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A Partial Replacement of Cement and Fine Aggregate with MDP and GGBS

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Abstract: Due to rapid development in infrastructure it truns out to be very necessary to find and adopt some eco-friendly products. It is becoming more and more obvious that gradual evolution in the field of construction has adverse effect on the well-beging the earth and putting future generation in danger. concrete could also be used for a few special purpose that special properties are more important than special properties are more important than those commonly considered. The most important objective of this study is to assess the chances of usage of GGBS (Ground Granulated Blast Furnace Slag)in concrete. The enhancement in a technology requires studying effects caused by the mineral admixture on the strength of the cementitious material. This project represents the results of an experiment investigations accomplish of concrete. In this experimental study the impact of GGBS on strength of referral concrete M20 was prepared using 43 Grade OPC and other mixes were prepared by replacing part of OPC with GGBS.The replacement levels were 0%, 20%, 30% and 40% (by weight of cement) for GGBS. And replacing fine aggregate with 0%, 20%, 30% and 40% crusher dust.
Keywords: GGBS, admixture, conctete

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 15% percentage of waste marble powder and then testing them on Compression Testing Machine (CTM). The focus of our project will be replacing cement and aggregate which are ingredients of concrete. The advancement of concrete technology can reduce the consumption of natural resources and energy sources and 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. It has been estimated that several million tons of MDP are produced during quarrying worldwide.

Hence utilization of marble powder has become an important alternative material towards the efficient utilization in concrete for improved harden properties of concrete. Marble is a metamorphic rock resulting from the transformation of a pure limestone. The purity of the marble is responsible for its color and appearance it is white if the limestone is composed solely of calcite (100% $CaCO_3$). Marble is used for construction and decoration; marble is durable, has a noble appearance, and is consequently in great demand. Chemically, marbles are crystalline rocks composed predominantly of calcite, dolomite or serpentine minerals. The other mineral constituents vary from origin to origin. The main impurities in raw limestone (for cement) which can affect the properties of finished cement are magnesia, phosphate, leads, zinc, alkalis and sulphides. A large quantity of MDP is generated during the cutting process. The result is that the mass of marble waste which is 20% of total marble quarried has reached as high as millions of tons. Leaving these waste materials to the environment directly can cause environmental problem.

II. METHODOLOGY

The objective of the project is:The ultimate focus of this work is to ascertain the performance of concrete mix containing Marble Dust Powder & Ground Granulated Blast Furnace Slag (GGBS) and compare it with the controlled concrete mix. The main objectives of this study are;

To determine the performance of concrete by partial replacement of fine aggregate by Ground Granulated Blast Furnace Slag (GGBS) in 10%, 15%, 20% variants.

To study the physical properties of Marble dust powder.

The compressive strength, tensile strength & flexural strength of ordinary Portland cement (43 Grade) M30 grade of concrete are obtained.
4. to design and proportion the concrete mix for M30 grade concrete.
To determine the most optimized mix of GGBS- based concrete.
Environmental friendly and sustainable reuse and disposal of Marble Dust Powder (MDP).
It reduces cost of concrete which impact the overall economy of the project

A. Material Used

1) Cement
2) Fine Aggregate
3) Coarse Aggregate
4) Marble Dust Powder
5) Ground Granulated Blast Furnace Slag Water

III.METHODOLGY ADOPTED FOR THE CASTING PROCESS

A. Specimen Preparation

Preparation of Materials

- All materials are brought to room temperature, preferably 27° ± 3°C before commencing the tests. The cement, marble dust powder, ground granulated glass Furness slag samples, on arrival at the laboratory, was thoroughly mixed dry by in such a manner as to ensure the greatest possible blending and uniformity in the material, cares being taken to avoid the on of foreign matter. The cement was stored in a dry place, preferably in air-tight metal containers.
- Samples of aggregates for each batch of concrete are of the desired grading and in an air-dried condition. Aggregate were separated into fine and coarse fractions and recombined for each concrete hatch in such a manner as to produce the desired grading.

B. Proportioning

The proportions of the materials, including water, in concrete mixes used for determining the suitability of the materials available, was in all respects to those to be employed in the work.

C. Weighing

The quantities of cement, each size of aggregate, and water for each batch were determined by weight, to an accura0.1 percent of the total weight of the batch.

D. Mixing Concrete

The concrete shall be mixed by hand, or preferably, in a laboratory batch mixer, in such a manner as to avoid loss of water or other materials. Each batch of concrete shall be of such a size as to leave about 10 percent excess after moulding the desired number of test specimens. In this research we were adopted machine mixing.

