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UTILIZATION OF MARBLE POWDER IN CEMENT MORTAR

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ABSTRACT:

The amount of solid waste being produced all over the globe is causing drastic effects on the environment. The solid waste disposal has been causing pollution and damages related to it. The marble mining and production industry creates masses of solid waste, with no methodical process for its disposal. Marble slurry is marble fines suspended in water, generated during the processing of marble. It constitutes 10% of the total stone quarried and 5-7% produced during polishing. Various studies have been conducted on the proper disposal of the solid waste generated during marble processing. This study if focused on the use of marble slurry as partial or complete replacement of aggregate in cement mortar. It elaborates on the tests conducted for compressive strength, abrasion resistance and water absorption in mortar specimen.

KEYWORDS:

- **Mortar**
- **Compressive strength**
- **Abrasion**
- **Water absorption**

INTRODUCTION:

Solid waste is any waste material produced as garbage, refuse, sludge from waste water treatment plants, water supply treatment plants, or air pollution control facilities and other discarded materials including solid, liquid, semi-solid, or contained gas material, resulting from industrial, commercial, mining and agricultural operations and from community activities, but does not include solid or dissolved materials in domestic sewage, or solid or dissolved materials in in irrigation return flows or industrial discharges. The solid waste generated in the mining and processing of rocks such as marble, granite, limestone, sandstone, etc., constitutes a large portion of the total waste generated. Waste hence produced is hazardous to the environment due to lack of its proper disposal.

Marble is formed by metamorphism of sedimentary carbonate rocks, mostly limestone or dolomite. It has been commonly used as a building material since ancient times, as is seen in Parthenon, Athenian treasury, plazzo dei conservatori, taj mahal, etc.. The increasing popularity of marble, growing demands for finished and unfinished products have led to a drastic growth of the marble industry. Due to this the number of marble quarries, and marble processing units have gone up significantly. This has led to a drastic increase in the amount of waste being generated. For the disposal of this waste no organized and not damaging (to the environment) method has been obtained; the disposal of the waste generated are usually dumped in pits in forest areas, creating huge mounds of waste; the waste deposited on the roads, riverbeds, pasturelands, agricultural fields, leading to immense environment degradation; there is no segregation of the overburden from rock fragments, causing loss of fertile topsoil; there is a severe health hazard to the workers on account of dust and water pollution.

Marble slurry basically is marbles fines suspended in water, generated during processing and polishing of marble. The hazardous dumping process of marble slurry poses a severe threat to the environment, ecosystem and the health of the people. There is no way of stopping slurry generation, even with the advancements in technology. The only sure method of controlling the effects of this hazardous waste is its complete utilization.

1) A research on the marble dust as partially replacement of cement in concrete was conducted by Vaidevi C in 2013. They concluded that the marble dust from marble processing is an industrial waste which can be utilized. The use of this marble waste was done in various percentage replacements, for the production of concrete mixtures. In this research, marble powder generated during the shaping process of marble blocks was collected and replaced in the concrete mixtures as cementitious material. The study conclude that wastes generated by marble, which are in the dust/powder form, can be used as cementitious material in concrete mixtures where they are available and can reduce the cost of constructions.

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2) A research on Effect of the lime content in marble powder for producing high Strength concrete was conducted by V.M. Sounthararajanet.al in 2013. They concluded that the marble powder waste up to 10% by weight of cement can be used as replacement of aggregates for hardened concrete properties and they evaluated the effect of different percentage replacements of marble powder on the splitting tensile strength, flexural strength and compressive strength. They observed increase in the compressive strength of 46.80 Mpa at 7 days for 10% replacement of marble powder in cement content i.e. Improvement in strength properties and also an improved mechanical properties as compared to controlled concrete.

3) A research has been done on Influence of Marble powder/granules in Concrete mix which was conducted by Baboo Rai et.al (2011). They concluded that the use of marble powder/granules as constituents in mortar or concrete by partially replacing quantities of cement and aggregates in terms of the relative workability & compressive as well as flexural strengths. Partial replacement of aggregates and cement by varying percentage of marble powder or granules results in increased workability and compressive strengths of the mortar and concrete.

EXPERIMENTAL INVESTIGATION:

MATERIAL PROPERTIES AND PREPARATION OF TEST SPECIMENS

TABLE 1. Properties of Cement

S. No.	Properties	Value
1.	OPC	Grade 43
2.	Specific gravity	3.10
3.	Normal consistency	30.5%
4.	Initial setting time	135min
5.	Final setting time	200 min

TABLE 2. Properties of Natural river sand

S. No.	Properties	Value
1.	Zone	II
2.	void content	34%
3.	specific gravity	2.57
4.	free surface moisture	1%
5.	fineness modulus	2.735

TABLE 3.Physical properties of marble powder

Property	Result
Bulk density	1.3-1.5
Specific gravity	2.83-2.87

TABLE 4. Particle size distribution of marble powder

Particle size	% Finer by volume
363.1	100
193.0-205.8	90

TABLE 5. Chemical analysis of marble powder

Test carried out	Result in %
Loss on ignition	43.40
Silica	2.29
Alumina	1.08
Iron Oxide	0.19
Lime	49.05
Magnesia	4.44

TABLE 6. Marble waste utilization

Sr. No	Utilization Area	Utilization %
1	Structural fill ,Soil stabilization, and road embankment work	10-15
2	Cement	10-12
3	Aggregates	2-5
4	Bricks , Blocks, Tiles	11-13
5	Paint ,Binder ,Plaster	2-5
6	Concrete roofing sheets	5-10
7	Ceramic Products	10-12
9	Particle Board, Panels	10-12

LABORATORY TESTING PROGRAM:

TABLE 7. Mix detail of Specimen

% of replacement	Cement in g	Sand in g	Marble powder in g
0	1320	3960	0
5	1320	3762	198
10	1320	3564	396
15	1320	3366	594
20	1320	3168	792
25	1320	2970	990
30	1320	2772	1188
35	1320	2574	1386
40	1320	2376	1584

COMPRESSIVE STRENGTH:

As per the guidelines given by the IS codes the compressive strength test was conducted on three casted cube of mortar of size 70.6 mm and After 24 hr. of casting the cube was placed for curing. Compressive strength test was conducted after 28days by using compression testing machine at the uniform rate of loading 35N/mm^2.

