Experimental Investigation on Marble Dust As A Partial Replacement of Sand in Concrete

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Abstract- *The Sand is produced in a natural way. Mining of sand in Narmada River due to natural calamities there is a danger. In the coming time so we have to be ready to deal with this problem. So we are looking from marble dust. Marble Dust is a developing composite material that will allow the concrete industry to optimize materiel use, generate economic benefits and build structures that will be strong, durable and sensitive to the environment. The waste generated from the industries causes environmental problems. Hence the reuse of this waste material has to be emphasized. It has been estimated that several million tons of Marble dust are produced during quarrying worldwide. Hence utilization of marble powder has become an important alternative materials 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.*

I. INTRODUCTION

Marble dust contains high calcium oxide content of more than 50%. To avoid adverse environmental circumstances, the content of Sand is reduced in concrete and replaced by marble dust which reduces cost and addition of marble dust also increases strength and durability of concrete. The marble dust was replaced with Sand at 0%, 5%, 10%, 15% and 20% by weight of sand in M20(1:1.5:3) grade concrete. Concrete mixes were experimentally tested and compared in terms of compressive strength of the conventional cement concrete at 7 days and 28 days for 150mm*150mm*150mm Sized cubes. By addition of some good quality binding materials like marble dust, the various properties of concrete viz. workability, durability, strength, resistance to cracks and permeability can be effectively improved. The subsequent modification in microstructure of cement composites may enhance the properties like compressive strength, flexural strength, split tensile strength and durability and increases the service-life properties.

II. MATERIAL USED

a. Cement (OPC)
b. Sand
c. Aggregate
d. Marble Dust (waste)

a. Cement: Ordinary Portland cement is used to prepare M-20 grade Concrete. The cement used was fresh and without any lumps Water – cement ratio is 0.42 for this mix design using IS 456:2007.

b. Sand: Sand is naturally occurring granular material composed of finely divided rock and mineral particles. The most common constituent of sand is silica, typically within the kind of Quartz.

c. Aggregate: Aggregate are the important constituents in concrete. They give body to the concrete, reduce shrinkage and effect economy. Aggregates are the well-mined material in the world. Aggregates are a component of composite materials like concrete and asphalt concrete; the mixture is reinforcement to feature strength to the

composite material. Coarse aggregate of size 20mm is sieved and used.

d. Marble Dust: Marble has been commonly used for various purposes like flooring, cladding etc. as a building material since the ancient times. The industry's disposal of the marble powder material, consisting of very fine powder, today constitutes one of the environmental problems around the world.

Chemical Composition of Marble Dust

Test Conducted	Test Result
Silica	9.04
Alumina	0.88
Iron Oxide	0.86
Calcium Oxide	49.77
Magnesium	0.71

III. FORMULATION OF RESEARCH

Stage 1: In this stage of work Sand is partially replaced by Marble Dust is partially replaced Marble Dust in different percentages as shown in the table below. 5 batches are prepared in different proportions including conventional concrete mix (Cement as binder, Sand as fine aggregates & Natural Coarse Aggregates). Cubes and Cylinders are casted for determining Compressive Strength, Split Tensile strengths & Bond Stress respectively at 7 & 28 days.

Mix	Cement (%)	MD %	Sand (%)	Natural Coarse Aggregates (%)
1	100	--	100	100
2	100	5	95	100
3	100	10	90	100
4	100	15	85	100
5	100	20	80	100

Stage 2: In this stage of work density of concrete of all five types of mixes is also calculated & checked whether it is considered as light weight concrete or not. Density of light weight concrete is less than 2000 kg/m3. Cubes are casted for determining Density of different mixes respectively at 7 & 28 days.

IV. CALCULATIONS

Range Calculation

As per IS456, split tensile strength of concrete. = $0.7(fck)^{.5}$

The splitting tensile strength is calculated using the formula

Tsp = 2P/ pi DL
Where P = Applied load.
D = Diameter of the sample.
L = length of the specimen.

SPLIT TENSILE STRENGTH

T = 2P/ pi DL

Slump Cone Test:

S.NO.	COMBINATION	SLUMP VALUE (mm)
Mix-01	C+S+NCA+WATER	82
Mix-02	C+S(95%)+NCA+MD(5%)+ WATER	70
Mix-03	C+S(90%)+NCA+MD(10%)+ WATER	75
Mix-04	C+S(85%)+NCA+MD(15%)+ WATER	72
Mix-05	C+S(80%)+NCA+MD(20%)+ WATER	65

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V. COMPRESSIVE STRENGTH

Compressive strength test is performed on 3 cubes of each batch mix for 7 days & 28 days. There are 5 batch mixes and each one having 6 cubes. Of these 6 cubes, 3 cubes are tested for 7 days & 28 days each. An average of 3 values as tabulated in subhead results, are considered for discussions.

