Strength and Durability Analysis of Concrete by Partial Replacement of Cement with Marble Dust and Alccofin

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ABSTRACT: The contribution of mineral admixture i.e.Alccofine-1203 and marble dust powder to the mechanical properties of concrete for high strength and workability is done experimentally. In this study partial replacement of cement has been done at 0%, 5%, 7.5% and 10% with Alcoffine-1203 and 1.5% by volume of concrete of MP (Marble Powder) will be added. Compressive as well as flexural strength of concrete made with AL-MP has been compared with conventional concrete of grade M30. Results are expected to show that there is a gain of strength with the addition of AL and MP. The optimized strength value of concrete for both compressive as well as flexural strength at 5%, 7.5% and 10% with Alcoffine-1203 and 1.5% by volume of concrete of MP (Marble Powder) will be noted. RCMT is expected to show that with the increase of addition of Alccofine-1203 and Marble powder, there is a decrease in rate of penetration of chloride ions, hence good durability as compared to standard concrete may be achieved.

KEYWORDS: Alccofine-1203; marble dust; strength; durability; RCMT

I. INTRODUCTION

- The use of the replacement materials offer cost reduction, energy savings, arguably superior products, and fewer hazards in the environment.
- Marble waste in general is a very important material for achieving sustainable development.
- Alccofine and marble dust contents on the physical and mechanical properties of fresh and hardened concrete have been investigated in this study.
- Slump and air content of fresh concrete and absorption and compressive strength of hardened concrete will also be investigated.

II. LITERATURE SURVEY

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1) Investigation on Strength Properties of Concrete with Partial Replacement of Cement by Marble Powder and Fine Aggregate by Granite Powder-

R.Anuradha et al (27 September 2017) have studied the mechanical properties of concrete mixtures in which fine aggregate (sand) and cement were partially replaced with Granite powder and marble powder. The replacement is done by 5%, 10%, 15%, 20%, and 25% of cement by marble powder and 5%, 10%, 15%, 20%, 25% of fine aggregate by granite powder to evaluate the effect of presence of these replacement materials on the strength of specimens. This project also describes the feasibility of using the marble sludge and granite powder in concrete production as partial replacement of cement and fine aggregate. It should be designed to have a higher workability, high mechanical properties and greater durability than those of traditional concrete.

Results

a) Compressive Strength.

On partial replacement of OPC by 5% and 10% of marble powder and fine aggregate by granite powder gives a gradual increase in compressive strength when compared to conventional mix. Whereas at 15% the compressive strength is equal to that of

conventional concrete compressive strength decreases at 20% and 25%.

b) Split tensile strength-

On partial replacement of OPC by 5% and 10% of marble powder and fine aggregate by granite powder gives a gradual increase in tensile strength when compared to conventional mix. Whereas at 15% the tensile strength is equal to that of conventional concrete tensile strength decreases at 20% and 25%.

2) Partial Replacement of Cement with Marble Dust Powder

Mr. Ranjan Kumar et al (August 2015) have studied that, the effect of marble dust powder (MDP) in concrete on strength is presented. Five concrete mixtures containing 0%, 5%, 10%, and 20% MDP as cement replacement by weight basis has been prepared. Water/cement ratio (0.43) was kept constant, in all the concrete mixes. Compressive strength, split tensile strength & flexural strength of the concrete mixtures has been obtained at 7 and 28 days. The results of the laboratory work showed that replacement of cement with MDP increase, up to 10% for compressive strength, & up to 15% for split tensile strength & flexural strength of concrete.

Objective of investigation

In this project main objective was to study the influence of partial replacement of cement with MDP. The compressive strength, tensile strength & flexural strength of ordinary M25 grade of concrete are obtained. Similarly compressive strength, tensile strength & flexural strength were obtained for 5%, 10%, 15%, & 20% replacement of cement with MDP by weight. The water cement ratio (0.43) kept constant throughout the investigation of this project work.

