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Experimental Investigation on Partially Replacement of Cement with Marble Wastes

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Abstract:
Due to urbanization, the usage of cement in the construction industry gets increased rapidly. Due to the increasing demand for cement, marble powder is used as a partial replacement of cement for economic status. One of the major waste generating industries is the marble quarry and production industry by 70% of this precious mineral resource is wasted in the mining processing and polishing procedures.40% of marble waste is generated worldwide during quarrying operations in the form of rock fragments and 30% waste generated during processing. It is being dumped either in nearby empty pits, roads, riverbeds, pasturelands, agricultural fields or landfill leading to wide spreading environmental pollution. Marble powder contains high calcium oxide content of more than 50%. The potential use of marble dust can be an ideal choice for substituting in a cementations binder as the reactivity efficiency increases due to the presence of lime. Marble waste is a solid waste material generated from the marble processing and can be used as a filler material in cement while preparing concrete. The series of tests are conducted to study the effect of 5%, 10%, 15%,20% and 25% replacement of cement with marble powder on compressive strength and split tensile strength and compare it with the conventional concrete .

Keywords: concrete, fine aggregate, marble powder, strength, workability

I. INTRODUCTION

Improving the properties of concrete by addition of waste marble powder is becoming more popular now days because it helps in achieving the economy and superior alternative for the concrete ingredient, which offers high strength. This project deals with the casting of the concrete cubes with varying percentage of waste marble powder and then testing them on Compression Testing Machine (CTM).

The focus of our project will be replacing cement. The advancement of concrete technology can reduce the consumption of natural resources and energy sources and also lessen the burden of pollutants on environment. Presently large amounts of marble dust are generated in natural stone processing plants with an important impact on environment and humans. This project describes the feasibility of using the marble sludge dust in concrete production as partial replacement of cement and to reduce the cost of the concrete by marble powder in the most economical way.

II. MATERIALS AND THEIR PROPERTIES

Cement

The most common cement used is an ordinary Portland slag cement was used, which is used for general concrete structures. Many tests were conducted on cement; some of them are consistency tests, setting tests, soundness tests, etc.

COARSE AGGREGATE

In coarse aggregate most of which are retained on the 4.75mm IS sieve and contain only so much of coarse material as is permitted by the specification are termed coarse aggregate. The grading of coarse aggregates should be as per specifications of IS 383-1970.

FINE AGGREGATE

Locally available river sand was used as fine aggregate. Fine aggregate most of which passes through a 4.75 mm IS sieve and contains only so much fine material as its permitted by the specification.

WATER

Accordingly portable water was used for the preparation of all concrete specimens. The water used in the concreting work as well curing purpose was the portable water which is free from impurities.

MARBLE POWDER

Marble is a metamorphic rock composed of recrystallized carbonate minerals most commonly calcite or dolomite. Marble may be foliated. Geoygists use the term marble to refer to metamorphosed limestone.

Marble is commonly used for sculpture and as a building material. Marble powder was collected from the dressing and processing unit. It was initially in wet from after that it is dried by exposing in the sun and finally sieved by IS -90 micron sieve before mixing in concrete.

MIX DESIGN:

Mix design for concrete was made using the properties of constituents of concrete. Grade of concrete was taken as M20 and the mix design was done as per IS:10262-

III. DESIGN STIPULATIONS MIX DESIGN OF M 20

TARGET MEAN STRENGTH FOR MIX DESIGN

fck =fck +1.65s
fck =20+1.65×4.6
= 27.59N/mm2
As per IS;10262-1982,

Water cement ratio = 0.5
Water content = 186 kg/m3
Sand content = 35%
For change in value of water cement ratio, compacting factor and sand belonging to Zone 3 ,the following adjustment is required .

DETERMINATION OF CEMENT CONTENT

Water cement ratio = 0.50
Water = 191.61
Cement = 191.6/0.50 = 383 kg/m3
This cement content is adequate for mild exposure condition, according to Appendix A of IS ; 456-1978.

