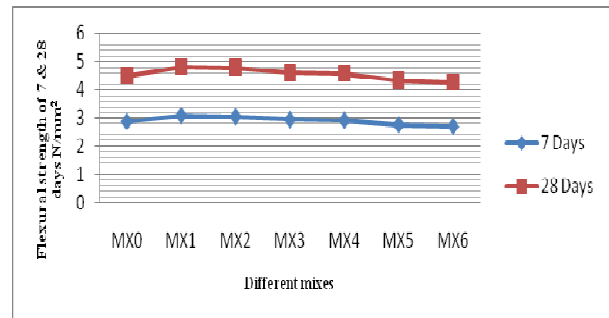


Figure 10. Comparison of Different Mixes of Split Tensile Strength after 7 & 28 Days

• Flexural Strength

It can be observed that the flexure strength for the concrete mix containing 10% of marble powder dust in cement got increased by the value of 5.9% & 6% in 7 & 28 days respectively and for 10% replacement with sand the flexure strength also got increased about 7.3% & 7.1% in 7 & 28 days respectively but it increased slightly when the mix contains 15% marble powder dust against cement about 1.7% & 1.5% in 7 & 28 days respectively and 2.4% & 2.2% when mix contains 15% marble powder dust against sand in 7 & 28 days respectively. Also when sand (10%) and cement (10%) were partially replaced with marble powder dust it decreases the strength about 3.8% & 4% in 7 & 28 days respectively and 5.9% & 5.5% when sand (15%) and cement (15%) were partially replaced with marble powder dust in 7 & 28 days respectively. Hence result shows that marble powder when mixes with sand and cement together has low flexural strength, and individually it enhances the strength upto some proportion.

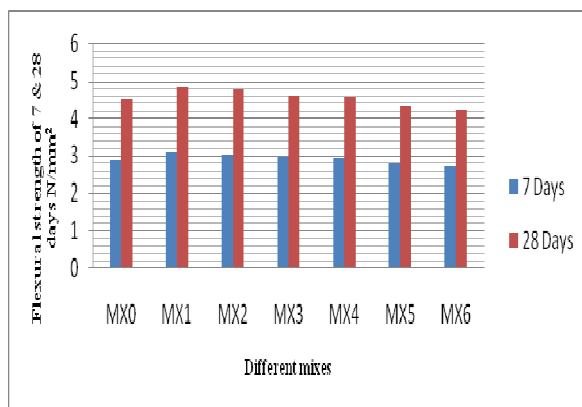


Figure 9. Graph between Different Mixes and Flexural Strength of 7 & 28 Days

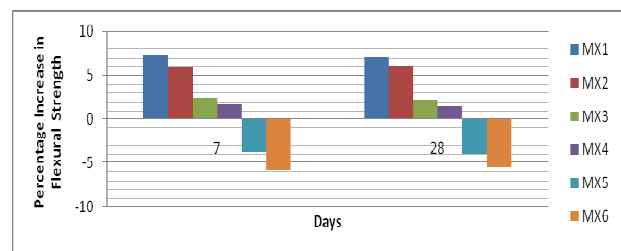


Figure 11. Percentage (%) increase in Flexural Strength by using marble waste

6. CONCLUSION

1. The Compressive strength of the Concrete decreases by the recycled aggregates. At 100 % replacement the Compressive Strength decreases by 31.1% due to the weak adhered mortar. Compressive Strength of the Concrete increases with the marble dust by 8% due to the increased porosity due to marble dust.
2. The best compressive strength results are obtained by using 25% recycled aggregates and 10% Marble Dust.
3. Split Tensile Strength of the Concrete also decreases by 27.55 % as compared to normal concrete on Replacement with the Recycled aggregates .Replacement with the marble Dust increases the Split Tensile Strength of the Concrete.
4. Concrete Mix having 25 % Recycled Aggregates and 10% marble dust will give the Split Tensile Strength equivalent to the Normal Mix, hence this can be considered as the optimum mix in terms of the Strength
5. The abrasion resistance of the concrete decreases with the increase in the Recycled aggregate content or In simple words the Depth of wear increases with the recycled aggregate content. The depth of Wear increases by 9.16%, 19.84% and 29% at 25%, 50% and 100% Replacement by the recycled aggregates as compared to Normal Concrete due to weaker attached matrix of the Recycled Aggregates.
6. Replacement of the Cement with 10% Marble Dust decreases the Depth of Wear by 16.03% Compared



to Normal Concrete. At a Particular Replacement percentage of Marble Dust, the effectiveness of marble dust in improving the depth of wear decreases with increasing recycled aggregate content due to the increase in the Porosity by the Recycled Aggregates. The percentage reduction of cost for optimum mix is 10.8% when compared to normal mix.

7. The study indicates that using marble powder upto 10% and recycled aggregates upto 25% can be effectively used without compromising the quality of concrete.

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