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

Conclusion drawn from this research-

The usage of MDP in concrete improved its quality in terms of strength. The following conclusions were based on the study on the test result.

a) The Compressive strength of Concrete increases up to 10% replacement of cement by MDP and further increasing of percentage of MDP leads to decrease in compressive strength of concrete.
b) The Split tensile strength of concrete increases up to 15% replacement of cement by MDP & further increasing of percentage of MDP leads to decrease in Split tensile strength of concrete.
c) The Flexural strength increases up to 15% replacement of cement by MDP and further increases in the percentage of MDP leads to decrease in flexural strength.
d) It is concluded that the MDP can be used as a replacement material of cement, and 10% replacement of cement with MDP gives an excellent result in strength, as compared to the normal concrete.
e) Use of these waste material leads to sustainable development in construction industry.
f) To save the environment, MDP may be used as better partial substitute as a replacement of cement in concrete.

3) Study on Marble Powder as Partial Replacement of Cement in Normal Compacting Concrete

Dr. B. Krishna Rao et al (27 December 2016) have studied that, the 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 cementitious binder as the reactivity efficiency increases due to the presence of lime. A total of five concrete mixes, containing 0%, 5%, 10%, 15% and 20% partial replacement of cement with marble powder are investigated in the laboratory. These mixes were tested to determine compressive strength, split tensile strength and flexural strength for 7, 28 and 56 days.

Conclusions:

It can be seen from the results of this study that use of marble dust replacement of cement in the production of concrete for the construction industry should be encouraged where there comparative cost advantage, the following conclusions can be made from this study.

- The workability increased with increase of marble powder.
- The mechanical properties increased with increasing of curing days.
- The compressive strength increased with increase of

- It was observed that 2.81%, 2.92% and 4.58% of strength increased compared to normal mix with 10% replacement of marble powder at 7, 28 and 56days respectively.
- It was observed that 0.43%, 11.6% and 5.6% of spilt tensile strength increased at 10% of marble powder compared to normal mix at 7, 28 and 56days respectively.
- It was noticed that 11.22%, 20% and 14.8% of flexural strength increased at 10% replacement of marble powder compared to normal mix at 7, 28 and 56days respectively.
- Considerable reduction in strength was observed at 15% and 20% replacement of marble powder.
- For compressive strength, spilt tensile strength and flexural strength 10% replacement with marble powder is found to be a best alternative for replacement as increase in percentage of strength is high compared to other variations in the mix.

4) Use of marble powder as a partial replacement of cement

Mrs. Shalaka S. Utkar et al (April 2014) have studied that, improving the properties of concrete by addition of waste marble powder is becoming more popular now a day because it helps in achieving the economy and is a superior alternative for the concrete ingredient, which offers high strength. In this project we are going to test the cubes with varying percentage of waste marble powder and then test them on Compression Testing Machine (CTM). The focus of our project will be strengthening concrete by replacing cement by marble powder in the most economical way by using the proper grade of concrete for increasing Load Carrying Capacity.

Objectives of this research:

1. To study the influence of partial replacement of cement with waste marble powder, and to compare it with the compressive strength of ordinary M20 concrete.
2. To determine and find the percentage of marble powder replaced in concrete that makes it economical.
3. As marble powder acts like a pollutant so by partially replacing cement with marble powder there will be reduction in pollution.

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.

5) Influence of Mineral Admixture (Alccofine-1203) On the Properties of Hybrid Fiber Reinforced Concrete

Manisha M. Magdum et al, have studied that, the contribution of mineral admixture i.e.Alccofine-1203 to the mechanical properties of hybrid fibre reinforced concrete with high strength and workability is investigated. It reduces thermal, shrinkage cracks and increases strength as compared to conventional concrete. Fiber volume fraction (VF) 1.5% by volume of concrete was added with Alcoffine-1203 contribution of 5%, 7.5% and 10% by weight of cement. Hybrid fibers contribute to increase the flexural strength while the Alccofine-1203 boosts the compressive strength of concrete**.**