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E. Machine Mixing

Mixing drum used was hand-loaded therefore it was charged with the dry materials in a manner that, ut one-half of the coarse aggregate, then with the fine aggregate, then with the cement and finally he remaining coarse aggregate on top and then water was added immediately before the Rotation of the drum is started. The period of mixing was not less than 2 minutes after all the materials are in the drum, and rotations were continuing till the resulting concrete is uniform in appearance.

V. MOULDS

A. Cube Moulds

The mould used are of 150mm x 150mm x 150mm size conforming to IS: 10086- 1982 In assembling the mould for use, the joints between the sections of mould was thinly coated with mould oil and a similar coating of mould oil was applied between the contact surfaces of the bottom of the mould and the base plate in order to ensure that no water escapes during the filling. The interior surfaces of the assembled mould were thinly coated with mould oil to prevent adhesion of the concrete.

Fig. No. 4.2 Cube Mould

B. Cylinders

The cylindrical mould used are of size 150 mm diameter and 300 mm height conforming to IS: 10086-1982 The mould and base plate was coated with a thin film of mould oil before use, in order to prevent adhesion of the concrete.

Fig. No. 4.3 Cylinder Mould

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C. Beams

The beam moulds used are of size 100mm X 100mm X 500mm confirming to IS: 10086-1982. Used for making cement concrete prisms or bars of square cross-section for flexural strength test. Insidefaces are machined flat to within +0.02 mm tolerance and inside dimensions are accurate to +0.2 mm. Made of cast iron or steel, supplied complete with base plate.

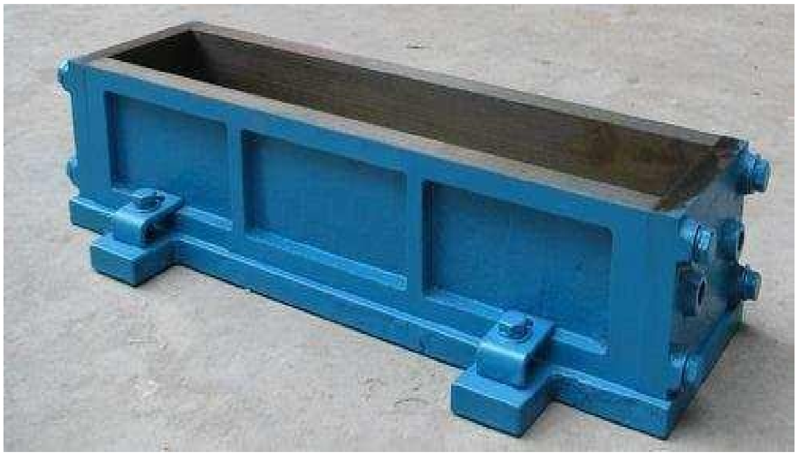

Fig. No. 4.4 Beam Mould

D. Tamping Bar

The tamping bar used was conforming according to IS: 10086-1982

Fig. No. 4.5 Tamping Bar

E. Compacting

The test specimens were made as soon as practicable after mixing, and in such a way as to produce full compaction of the concrete with neither segregation nor excessive laitance. The concrete was filled into the mould in layers approximately 5 cm deep. In placing each scoopful of concrete, the scoop was moved around the top edge of the mould as the concrete slides from it, in order to ensure a symmetrical distribution of the concrete within the mould. Each layer was compacted either by hand or by vibration. After the top layer has been compacted, the surface of the concrete was finished level with the top of the mould, using a trowel, and covered with a metal plate to prevent evaporation.

F. Curing

The test specimens were stored in a place, free from vibration, in moist air of at least 90 percent relative humidity and at a temperature of 27°± 2°C for 7 and 28 days from the time of addition of water to the dry ingredients. After this period, the specimen was marked and removed from the holds and, unless required for test within 24 hours, immediately submerged in clean, fresh water or saturated lime solution and kept there until taken out just prior to test. The water in which the specimens were submerged was renewed after every seven days and was maintained at a temperature of 27°± 2°C. The specimens were not allowed to become dry at any time until they havebeen tested.

