

REVIEW ON USE OF MARBLE POWDER AS PARTIAL REPLACEMENT OF CEMENT IN CONCRETE MIX

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ABSTRACT: *The utilization of the solid waste in cement manufacturing company will help in conservation of natural resources like limestone. The use of marble powder as a partial replacement of Cement can reduce the production cost of cement and may be control the emission of harmful gases into the environment and proved Eco friendly to the environment. Earlier research also indicate that the effects of marble powder on the properties of cement such as consistency, initial setting time, final setting and soundness remain within the acceptable ranges of different standards. The production of cheaper and more durable concrete using marble powder can solve to some extent the ecological and environmental problems. Therefore this paper provides a scope for more research which is required to design economical and durable concrete with this solid waste (marble powder). Due to this a Dissertation work is decide to find out the effect of marble powder on the properties of concrete by partial replacement of cement with marble powder in a concrete mix . The effect on concrete mix can be determined by the help workability test of concrete, compressive strength of concrete and Flexural strength of concrete.*

Key Words: *Marble Powder, Cement, Concrete, Workability, Compressive Strength, Flexural Strength.*

I. INTRODUCTION

The ingredients of Cement Concrete mix is Cement, fine aggregate and Coarse aggregate. Generally, we use sand (natural/crushed) as fine aggregate and cement as binding material in required quantity for different grades of Concrete mix to full fill the designed compressive strength. For manufacturing the cement, lot of environmental status deflecting due to originating the carbon dioxide, nitrogen oxide, sulfur dioxide, carbon monoxide gases in the environment. Therefore a lot of air pollution, soil pollution, etc. occurs during manufacturing of cement. To minimize these pollutant effects, we required the alternative of minimum consumption of Cement. In view of this, the study has been carried out by utilizing the marble powder up to the same extent at the place of cement. So that the environmental condition may not be disturbed as well as economy in construction material can achieve. 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% CaCO₃). Chemically, marbles are crystalline rocks composed predominantly of calcite, dolomite or serpentine minerals. The other mineral constituents vary from

origin to origin. Quartz, muscovite, tremolite, actinolite , micro line, talc, garnet, osterite and biotite are the major mineral impurities whereas SiO₂, limonite, Fe₂O₃, manganese, 3H₂O and FeS₂ (pyrite) are the major chemical impurities associated with marble. The main impurities in raw limestone (for cement) which can affect the properties of finished cement are magnesia, phosphate, leads, zinc, alkalis and sulphides. Now a day, Use of Marble stone in different building work & Engineering work is increasing day by day in the form of ornamental work of buildings and different construction practices. There by the waste of marble stone, i.e. pieces/chips create the waste disposal problem. Therefore, to utilize this marble stone piece/chips in the shape of powder seems to be a better alternative of cement, ecological balance as well as economy also.

II. MATERIALS

CEMENT- Cement is fine powder which is obtained after calcinations of lime and clay in required proportions with addition of very small quantities gypsum.

TABLE-1: CHEMICAL CONSTITUENTS OF PORTLAND CEMENT

S.no.	Ingredients	Appr. proportion	Common Proportion
1	Lime(Cao)	60-67%	62%
2	Silica(SiO ₂)	17-25%	22%
3	Alumina(Al ₂ O ₃)	3-8%	5%
4	Iron Oxide(Fe ₂ O ₃)	3-4%	3%
5	CalciumSulphate(CaSO ₄)	3-4%	4%
6	Magnesia(MgO)	0.1-3%	2%
7	Sulphur(S)	1-3%	1%
8	Alkalies	0.2-1%	1%

TABLE NO. 2: CHARACTERISTICS PROPERTIES OF CEMENT

S.n.	Test of cement	IS Requirements
1	Consistency of cement	---
2	Initial setting Time	Minimum 30 minutes As per IS 4031-1968
3	Final setting Time	maximum 600 minutes As per IS 4031-1968
4	Fineness	Max. 10% As per IS 269-1976
5	Soundness	Upto 10.00 mm As per IS :8112-1989

6	Specific Gravity	3.15 As per IS :8112-1989
7	Compressive Strength (N/mm ²) 3 days 7 days (c) 28 days	As per IS :8112-1989 >23 >33 >43

FINE AGGREGATES: The aggregate which is passing through 4.75 mm IS sieve and retain on 75 micron IS sieved are known as fine aggregates. The maximum particle size of fine aggregate like sand is 4.75 mm and minimum particle size of fine aggregate is 75 microns.

TABLE NO.-3: SIEVE ANALYSIS FOR FINE AGGREGATES

IS Sieves required	IS : 383-1970 Requirements for Zone –I in %age	IS : 383-1970 Requirements for Zone – II in %age	IS : 383-1970 Requirements for Zone – III in %age	IS : 383-1970 Requirements for Zone –IV in %age
4.75mm	90-100	90-100	90-100	95-100
2.36mm	60-95	75-100	85-100	95-100
1.18mm	30-70	55-90	75-100	90-100
600mic	15-34	35-55	60-79	80-100
300mic	5-20	8-30	12-40	15-50
150mic	0-10	0-10	0-10	0-15

COARSE AGGREGATES: The material which is passing through 75mm IS sieve and retain on 4.75mm IS sieves are known as coarse aggregates. The maximum particle size of coarse aggregate is 75 mm and minimum particle size of coarse aggregate is 4.75 mm.