Conclusions drawn from this experimental study:

This study presents influence of mineral admixture (Alccofine-1203) on mechanical properties of hybrid fiber reinforced concrete. The mechanical properties of the concrete mixtures were evaluated based on compressive and flexural strength.The following conclusions were drawn from the study:

- Experiments with M60 grade of concrete suggest that 7.5% replacement of cement with Alccofine-1203 and 1.5% hybrid fibers(80% steel fiber and 20% polypropylene fiber) resulted in best concrete compressive strength. Compressive strength was increased with increase in percentage ofAlccofine-1203.
- The flexural strength of concrete with 7.5% replacement of cement with Alccofine-1203and 1.5% hybrid fibers (80% steel fiber and 20% polypropylene fiber)resulted in maximum.
- It isrecommended to use Alccofine-1203in concrete as replacement for cement is possible.
- The results indicated that the use of hybrid fibers with Alccofine-1203 enhance the mechanical properties of concrete.

6) A Review on Alccofine : A supplementary cementitous material -

Saurabh Gupta et al (Feburary 2015 page 68-75) have studied that, Supplementary cementitious materials (SCM) are becoming popular in the construction industry as these materials are bringing technical revolution in the field of civil engineering. Alccofine is a new generation micro fine concrete material for high Strength Concrete which is important in respect of workability as well as strength. The aim of this paper is to highlight the importance of Alccofine as Supplementary cementitious materials in construction industries. This can be used as a SCM due to its ultrafine size and high content of calcium oxide (Cao),

Alccofine1203 is essential in terms of reducing heat of hydration and strength at all stages whereas Alccofine 1101 can be used as a grouting purpose.

Conclusion drawn:

The conclusion from the experiment can be drawn that Alccofine being use as mineral admixture in a concrete mix increase the initial strength of the concrete than the ordinary concrete. The concrete possess high workability and retain the workability for sufficient time. Alccofine is easy to use and can be added directly with cement, ultrafine particle of Alccofine provide better and smooth surface finish. For high strength concrete the cost of the concrete mix prepared with Alccofine is lesser than the concrete without Alccofine. It also lower the water/binder ratio.

7) To Study the Behaviour of Marble Powder as Supplementry Cementitious Material in Concrete

Pooja J. Chavhan et al (2014), have studied that, marble powder is replace by sand the research is carried out by using M25 grade concrete with replacement of 0%, 5%,10%,15%,20%,25%,30%,35%,40%,45%,50% marble powder by sand and is carried out to determine the optimum percentage of replacement at which maximum compressive strength and also split tensile strength is achieved There are several reuse and recycling solutions for this industrial by-product, both at an experimental phase and in practical applications. These industrial wastes are dumped in the nearby land and the natural fertility of the soil is spoiled. The physical, chemical and mechanical properties of the waste are analysed.

The objectives and scope of present study are: -

1. To find the optimum percentage of replacement of natural sand with marble powder at which maximum strength is obtained.
2. To find the optimum mix design with regards to the amount of water, Marble powder and cement ratio.
3. To conduct compression test on and control concrete on standard IS specimen size (150x150x150) mm.
4. To study in detail about the presence marble powder in concrete.
5. To conduct compressive strength test, split tensile strength test
6. To provide economical construction material.
7. Provide safeguard to the environment by utilizing waste properly.

