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EXPERIMENTAL STUDY ON C60 GRADE SELF-COMPACTION CONCRETE WITH MARBLE POWDER

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Abstract:-
Now days, self-compacting concrete is commonly used in construction industries. The main advantage of using self-compaction concrete is, achieving the required strength without using the vibrators. In the present study, marble powder was added with self-compaction concrete and their properties were studied. In Oman, marble factories produced marble powders around 20-25% of total quantity of marbles by polishing and processing of marble blocks. These factories are facing problem to dump those powders as landfill. These waste can be used as partially or completely replacement of cement in concrete. In the present study, marble powders were mixed with C60 grade concrete as partial replacement of cement (0%, 5%, 01% and 15%). Also flow test and compression test were conducted to study the effect of mixing marble powder in self-compacting concrete.

Keywords:- *self-compaction concrete, cement, marble Powder, workability, compressive strength*

1. INTRODUCTION

Marble is most important material in building construction and used as flooring and other works of decoration. Marble is a type of metamorphic rock and plenty of marble stones are available in Oman. Also these stones are used for the flooring construction of buildings. Huge quantity of marble pieces and powders are available while cutting and polishing of those marble stones. In this project work, an attempt was carried out to effective use of marble waste powder in concrete preparation. In the present study, marble powder is used effectively by adding in self-compaction concrete as partial replacement of cement. Main aim of this experimental work is to study the strength behaviour of self-compacting concrete by partial replacement of cement with marble powder. Marble powders are replaced partially by 0%, 5%, 01% and 15% of the cement.

Many research works carried out in Self-Compacting Concrete (SCC) so far. It was first developed to increase concrete usage by engineers in Japan in the early 1980s with the introduction of conventional super-plasticizers to create highly fluid concrete. Self-compacting concrete (SCC) is developing gradually to meet many aspects of construction technology, especially reinforced concrete. In SCC, vibratos are not required for concrete compaction. Abdelkader El Mir et al, studied the porosity of self-compacting concrete [1], Kursat East Alyamac & Ragap have done investigation on fracture parameters of self-compacting concrete produced with marble powder by Peak-Load Method [2]. Navid Ranjbar et al studied the durability and mechanical properties of self-compacting concrete incorporating palm oil fuel ash [3]. Oluborode & Olofintuyi have conducted strength evaluation of Self-Compacting Concrete with corn cob ash in blended Portland cement [4]. Vivek et al have done experimental investigation on properties of self-compacting and self-curing concrete with silica fume and light weight aggregates [5].

3. Experimental methodology

Concrete consists of different materials such as fine aggregate, coarse aggregate, cement, water and admixtures.
For SSC, free flow of concrete is required to avoid vibration. At the same time, water content in concrete is inversely proportional to the strength of the concrete. Hence, admixtures such as super plasticizers are added with the concrete to increase the workability and maintain good strength.

3.1 Cement

Ordinary Portland cement was used for experimental work and Table 1 shows the properties of OPC.

Table 1 Physical properties of OPC (Supplied by manufacturer)

Properties	Result
Specific Surface area	3403 cm^2/g
Soundness: Expansion	0.67mm
Normal consistency	27.5%
Compressive Strength 28 days	54.4Mpa

3.2 Aggregate

Crushed rock is used as fine aggregate and the source and properties of fine and coarse aggregates are mentioned in Table 2 and 3 respectively. 10 mm size coarse aggregate was used for experimental work.

Table 2 Properties of Fine Aggregate

Type	Source	Water absorption	Specific properties	Fineness modulus
Washed sand	Al Habsi Crusher	1.8	2.64	2.88

Table 3 Properties of Course Aggregate

Type	Source	Water absorption	Specific properties	Fineness modulus
10mm	Al Habsi Crusher	0.8	2.70	4.42

3.3 Marble powder

The marble powder was obtained by crushing marble chips from a marble industry as shown in Figure 1. Table 4 shows the physical properties of marble powder.

Table 4 Physical properties of marble powder

Test performed	Results
Specific gravity	2.67
Moisture content	1.8%
Water absorption	2.1%
Bulk density	1520 kg/m^3

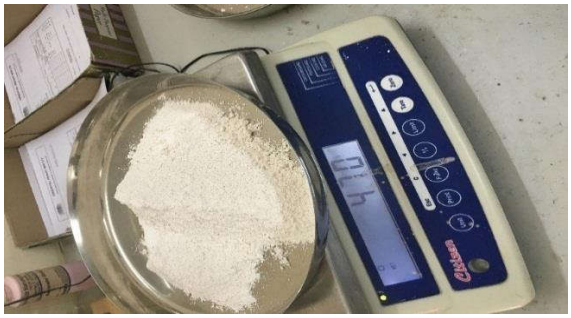


Figure 1 Marble Powder

3.4 Concrete mix

The grade of concrete used for concrete was C60. Four different mixes (M1, M2, M3 and M4) with replacement percentage, 0%, 5%, 10%, and 15% of cement by marble powder were considered for experimental work. Mix ratio and weight of concrete ingredients were prepared based on concrete mix design American Concrete Institute (ACI) code. Also water/ cement ratio was determined as per the code. Twelve cubes were cast to study the properties of self-compaction concrete. The mix proportion used to mix concrete 1:2.56:3.3 by volume and water/cement ratio of 0.55.

