Study on Asphaltic Concrete Pavement for utilization of Calcium Carbonate (Marble) Dust

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Abstract*: The main objective of this research is to investigate the possibility of utilizing waste marble dust (MD) in cement and concrete production. In present study experimental investigation conducted on optimum marble dust replacement with sand. After cutting and sawing marbles, in large amount of marble slurry produce. This marble slurry disposed to open land area, it make land pollution and harmful to land. In road construction it can use as substitute of fine aggregate, it has good binding property and gives enough strength to concrete and due to this it is suitable to bear heavy load on rigid pavement. In present study compressive strength of concrete at 28 days was checked, and this concrete is prepared by mixing cement, aggregates, water and sand. In further study sand is replaced by marble dust, and then concrete was prepared. The replacement ratios which have been studied were 0.0%, 10%, 20%, 30%, 40%, and 50% by weight. Water - cement ratio kept 0.55. Concrete made with marble dust as sand replacement achieved better performance compared to normal concrete. Experiment such as specific gravity test of sand and marble dust by pycnometer method, moisture content of marble dust and sand by oven drying method, specific gravity test of cement by Le-Chatlier flask method, normal consistency of cement, and initial setting time of cement, were performed to determine the physical property of concrete. On fresh concrete slump test was preformed to check workability of concrete and after then compressive strength was checked. Thus marble dust is appropriate substitute of fine aggregates in concrete mix for construction.

1. INTRODUCTION

Marble is a non-foliated metamorphic rock composed of re-crystallized carbonate minerals, most commonly calcite or dolomite. Geologists use the term "marble" to refer to metamorphosed limestone; however, stonemasons use the term more broadly to encompass un-metamorphosed limestone. 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. 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 sulfides.

1.1 Generation of marble dust

In general there are two types of waste named as quarry/ cutting/ sawing from in-situ stone site and polishing wastefrom construction sites. During the processing of stone, the raw stone block is cut as demanded either into tiles or slabs of various thickness (usually 2 or 4 cm), using diamond blades. Water is showered on blades while stone blocks are cut into sheets of varying thickness, to cool the blades and absorb the dust produced during the cutting operation.

1.2 Use of marble dust

Fig. 1: Generation of marble dust

Marble stone industry generates both solid waste and Stone slurry. Whereas solid waste results from the rejects at the mine sites or at the processing units, stone slurry is a semi liquid substance consisting of particles originating from the sawing and the polishing processes and water used to cool and lubricate the sawing and polishing machines. Stone slurry generated during processing corresponds to around 20% of the final product from stone industry. Therefore the scientific and industrial community must commit towards more sustainable practices. There are several reuse and recycling solutions for this industrial by-product, both at an experimental phase and in practical applications. Marble dust is an additive for thermoplastic and as a hardening agent for rubber industry.

Other uses are as follows:-

- Power coating, paints and ceramic industry
- Reinforced polyester glass fiber
- Leather cloth and flooring applications
- Detergent applications
- Glass industry (in manufacturing sheet & optical glasses)

2. OBJECTIVE AND SCOPE OF STUDY

2.1. Objective of this study –

Tests and analysis on Marble dust concrete prepared by marble dust optimum replacement with Fine aggregates. 28 days compressive strength of marble dust concrete isto be checked.

2.2. Scope of work-

Following procedure to be done for this work-

- Materials are to be collected,
- To find out the physical properties of materials.
- Materials are to be mixed in proper proportion and molded in a cube,
- In this study, normal grade of cement have to be taken, and prepare marble dust concrete by mixing marble dust with maximum replacement of sand. Various mixing proportion specimen of sand and marble dust prepared 10% to 50% replacement of sand by weight with marble dust.
- These various specimens of marble dust cement concrete are to be tested and normal 28 days compressive strength is to be checked.
- Analyzing tests result

3. Activity chart: working plan

Collection of materials
Mixing process
Curing process
Testing process
Analysis of results