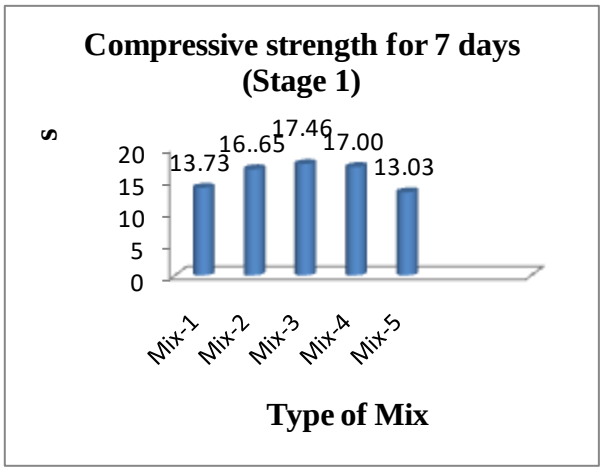


Fig: Compressive Strength at 7 days (Stage-1)

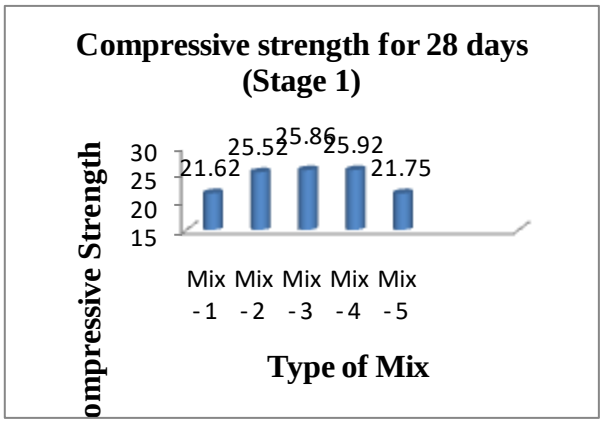


Fig: Compressive Strength at 28 days (Stage-1)

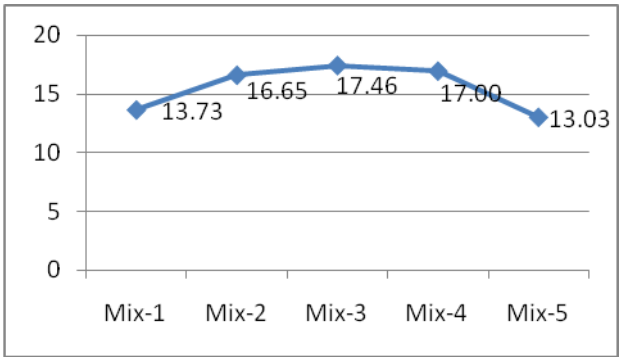
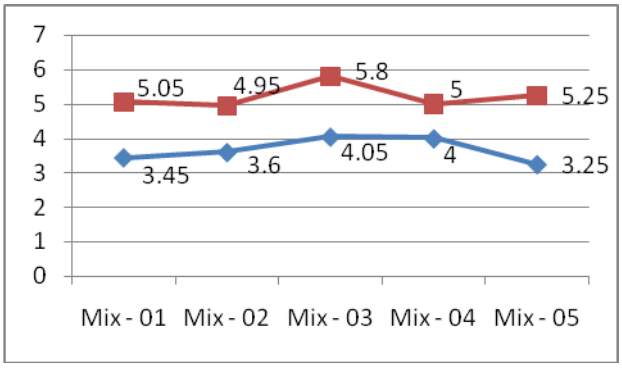


Fig: Compressive Strength in N/mm^2 at various age (Days) (Stage-1)

As shown in the Fig: 1 (7 days strength), when Sand is partially replaced 10% by Marble dust, compressive strength is increased by 21.74%. Afterwards when addition of % of Marble dust is replaced, strength starts decreasing, a minimum strength is achieved. 28 days strength in Fig: 2 show an increment of 16.85% of strength of 10% replacement of Marble dust as compared with conventional concrete. Again strength is decreased when addition of percentage of Marble dust increase.



As shown in the graph: (7 days strength), when cement is partially replaced 10% by MD i.e., Split Tensile strength is increased by 23%. Afterwards when % of MD is increased the strength starts decreasing

28 days strength in graph: shows and increment of 29% of strength of 10% replacement of MD as compared with conventional concrete. Again strength is decreased when % of MD is increased.

VI. CONCLUSION

Compressive strength, Split Tensile strength, Bond strength and Density of concrete mixes is tested with adding certain percentage of Marble Dust at 7 & 28 days of curing. Marble Dust is used in the concrete which is replaced by 0%, 5%, 10%, 15%, and 20% by the weight of Sand, optimum Marble Dust content to be 5% (by weight of Sand) is taken in our work and different properties of concrete is examined. After performing all the tests and analyzing their result, the following conclusions can be derived:

1. Maximum increase in compressive strength of concrete occurred when 10% sand (mix-03) replacement was done with Marble Dust.
2. Maximum increase in bond strength of concrete occurred when 10% sand (mix-03) replacement was done with Marble Dust.

3. Split tensile strength is maximum when 15% Sand replacement was done with Marble Dust by weight of Sand.

Using the Marble Dust as cement and aggregate in concrete can reduce the material cost in construction because of the low cost and abundant Industrial waste. This type of concrete we named "Marble Waste Concrete" can be used in rural or Industrial areas and places where Marble Dust is abundant and may also be used where cement and conventional aggregates are costly. Thus, economy can be achieved in construction. Marble Dust is also classified as structural Medium lightweight concrete. By reinforcing the concrete with Marble Dust which are Minimum Cost or freely available, we can reduce the environmental waste and split tensile strength increases in case of 5% Marble Dust.

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