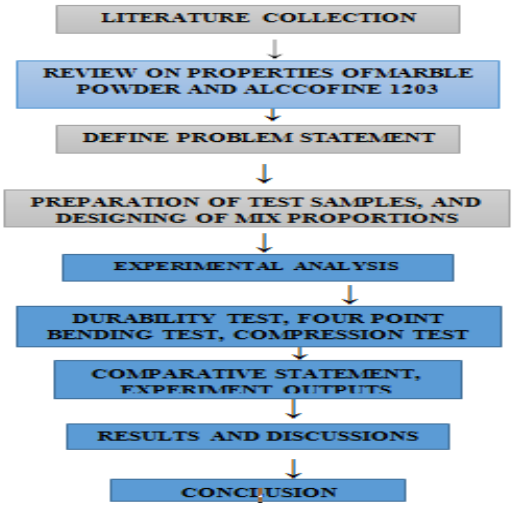
Conclusions drawn by the author:

Based on the results presented above, the following conclusion can be drawn:

1. Compressive strength increases with increase of marble powder
2. Compressive strength increases with 30% replacement and also 45%, 50% replacement by sand
3. The maximum 28 days split tensile strength was obtained with 45%marble powder replaced with fine aggregate.
4. We have put forth a simple step to minimize the costs for construction with usage of marble powder which is freely or cheaply available; more importantly.
5. We have also stepped into a realm of saving the environmental pollution by cement production; being our main objective as Civil Engineers.
6. Marble slurry utilization in black cotton soil is one of the best ways to improve soil properties and to protect the environment up to some extent from the harmful effects of disposal of marble slurry in land and water.

III. METHODOLOGY

- This project aims to study the physical properties of concrete mixed marble dust and alccofine 1203 by conducting durability tests on cubes prepared of concrete of size 150x150x150mm.
- This study also aims to study the flexural behaviour by experimental investigations conducted on the beams by conducting four point bending test on the beams.
- Proportions used are 5%, 7.5%, 10%.
- 1.5% marble dust by the volume of concrete
- Specimens were tested after the 28 day moist curing period.



IV. MIX DESIGN (M30)

Concrete Mix Design of M30 Grade Concrete

Step 1: Determining the Target Strength for Mix Proportioning

F'ck = fck + 1.65 x S

30 + 1.65 x 5.0 = 38.25 N/mm2

Step 2: Selection of Water-Cement Ratio:-

, Maximum water-cement ratio = 0.50

Step 3: Selection of Water Content

Maximum water content for 20 mm aggregate = 186 Kg

Estimated water content for 100 Slump = 186+ (6/100) X 186 = 197 litre

Water content = 197 liters

Step 4: Calculation of Cement Content

Cement Content = Water content / "w-c ratio" = (197/0.50) = 394 kgs

As per clause 8.2.4.2 of IS: 456

Maximum cement content = 450 kg/m3, hence ok too

Step 5: Proportion of Volume of Coarse Aggregate and Fine Aggregate Content

From Table 3 of IS 10262- 2009, Volume of coarse aggregate corresponding to 20 mm size and fine aggregate (Zone I) = 0.60

Step 6: Estimation of Concrete Mix Calculations

1. Volume of cement=(39/3.15) x (1/1000) = 0.125 m3
2. Volume of water== (197/1) x (1/1000) = 0.197 m3
3. Total Volume of Aggregates = 1- (b+c) =1- (0.125+0.197) = 0.678 m3
4. Mass of coarse aggregates=0.678 X 0.60 X 2.80 X 1000 = 1139 kg/m3
5. Mass of fine aggregates=0.678 X 0.40 X 2.70 X 1000 = 732 kg/m3

Step-7: Concrete Mix Proportions

Ratio = 1 : 0.75 : 1.5

Target strength for mix proportioning: target strength = 20 + 1.65 * 4 = 26.6 N/mm2 (For M20)

= 30 + 1.65* 4 = 36.6 N/mm2 (For M30)

V. CONCLUSION

Based on previous studies, the modified performance of concrete with different mixing amounts of alccofine and marble dust will be evaluated in detail in order to solve the shortage of natural sand and make full use of industrial waste.

The following conclusions will be noted:

1. To observe the compressive strength and spilt tensile of concrete mix using alccofine and marble dust
2. To observe the water permeability on the basis of IS: 3085-1965.
3. Strength development of the alccofine and marble dust mixes.
4. Performance of alccofine and marble dust mixes for partial substitute for natural sand to prepare concrete

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