MARBLE POWDER: Marble powder is obtained by Crushing and Grinding of the marble chips or marble stone. It can be also obtained from marble slurry. Marble is a metamorphic rock resulting from the transformation of the pure limestone. The purity of marble is depends upon its colour and appearance. It is white if the limestone is composed of solely of calcite (100%CaCO₃).

III. LITERATURE REVIEWS

Valeria Corinaldesi et al (2005) investigated the characteristics of marble powder and observed that marble powder has very high fineness value of about 1.5 m²/g, with 90% of particles passing through 50µm-sieves and 50% through 7 µm. He observed that the marble powder

has a high specific surface area, implying that its addition as a mineral in mortars and concretes, especially in self compacting concrete should impart more cohesiveness. He also found that that 10% of sand can be replaced by marble powder provided maximum compressive strength at about same workability. [1]

Demirel and Yazicioglu (2006) found, in addition to marble powder, silica fume, fly ash, pumice powder and ground granulated blast furnace slag can be widely used in the construction sector as a mineral admixture instead of Cement, Marble powder can be used either to produce new products or as an admixture so that the natural resources are used more efficiently and the environment is saved from dumpsites of marble waste. [2]

Hanifi Binic(2007) stated that marble dust concrete has higher compressive strength than that of the corresponding lime stone dust concrete having equal w/c and mix proportion. The results shows that the Marble dust concrete would probably have lower water permeability than the lime stone concrete. As non pozzolanic fines it is at present the limestone and dolomite ones which are most frequently used to increase the content of fine particles in self compacting concretes. Compared to normal plain concrete of the same w/c ratio and the same cement, the concrete having high limestone filler content of suitable particle size distribution generally improves the strength characteristics. [3]

Kursat & Ragip (2009) found some relationship between properties of fresh and hardened self compacting concrete (SCC). They also described a method of preliminary mix design for SCC based on monogram. [4]

Bahar Demirel (2010) presented the effect of using waste marble powder on the mechanical properties of concrete. Four different series of concrete – mixture were prepared in order to examine the effect of waste marble powder on the compressive strength of concrete in the percentages of 0, 25, 50 and 100% by weight. The compressive strength of concrete specimens was checked at the curing aging of 3, 7, 28, and 90 days. It has been observed that the addition of marble powder enhances the compressive strength of concrete. [5]

Baboo Rai, Khan Naushad (2011) conducted the study on cubes of mortar (1:3) with varying percentage marble powder replaced by weight of cement and tested at three different intervals of curing 7days, 14 days and 28 days respectively. Also cubes of (1:3) mortar with partial replacement of sand with the same amount of Marble Granules were casted and their strength was evaluated after 7, 14, and 28 days in different intervals. Different properties of concrete like compressive strength, workability and flexural strength was checked at different intervals of curing. Finally, it was observed that the by partially replacement of the marble powder or marble granules increased workability, compressive strength and flexural strength of concrete. [6]

Prof. P.A. Shirule, Aatur Rahman, Rakesh D.Gupta (2012) presented the feasibility of using the marble dust in concrete production as partial replacement of cement. Different properties of hardened concrete have been investigated at

7days and 28 days curing periods by the replacement of 0,5,10,15and 20% marble powder by weight of cement. It was observed that upto 10% replacement of marble powder by weight of cement enhanced the Split tensile strength and compressive strength of concrete M20. [7]

Hassan A. Mohamadien (2012) investigates the effect of marble powder and silica fume of different percentages as partial replacement for cement on mortar. By replacement of marble powder and silica fume with cement content separately at 0%, 5%, 10%, 15%, 20%, 30% and 50 % by weight were investigated. Different mechanical properties of mortar were measured in terms of compressive strength at 7 and 28 days curing periods. It was observed that at 15% replacement ratio for each the marble powder and silica fume increase the compressive strength of concrete at 7days and 28days test. It showed that compressive strength was increased by 31.4%, 48.3% at 7, and 28 days respectively at 15% replacement ratio of silica fume with cement content and also in replacement of marble powder with cement content the compressive strength increased by 22.7%, 27.8% at 7, and 28 days at 15% replacement ratio of marble powder with cement content respectively. [8]

Noha M.Soliman (2013) presented the effect of using marble powder in concrete mixes and Reinforced Concrete Slabs. The experimental results showed that, the use of a required amount of marble powder as a partial replacement of cement increases the Compressive strength and Tensile strength of Concrete. Commercial grades ASTM Type I Portland cement, which is produced as CEM I Portland cement (CEM I 42.5) in Turkey was used in order to prepare all concrete specimens. The marble sludge was obtained in wet form as an industrial by- product directly from the deposits of marble factories, which forms during the sawing, shaping and polishing processes of marble in Elazig region. The wet marble sludge was dried up prior to the preparation of the samples. The dried material was sieved through a 0.25 mm sieve and finally the marble dust was obtained to be used in the experiments as fine sand aggregate. [9]