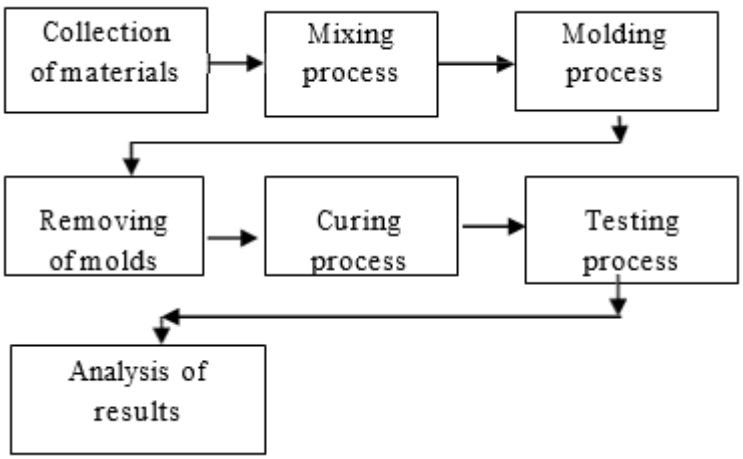

Fig. 2: Work plan for study

- Collection of material: for marble dust concrete materials are collected like normal grade of cement, aggregates, marble dust, water etc.

- Weighing and mixing process: material are weighed in proper way and as required and after then mixed in proper way and by design mix method.
- Molding process: concrete mixer are molded in cube sized 150*150*150 mm^3
- Removing of mold: After one day mold is removed.
- Curing process: concrete cubes are cured normally in fresh water for 7 to 28 days.
- Testing process: after removing of mould, concrete cubes are tested in laboratory. Various tastes are to be done.
- Analysis and test result: after various test on cube, result are calculated

4. Experimental study

In present study experimental investigation conducted on optimum marble dust replacement with sand. Experiments were conducted to find physical property of materials and workability and strength of concrete mix.

A. Physical properties of materials

A physical property is any property that is measurable whose value describes a state of a physical system. The changes in the physical properties of a system can be used to describe its transformations or evolutions between its momentary states. Physical properties are often referred to as observables.

Following physical properties as mentioned in table-1 was conducted in laboratory for this experimental study.

Table-1: Physical property of materials

1	Properties of Cement 1) Specific gravity 2) Standard Consistency 3) Initial setting time	 3.15 33P 40-45 minute
2	Property of Fine aggregates 1) Specific gravity 2) Moisture content	 2.58 8.86%
3	Property of Marble dust 1) Specific gravity 2) Moisture content	 3.06 4.21%

B. Concrete mixing-

For present experimental study, M-20 grade of concrete was prepared. Concrete was mixed in 1:1.5:3 proportions and w/c ratio was kept 0.55. Sand was replaced marble dust, marble dust added as 10%, 20%, 30%, 40% and 50% weight of sand which was used in mixing concrete. As mentioned in table-2 materials were weighed and mixed by manually. 3 to 5 minutes materials were mixed thoroughly. By Water/cement ratio determine the amount of water in concrete mix, if more water or less water added to mix it will decrease the strength of concrete. When concrete was well mixed, then slump test was conducted to determine its workability and slump value. For road construction slump value consider in range of 25- 50 mm of slump value.

Table- 2: Material requirements

Marble dust (kg)	Cement (kg)	Sand (kg)	Aggregates (kg)
0.000	7.500	11.250	22.500
1.125	7.500	10.125	22.500
2.250	7.500	9.0	22.500
3.375	7.500	7.875	22.500
4.500	7.500	6.75	22.500
5.625	7.500	5.625	22.500

After determining slump value of concrete, it was molded in cubes. These concrete cured very well in fresh water for 7 to 28 days. Compressive strength is determined on these concrete cubes by compressive strength testing machine (CTM).

C. Slump test-

The concrete slump test is an empirical test that measures the workability of fresh concrete. More specifically, it measures the consistency of the concrete in that specific batch. This test is performed to check the consistency of freshly made concrete.