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Summarized Material Test Result for Concrete Mix Design

Sr.no	Test description	
i	Specific gravity of cement	3.15
ii	Specific Gravity of Fine Aggregate	2.53
iii	Specific Gravity of Coarse Aggregate	2.7
iv	Water Absorption Fine Aggregate	3%
v	Water Absorption Coarse Aggregate(20mm)	3%
vi	Grading Zone of Fine Aggregate	II
vii	Bulk Density of Coarse Aggregate	1.548
viii	Bulk Density of Fine Aggregate	1.873
ix	Water Cement Ratio	.45

Stipulation for Proportioning

Grade designation	M30
Type of cement	OPC 53
Maximum nominal size of aggregate	20mm
Minimum cement content	320 kg/m^3
Maximum water-cement ratio	0.45
Exposure condition	Moderate
Method of concrete placing	Manual
Degree of supervision	Good
Type of aggregate	Crushed Angular

VI. MIX DESGN PROCEDURE FOR CONCRETE M20 GRADE

A. Step1: Target Mean Strength

For Mix Proportioning

f'ck =fck + 1.65 s

where,

f'ck = target average compressive strength at 28 days,

fck = characteristics compressive strength at 28 days, ands = standard deviation.

From Table I of IS 10262:2009, Standard Deviation, s = 5 N/mm^2.Therefore, target strength = 30 + 1.65 x 5 = 38.25 N/mm^2.

B. Step2: Selection Of Water•Cement Ratio

Maximum water-cement ratio = 0.5Adopt water-cement ratio = 0.45

C. Step3: Selection Of Water Contet

Maximum size of aggregate=20mm

Water content for 20 mm aggregate = 186 litre From Table 2 of IS 10262:2009

(for 25 to 50 mm slump range) Estimated water content for 125-150mm slump = 186+ (9/186) = 196.74 litre.

D. Step4: Calculation Of Cement Content

Adopted w/c Ratio = 0.45

Cement Content = 300/0.45 = 437.2kg/m^3

= 437.2 kg/m^3 > 300 kg/m^3 hence Ok.

E. Step5:Proportio0n 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 aggregate andfine aggregate (Zone II) for water-cement ratio of 0.50 =0.62 .

In the present case water-cement ratio is 0.45. Therefore, volume of coarse aggregate is required to be increased to decrease the fine aggregate content. As the water-cement ratio is lower by 0.06. The proportionof volume of coarse aggregate is increased by 0.02 (at the rate of -/+ 0.01 for every ± 0.05 change in water- cement ratio). Therefore, corrected proportion of volume of coarse aggregate for the water-cement ratio of 0.45 = 0.64

Volume of Coarse aggregate content = .64-0.01= 0.63.Volume of Fine aggregate content = .37

F. Step6: Mix Calculations

The mix calculations per unit volume of concrete shall be as follows:

1) Volume of concrete = 1 m^3
2) Volume of cement = [Mass of cement] / {[Specific Gravity of Cement] x 1000}
   = 437.2/{3.15 x 1000}
   = 0.138m^3
3) Volume of water = [Mass of water] / {[Specific Gravity of water] x 1000}
   = 197.74/{1 x 1000}
   = 0.197m^3
4) Volume of all in aggregate = [a-(b+c+d)]
   = [1-(0.138+0.197)]
   = 0.665m^3
5) Mass of coarse aggregate= d x Volume of Coarse Aggregate x Specific Gravity of Fine Aggregate x 1000
   = 0.665x 0.63x 2.7 x 1000
   = 1131.16 kg/m^3
6) Mass of fine aggregate = d x Volume of Fine Aggregate x Specific Gravity of Fine Aggregate x 1000

= **Trail Mix Ratio**

= 0.665x 0.37x 2.53 x 1000

= 622.50 kg/m^3

	Water (Lit)	Cement (kg/m^3)	fine aggregate (kg/m^3)	coarse aggregate (kg/m^3)
By weight (kg)	196.4	437.2	622.50	1131.16
By volume(m^3) =	.45	1	1.4	2.5

= **Concrete mix design proportion including MDP and GGBS**

Sr.no	%replacement of GGBS	W/C ratio	C	FA	CA	MDP	GGBS
1	0% replacement	0.45	1	1.4	2.5	-	-
2	10% replacement	0.45	1	1.26	2.5	0.1	0.14
3	20% replacement	0.45	1	1.12	2.5	0.1	0.28
4 =	30% replacement	0.45	1	0.98	2.5	0.1	0.42

VII. CONCLUSIONS

1) The project gives idea about using appropriate proportion of MDP and GGBS for the partial replacement of cement and fine aggregate
2) Since natural river sand has been drastically depleted since decade this replacement provide better alternative to natural one usual GGBS is done.
3) MDP is a residue from huge quarries left out which is either disposal or used for landfill.
4) We can used it as a partial replacement to cement in appropriate proportion, sustainable of these would help in producing a economical concrete mix which would be used for paver concrete pavements and various other elements of concrete hence material variation would surely result to an efficient and economical mix design.

The mix (M3) proves to be weak. So M1 &M2 can be used for various purposes Since the workability of M3 is reduced due to which the strength is also affected and considerably reduced

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