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The consequences of waste marble dust on the mechanical properties of the concrete

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Abstract— Concrete is the most vital constituent used in the construction business right through the world, where the fine aggregate is generally natural sand. The demand for natural sand in the construction industry has repeatedly increased which has resulted in the reduction of sources and an increase in price. In such a situation the marble dust can be an economical option to the river sand in & as fine aggregate. Disposal of the marble powder material from the marble industry is one of the environmental problems worldwide today.

This paper presents the consequences of study undertaken to explore the feasibility of using quarry dust and waste marble powder in concrete.

Key Words — Marble powder dust, Workability, Compressive strength and Flexural strength.

1. INTRODUCTION

These day marbles are extensively used in construction work. A large amount of waste is generated during sawing, grinding and polishing process. The result is that the marble waste which is 20% of total marble quarried has reached as high millions of tons. Normally the marble wastes are being dumped in any nearby pit or vacant space near the marble processing industries, although notified areas have been marked for dumping the same. This leads to enlarged environmental risks as dust pollution spreads alongside for a large area. In the dry season, the dust dries up, floats in the air, flies and deposits on crops and flora. In addition, the deposition of such generated huge amount of fine wastes certainly creates necrotic ecological conditions for flora and fauna changing landscapes and habitats. The accumulated waste also contaminates the surface and underground water reserves. Now a day's marble waste is one of the causes of environmental problems around the world.

Therefore, max. Utilization of marble waste in various industrial sectors, especially the construction, agriculture, glass and paper industries would help to protect the milieu. Concrete is the most widely used construction material in the civil construction work because of its high structural strength and stability. Concrete is a heterogeneous mix mass of cement, aggregate (coarse and fine aggregate) and water. Aggregate can not only limit the strength of concrete also affect the durability and performance of concrete. The worldwide consumption of sand as fine aggregate in concrete production is very high, so maximum areas are facing acute shortage of good quality of sand.

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). 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.

Marble dust: Marble powder is produced from the marble processing plants during the cutting, shaping and polishing. During this process, about 20-25% of the process marble is turn into the powder form. India being the topmost exporter of marble, every year million tons of marble waste form processing plants are released. The disposal of this waste marble on soils causes reduction in permeability and contaminates the over ground water when deposited along catchment area. Thus, utilizing these marble waste in construction industry itself would help to protect the environment from dumpsites of marble and also limit the excessive mining of natural resources of sand.

Physical properties

- Colour - White
- Form - Powder
- Odour - Odourless
- Specific gravity - 2.68 gm/cm3

One of the logical means for reduction of the waste marble masses calls for utilizing them in building industry itself. Some attempts have been made to find and assess the possibilities of using waste marble powder in mortars and concretes and results about strength and workability were compared with control samples of conventional cements and mortar/concrete. Marble powder can be used as a; filler in concrete and paving materials and helps to reduce total void content in concrete.

1.1. Objective of Study.

The foremost objective of the present work is to examine the usability of the marble powder as partial

substitute of fine aggregate instead of sand in concrete. Effect of waste marble powder in concrete has been investigated by experimental tests on conventional concrete without marble powder with varying quantities of marble dust powder by replacing the sand partially.

1) To study the effect of use of waste marble dust on the mechanical properties of concrete.

2) To compare the compressive, flexural and tensile strength using marble dust with the given design mix.

To establish alternative for sand with partial use of marble dust in concrete

2. LITERATURE REVIEW

Dr. Suji D, et. Al. [1] found that the waste marble powder in place of cement is replaced partially with various percentages (2.5%, 5%, 7.5%, 10%, 12.5%, and 15%). & presented by his paper the results of study undertaken to investigate the feasibility of using quarry dust and waste marble powder in concrete. It is found that the studies of concrete made of quarry rock dust and waste marble powder increases at 12.5%. The flexural strength of beams is gradually increased up to 10% with addition of waste marble powder and quarry dust and further any addition of the concurrent products the strength decreases. Thus, it concluded that the replacement of natural sand with quarry rock dust, as partial replacement in concrete and also partial replacement of cement with waste marble powder is possible and economical when compared with conventional concrete.

Bhupendra Singh Kalchuri1, et. Al. [2] Concrete is prepared with marble powder as a partial replacement of fine aggregate (Sand) in different proportions i.e. 10%, 20%, 30% and 40% and tested for the period of 7days, 28days, 90days curing. The compressive strength of concrete is increased when the percentage of marble powder waste is increased up to 20% and by further increasing the percentage of marble powder waste compressive strength gets reduced. Test results obtained as there also indicates that the waste marble powder can be successfully utilized as partial replacement of fine aggregate in concrete production.