3.5 Casting of cube specimen and curing

The size of mold 150 × 150 × 150 mm was used for casting cubes. After 24 hours from the time of casting, cubes were removed from the mould and kept in water for 28 days curing. Figure 2 shows the cube with concrete after casting.

Figure 2 Casting of Cubes

3.6 Flow test

Workability of fresh self-compaction concrete was measured using flow test. The apparatus used for the flow test are metal mold which has two openings on both ends. The size of cone used for flow test was 8 cm diameter at the top and 4 cm diameter at the bottom and 30 cm height. Cone was placed on a level and hard surface and fresh self-compacting concrete was poured into the cone. Diameter of the fresh self-compacting concrete was measured as shown in Figure 3.

Figure 3 Flow test

3.7 Compressive strength test

Compression testing machine was used to determine the compressive strength of hardened concrete with different replacement of marble powder after 28 days curing.

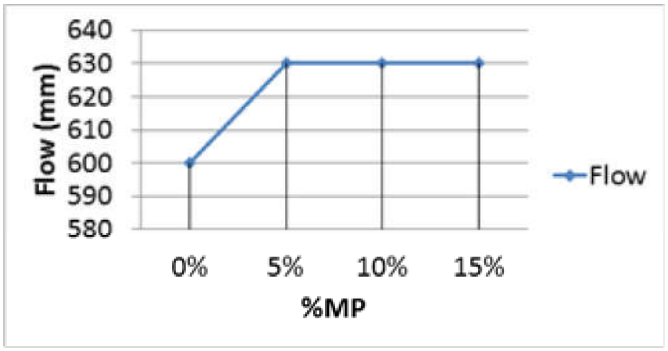
4 RESULTS AND DISCUSSIONS

4.1 Flow test result

The table and graph shows the results of workability test conducted on fresh concrete using flow test. The result showed for different percentage of replacement of cement with marble powder 0, 5, 10 and 15%. Table 5 shows that the flow diameter of concrete increased when the marble powder percentage was increased.

Table 5 Flow test result

Percentage of marble powder	0%	5%	10%	15%
Flow diameter (mm)	600	630	630	630



Note: MP – Marble Powder

Figure 4 Flow test result

4.2 Compressive strength result

Table 6 and figure 5 shows the compressive strength results of self-compaction concrete with various percentages of marble powder.

Table 6 Compressive strength result

Percentage of marble powder	0%	5%	10%	15%
Compressive strength in MPa	79.3	70.2	71.9	64.8

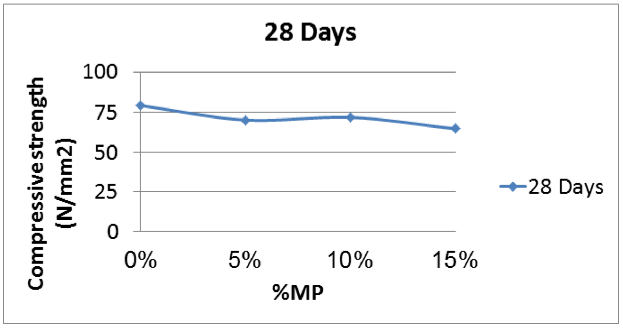


Figure 5 Compressive strength test results

The table and graph showed the results of compressive strength tests on cubes. The data given are for concrete grade C60 measure compressive strength for samples at 28 days curing for different percentage replacement of cement with marble powder.

As the result for 28 days curing shows the compressive strength decreases as adding more percentage of marble powder. At 5% replacement of cement with marble powder the compressive strength decreased to 70.2 N/mm^2 and at 10% replacement of cement with marble powder the compressive strength increased to 71.9 N/mm^2. For 15% replacement of cement with marble powder the compressive strength decreased to 64.8 N/mm^2.

5 CONCLUSIONS

The following conclusions were made based on the experimental results.

1. Marble dust available from cutting and polishing can be used effectively when added with self-compaction concrete as partial replacement of cement.
2. 28 days compressive strength of self-compaction concrete with and without marble powder is almost same and hence marble powder can be added with concrete as partial replacement of cement upto 15%.
3. In the present study, usage of waste marble powder as partial replacement of cement in concrete was conducted and found that this is the effective method of saving the environment.
4. For different percentage of marble powder 5, 10 and 15% and compared with control mix for self-compacting concrete grade C60. The result concluded the compressive strength for 28 days curing, the compressive strength decreased slightly as adding more percentage of marble powder.
5. At 5% replacement of cement with marble powder the compressive strength decreased to 70.2 N/mm^2 and at 10% replacement of cement with marble powder the compressive strength increased to 71.9 N/mm^2 while at 15% replacement of cement with marble powder the compressive strength decreased to 64.8 N/mm^2.

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