DETERMINATION OF COARSE AND FINE AGGREGATE CONTENT

From Table 3, for the specified maximum size of 20mm , the amount of entrapped air in the wet concrete is 2%. Taking this into account and applying equations from 3.5.1 of IS ; 10262 - 1982.

Therefore,

For fine aggregate ;-
0.98 = [191.58 + (383.16/2.608)+(1/0.315) x (fa / 2.59)] x (1/1000)
fa = 525.82

For coarse aggregate;-
0.98 = [191.58 + (383.16/2.608) + (1/(1-0.315) x (Ca / 2.83)] x (1/1000)
Ca = 1139.43 kg/m3
The mix proportions then becomes
Water: Cement: Fine aggregate: Coarse aggregate
191.61: 383kg: 525.82 : 1139.43kg or 0.50 :1:1.372: 2.97

VOLUMES

Volume of cube = 15 x 15 x 15 =3375cm3
Volume of cylinder = ? x 7.52 x 30 =5301.44
Total volume = 8676.44

Add 10% extra volume = 9544.084
Volume of concrete = (1 / 2.602) + (1.372 / 2.59) + (2.97 / 2.66) + (0.5 / 1) = 2.529
Weight of cement= (1 / V) x volume = (1 / 2.529) x 9544.084) = 3.77kg
Weight of fine aggregate = 1.372 x 3773.85 = 5.177 kg
Weight of coarse aggregate = 2.97 x 3773.85 = 11.208 kg
Required amount of water = 0.5 x 3773.85 = 1886.92 litre

MIX PROPORTIONS:

Five concrete mixes with stone dust were produced, replacing 0%(reference mixture), 5%, 10%, 15%, and 20%, Cement, in terms of weight. The concrete mix proportion for M20 grade was designed in accordance with I.S. code.

IV. RESULTS AND DISCUSSION

The test results conducted on the conventional concrete cube as well as the cube with varying percentage of marble powder and the strength at end curing days of 7, 14 and 28.

COMPRESSIVE STRENGTH– 7 DAYS: COMPRESSIVE STRENGTH – 14 DAYS:

Table.1. Compressive Strength – 7 days

Percentage Replacement of Marble Powder (%)	1. Load in (kN)	2. Load in (kN)	Compressive Strength in (MPa)
0%	606.5	616.5	21.175
5%	487.5	611	21.40
10%	537.6	540	23.5
15%	569.5	547.5	24.82
20%	494.5	525.5	22.66
25%	482	460.5	20.94

Table.2. Compressive Strength – 14 days

Percentage Replacement of Marble Powder (%)	1. Load in (kN)	2. Load in (kN)	Compressive Strength in (MPa)
0%	762.5	771.5	34.08
5%	698	703	31.13
10 %	716	703	31.5
15%	571	728.5	28.87
20%	626	636	28.04
25%	577	594.5	26.03

COMPRESSIVE STRENGTH –28 DAYS:

Table.3. Compressive Strength –28 days

Percentage Replacement of Marble Powder (%)	1. Load in (kN)	2. Load in (kN)	Compressive Strength in (MPa)
0%	874.5	905	39.54
5%	815.5	835.5	36.68
10 %	799	771	34.88
15%	727.5	728	32.34
20%	713.75	715.2	31.5
25%	699.5	680.5	30.66

V. CONCLUSION

The compressive behavior of Concrete of cube was studied. The Cubes of varying percentages like 0% 5%, 10%, 15%, 20% and 25% were casted and cured at specific days of internal and tested on Compressive Testing Machine. After the testing the result analysis is made and cost analysis is made from that result following Conclusion is made.

1. Due to waste marble powder, it proved to be very effective in assuring very good cohesiveness of mortar and concrete.
2. From the above study, it is concluded that the waste marble powder can be used as a partial replacement material for cement; and 20% replacement of marble dust gives an excellent result in strength aspect and quality aspect and it is better than the conventional concrete.
3. The results showed that the substitution of 20% of the cement content by waste marble powder induced higher compressive strength, and improvement of properties related to durability.
4. The best possible way of disposal of waste material like waste marble powder can be by using it in concrete, which will reduce environmental burden.

VI. REFERENCES

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