Mr. Aalok D. Sakalkale et. Al. [3] This study is aimed at utilizing Waste marble powder construction industry itself as fine aggregate in concrete, replacing natural sand. The replacement is done partially and fully in the proportion 0%, 25%, 50% and 100% and its effect on properties of concrete were investigated. The compressive strength and flexural strength of concrete is increased with addition of waste marble powder up to 50% by weight. The split tensile strength of cylinders is decreased with addition of waste marble powder, from control mix to 100% replacement of sand. Thus, 25% sand replacement with WMD can also give better tensile strength. Thus, found out the optimum percentage for replacement of sand with marble powder in concrete is almost 50%.

Bahar Demirel [4], Marble dust as a fine material on the mechanical properties of the concrete have been investigated. For this purpose four different series of concrete-mixtures were prepared by replacing the fine sand with at proportions of 0, 25, 50 and 100% by weight. It was observed that the addition of WMD such that would replace the fine material passing through a 0.25 mm sieve at particular proportions has displayed an enhancing effect on compressive strength. The SEM investigations indicated that Ca(OH)2 morphology in specimens with and without WMD are different from each other.

3. EXPERIMENTAL BACKGROUND AND ANALYSIS

A Series of concrete specimens including the control specimen were prepared in order to examine the effect of substituting marble dust (0, 2.5, 5%, 7.5%, 8% and 10% by weight) in place of sand to explore the basic strength properties of concrete. Ordinary Portland cement (OPC), grade 43 confirming to IS 8112:1989 was used throughout the investigation. The marble dust obtained as an industrial by-product directly from the deposits of marble factories is used as a sand replacement material. The coarse aggregate used in this investigation have a maximum size of 20 mm with grading confirming to IS-383-1970.

The natural river sand passing through 4.75mm sieves is used throughout the process. The design of concrete mix is done as per guidelines of IS 10262: 2009 with a grade of M30 concrete. The mixing of concrete is done using a standard mechanical mixer. The mixing is to be done for two minutes for all the ingredients to feed inside the mixer.

Compaction of all specimens was done by using shake table vibrator. The top surface of concrete is leveled and finished smooth. The compressive test and the flexural strength test are performed as per IS 516: 1959 and split tensile test is performed as per IS 5816: 1970. Various tests were performed on the concrete ingredients that were required, given by table below.

Table No. 1: Test on Concrete ingredients.

S. No.	Tests performed	Result Observed
1	Specific gravity of cement	3.15
2	Consistency	32%
3	Initial setting time	74 min
4	Final setting time	255 min
5	Specific gravity of sand	2.61
6	Specific gravity of aggregate	2.8
7	Aggregate impact value	5.26%
8	Aggregate crushing value	15.09%

Table No. 2: Batching of Concrete Mix.

Cement	Sand	Aggregate	W/c ratio	Water
Kg/M³	Kg/M³	Kg/M³		Liters
413.09	746.76	1063.42	0.45	185.89

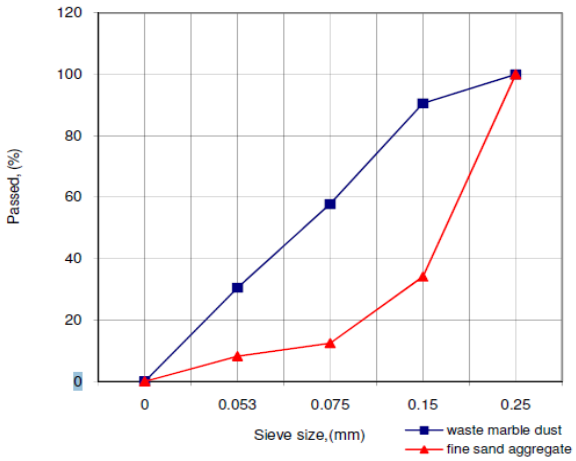
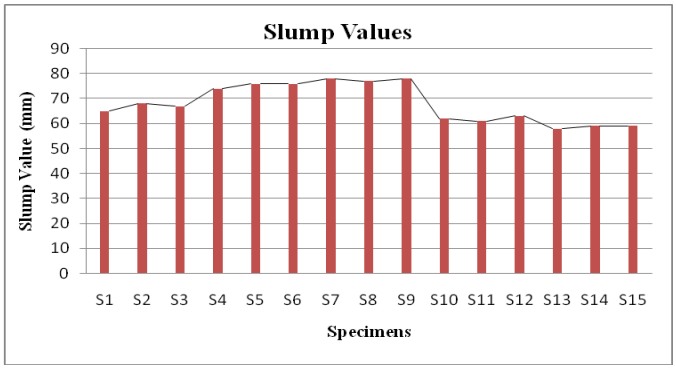


Fig. -1. Grain size distribution of fine sand aggregate and marble dust.