Animesh Mishra, Abhishek Pandey, Prateek Maheshwari, Abhishek Chouhan, S. Suresh,

Shaktinath Das (2013) present the use of marble dust in green cement for sustainable concrete. In this study the compressive strength and mechanical properties were investigated. Compressive strength was discussed as a function of different parameters like curing time, composition of binder. Final results show that the blended cements developed higher strength, at 28 days compared to 7 days. It observed that strength increases as the marble content increased. So, it helps in the lower consumption of the natural resources and also controls the pollution. [11]

V. M. Sounthararajan and A. Sivakumar (2013) adds lime content in marble powder and check its effects on concrete mix. The effect of different percentage replacement of marble powder on the compressive strength, splitting tensile strength and flexural strength was determined. It can be noted that the influence of fine to coarse aggregate ratio (F and cement-to-total aggregate ratio had a higher influence on the improvement in strength properties of concrete. The test

results show that 10% replacement of marble powder in cement content improve in mechanical properties of concrete as compared to the conventional concrete.[12]

Md Mahboob Ali, Prof. S.M.Hashmz (2014) investigated the strength characteristics of concrete using marble dust powder as a partial replacement of cement and sand by stone dust. The dissertation work was carried with M30 grade concrete for which the marble powder is replaced by 5%, 10%, 15% and 20% by weight of cement. For all the mixes compressive strength, flexural and split tensile strength are determined at different days of curing. Final results of dissertation was indicated that upto 10% replacement of marble dust and 20 percent replacement of stone dust by weight of sand improved the compressive, flexural and split tensile strength of concrete.[13]

Er. Raj P.Singh Kushwah, Prof. (Dr.), Ishwar Chand Sharma, Prof(Dr.) PBL Charurasia(2015) presented in his paper that the marble can be utilized in concrete mix by replacement of fine aggregates. Different properties of marble slurry are determined like specific gravity, fineness modulus etc. and investigated that utilization of marble slurry by replacing it with sand upto 30 % shows equal strength as of cement concrete ratio 1:2:4 with 0% marble slurry. It shows that marble slurry can be used for enhances the concrete properties. [16]

RohanK,RoshanRai, Dr.Bhavani Shankar,Akshay NK(2015) investigate the Influence of marble dust as partial replacement of cement in normal curing concrete. Concrete mix was prepare according to IS 10262:2009 and experimental studies were carried out to investigate the strength properties of M30 concrete made with various mixes. Properties include compressive strength, flexural strength and split tensile tests of hardened concrete has been studied with the 0%, 5%, 10%, 15%, and 20% replacement of marble powder. In this investigation they found that the compressive strength, tensile strength and Flexural strength concrete specimens is increased with addition of marble dust compared to conventional concrete up to 15%, and there is a sudden decrease in strength for 20% addition. [18]

IV. EXPERIMENTAL PROGRAM

To determine the effect of marble powder by partial replacement of cement with marble powder in concrete mix we can use following tests

- (i) Compressive Test of concrete
- (ii) Flexural Test of concrete

(i) COMPRESSIVE STRENGTH TEST:

Compressive strength of concrete cube is checked by a compression testing machine. The compression testing machine shall be equipped with hardened faces. The upper plate of test machine can be raised or lowered by means of a heavy screwed bolt. This test is conducted on the standard cubes of size 150mm x 150mm x 150 mm as per IS 516-1959 code. The compressive strength of concrete specimens is checked at the curing period of 7days, 14 days and 28 days. The concrete specimens stored in the water, should be tested

immediately after they removed from water and any surface water on concrete cubes should be wiped out with the help of a cloth. After that the specimens must be placed accurately between the plates and compressive strength of concrete cube is measured by applying a constant rate of loading within the range of .14 to .35 until the failure of cube between the plates.

(ii) FLEXURAL STRENGTH TEST

Flexural strength of concrete beam is tested by two point loading machine. Standard concrete specimens of size 100mm×100mm×500mm or 150mm ×150mm×700mm are tested over a span of 400mm and 600mm respectively on two point loading machine . The flexural strength of concrete beam is checked at the 7days, 14 days and 28 day curing period. The concrete specimens stored in water, should be tested immediately after they removed from the water and any surface water on concrete beams should be wiped out with the help of a cloth. After that the specimens must be placed accurately on Two point loading machine to the determination of the Flexural strength of Concrete.

V. CONCLUSIONS

- (i) According to past studies, it concludes that marble powder can be used as partial replacement of cement in a concrete mix.
- (ii) In a required quantity marble powder enhances the properties of concrete mix.
- (iii) It is a byproduct of the marble processing company and easily available in cheap rate as compare to cement.
- (iv) It may prove Eco friendly by controlling the production of cement which makes a cause of an unhealthy environment.
- (v) This solid material is capable of improving the physical and chemical properties of concrete mix.

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