Table- 3: Slump values of concrete

Marble dust content	Slump value (mm)
0%	30
10%	28
20%	25
30%	20
40%	20
50%	15

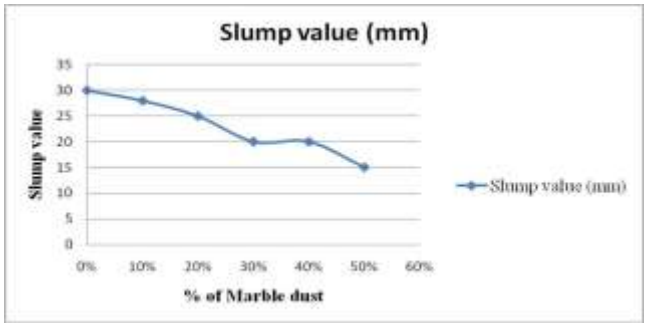

Chart – 1: Slump values of concrete

By chart, it can see that, as amount of marble dust increased slump value decreased, it shows it has less workability. Marble dust has better binding property and it make concrete mix stiff so slump value decreased. As amount of marble dust increased more water required to mix.

D. Compressive strength of concrete

The test is carried out to study the quality of cement from compression strength point of view the test consist of determining compression strength of 7and 28 days. Compression strength of cement is the property that most decides the qualities of strength of concrete. The compressive strength of concrete and cement mortar is a fundamental property that is thoroughly studied in almost all research works.

Table-4: Compressive strength of concrete

Concrete grade	Sample content	Compressive strength (7days) N/mm2	Compressive strength (28days) N/mm2
M 20	0% (only concrete)	27	35.92
	10% Marble Dust	24.81	37.47
	20% Marble Dust	24.72	34.94
	30% Marble Dust	18.71	32.25
	40% Marble Dust	15.23	31.93
	50% Marble Dust	12.98	28.46

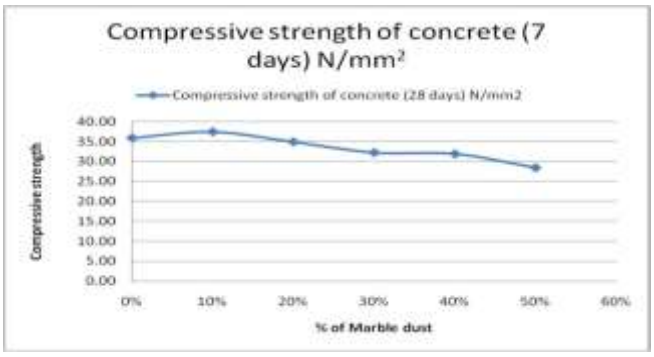

Chart-2: Compressive strength of concrete mix at 7 days

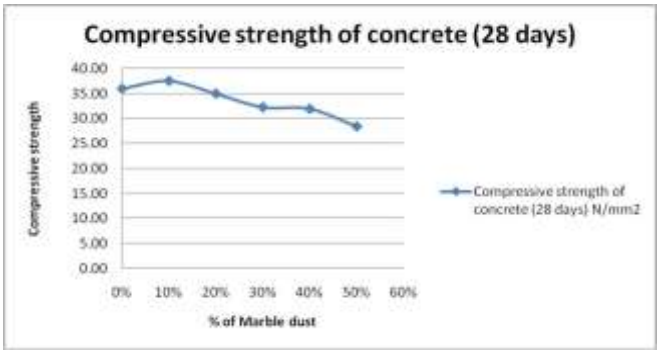

Chart- 3: Compressive strength of concrete mix at 28 days

Thus it can see in chart, compressive strength of concrete decrease as amount of marble dust increased, but up to 50% marble dust can replace in concrete, it has enough strength for work in road construction.

5. CONCLUSIONS

In present study experimental investigation conducted on optimum marble dust replacement with sand. After cutting and sawing marbles, in large amount of marble slurry produce. This marble slurry disposed to open land area, it make land pollution and harmful to land. In road construction it can use as substitute of fine aggregate, it good binding property and give enough strength to concrete.

- Specific gravity of sand 2.58 and marble dust's 3.06, thus specific gravity of marble dust is more than sand.
- Sand has more water content then marble dust. So for preparing concrete mix marble dust require more water to add.
- Initial setting time of cement was found 45-50 minute.
- In slump test workability of marble dust-concrete wasdetermined, as amount of marble dust increased slump value also decreased as compare to normal cement concrete. For desired slump value forworkability add more water added.
- In compressive strength test on harden concrete cube,it was found as amount of marble dust increased compressive strength decrease but it has enough compressive strength as require for construction. Up to 50% fine aggregate can replaced with sand.

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