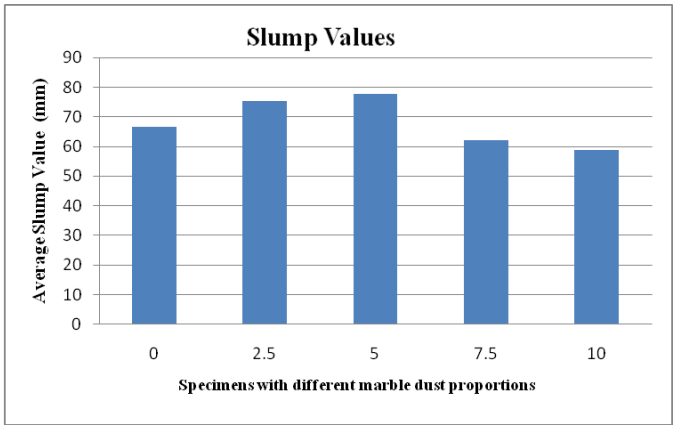
Table No.3: Mix Proportion for concrete M30

Material By Weight			Mix Proportion C:FA:WM:CA:water
Marble %	Sand (Kg)	Waste Marble (Kg)	
0	600	0.000	1:1.40:0.00:2.96:0.45
2.5	540	60	1:1.26:0.14:2.96:0.45
5	480	120	1:1.12:0.28:2.96:0.45
7.5	420	180	1:0.98:0.42:2.96:0.45
8	360	240	1:0.84:0.56:2.96:0.45

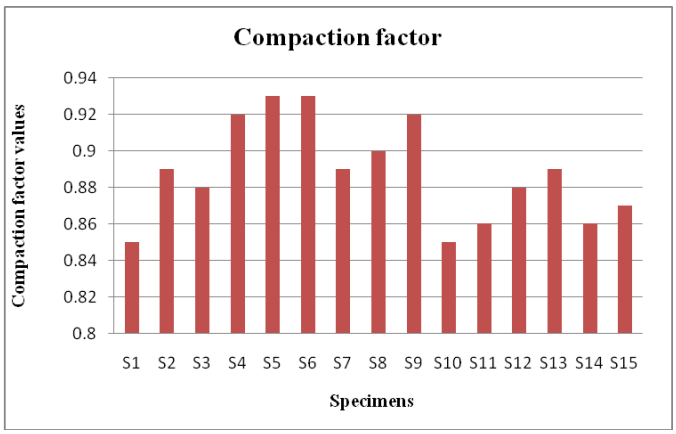
4. RESULT ANALYSIS



Graph No. 4.1 - Results of Slump test



Graph No. 4.2 - Results of average slump in mm at different marble dust %.



Graph No.4.3 - Results of Compaction Factor test for all specimens

5. RESULT DISCUSSION.

i. Compressive strength - Compressive strength tests were to performed on compression testing machine using concrete cube samples to obtain Compressive strength 38 N/mm2.

ii. Split Tensile Strength - The average failure load and the split tensile strength obtained 28 days of curing for cylindrical specimen is obtained as 36 N/mm2.

iii. Flexural Tensile Strength - The average failure load and the flexural strength obtained after 28 days of curing for beam specimen is obtained as 23.5 N/mm2.

iv. In concrete production replacement of various percentage of sand by marble waste powder gives comparable compressive and flexural strength as of marble waste free concrete specimens; but increasing the replacement range beyond 7.5% results in strength reduction. In concrete production, replacing of sand up to 20% by marble waste powder gives similar strength as of concrete mixes with 100% sand both at early and latter ages.

6. CONCLUSIONS

i. The strength of concrete increases with increase in percentage of marble up-to 7.5% then decreases.

ii. The flexural strength of marble dust induced concrete cube is best at 5%.

iii. The Marble dust reduces cement content in concrete mix hence its cost effective.

iv. IST is increased to 40 – 42 minutes.

v. w/c ratio is high in marble dust mix than conventional mix say0.45 - 0.48.

vi. Mechanical property of concrete with marble dust is increased considerably.

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