ABRASION TEST:

This test was done to measure the resistance to wear. After 28days of curing of casted cubes of size 70.6mm, for 24hr. these cubes are oven dried at 180C, a load of 600N was applied to the exposed area of 70.6*70.6mm^2 to wear on the specimen and a standard abrasive powder was also used.

WATER ABSORPTION TEST:

In this test, for 24hrs a sample which was cured for 28days and then oven dried was used and kept in water. With the help of that sample we measure the water absorbed in terms of percentage by weight.

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EXPERIMENTAL RESULTS AND DISCUSSION:

WATER ABSORPTION:

As per laboratory test performance on mortar with marble powder up to 20% replacement, the value of water absorption is comparatively less and further increase in marble powder percentage up to 30%, gives same results like control mix and up to 40% replacement, optimum value of water absorption is obtained.

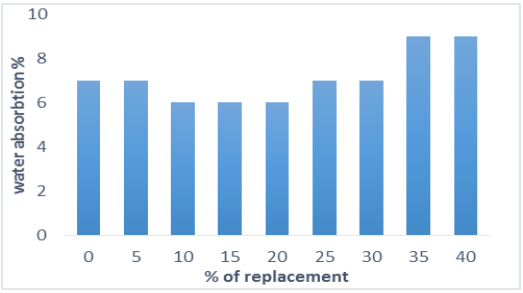

Fig 1. Water absorption with different variation of marble

TABLE 8. Result of Water absorption test

S. No.	Replacement % (specimen mark)	Water absorption in %
1	00	7
2	05	7
3	10	6
4	15	6
5	20	6
6	25	7
7	30	7
8	35	9
9	40	9

COMPRESSIVE STRENGTH:

After 28 days curing the 3 sample are tested and average compressive strength of 70.6mm size cube was shown in fig.2 , and it is clear from graph that at 5% replacement there is not any effect on strength as compare to control mix, at 10 % and 20% replacement level mortar got the highest strength and further increase in replacement the strength value gong to decrease and at 25% replacement again the strength was equal to control mix after this percentage replacement the strength of mortar is linearly decreases.

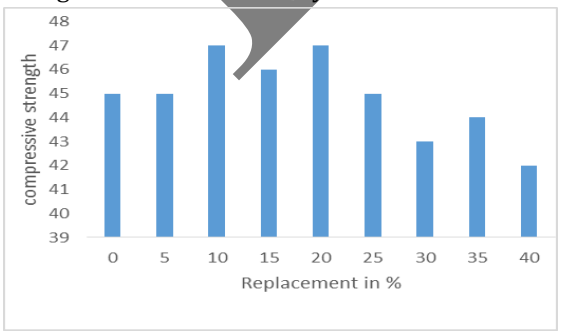

Fig 2. Compressive strength with different variation of marble

Table 9. Result of Compressive strength

S. No.	Replacement % (specimen mark)	Compressive strength (Mpa)
1	00	45
2	05	45
3	10	47
4	15	46
5	20	47
6	25	45
7	30	43
8	35	44
9	40	42

ABRASION TEST:

After conducting abrasion test on 70.6mm cube the result shows that the replacement up to 10% gives same result like control mix and at 15% replacement we get the minimum value, further increment of replacement gives higher abrasion value which is constant for all higher replacement percentage.

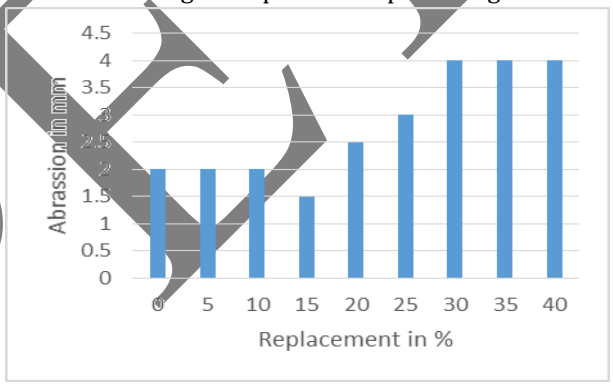

Fig 3. Abrassion with different variation of marble

TABLE 10. Result of Abrasion test

S. No.	Replacement % (specimen mark)	Abrasion in mm
1	00	2
2	05	2
3	10	2
4	15	1.5
5	20	2.5
6	25	3
7	30	4
8	35	4
9	40	4

CONCLUSIONS:

Based on the above study and experiments it is concluded that it is feasible to replace the sand by marble powder for improving the compressive strength (up to 20%), durability characteristics abrasion resistance value(up to 15%) and water absorption of the cement mortar.

Thus we can use marble powder as an alternative for the production of mortar to minimize the cost of the construction and for the proper utilization of disposal of marble powder.

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