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Partial Replacement of Cement with Marble Dust and Fine Aggregate with Stone Dust

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ABSTRACT:

Marble stone industry generates both solid and stone slurry and as per previous survey solid waste generation is more in marble stone industry, in and about 40% of waste is formed, that is around 68 million tones .So by dumping these wastes to the land may cause environmental problem and also effect the fertility of the soil. Therefore the scientific and industrial community must take responsibility towards more sustainable practices. There are many reuse and recycling solutions for industrial bi-product both at an experimental and in practical application. The physical, chemical and mechanical properties of the waste are studied. In this present study, concrete mix was prepared according to IS 10262:2009 and experimental studies were carried out to investigate the strength properties of M30 concrete made with various mixes.

Properties studied include compressive strength and split tensile tests of hardened concrete. Marble dust used was 0%, 5%, 10%, 15%, 20% and also strength will be compared with conventional concrete.

The resolution for taking up this investigation owing to the fact that nowadays natural aggregate (course and fine) confirming to Indian Standards is becoming scarcer and costlier due to its non-availability in time because of law of land, illegal dredging by sand mafia and accessibility to the river source during rainy season. Keeping this in view, this study was undertaken to evaluate the effect of partial replacement of natural sand with stone dust in concrete. Experimental programme was conducted using 30%, 40%, 50%, 60% and 70% partial replacement of fine aggregate with stone dust has been taken for concrete of M30 grade with 0.46 water cement ratio. In this study, set of cubes and beams were cast for compressive and split tensile strength respectively. Concrete specimens were tested after 7 and 28 d moist curing. It has been observed that 40% replacement of fine aggregate with stone dust is adaptable.

Keywords: ***Stone Dust, Marble dust,compressive strength, split tensile tests.***

I.INTRODUCTION:

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.

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Construction activities are taking place on huge scale all over the world and demand of construction materials are increasing day-by-day. Production of concrete and utilization of concrete has rapidly increased, which results in increased consumption of natural aggregate and sand (Patel et al., 2013). Aggregate is one of the main ingredients in producing concrete which covers 75% of the total for any concrete mix. Strength of concrete produced is dependent on the properties of aggregates used (Siva Kumar et al., 2014). Conventionally concrete is mixture of cement, sand and aggregate since all the ingredients of concrete are of geological origin, the construction industries are in stress to identify alternative materials to replace the demand of natural sand and aggregate (Nagpal et al., 2013). The key to achieving a strong, durable concrete rests in the careful proportioning, mixing and compacting of the ingredients (Sathawanea et al., 2013). Every year 250-400 tons of stone wastes are generated on site. The stone cutting plants are dumping the powder in any nearby pit or vacant spaces, near their unit although notified areas have been marked for dumping. This leads to serious environmental and dust pollution and occupation of a vast area of land, especially after the powder dries up so it is necessary to dispose the stone waste quickly and use in the construction industry (Patel and Pitroda, 2013).

1.2 Scope of the project:

- The experimental investigation is planned as under:
- To obtain mix proportions of control concrete by IS method
- To conduct compression test on RHA and control concrete on standard IS specimen size 150*150*150mm.(cube)
- To conduct Flexural test on RHA and control concrete on standard IS specimen size, Height 300 mm, diameter 150mm.(cylinder)

1.3 Objective of the project:

The objectives of this experimental project study are

1.Developing mix design for normal concrete relevant to IS: 10262-2009.

2.To study the strength properties of normal concrete of grade M30.

3.Tostudythe influence of partial replacement of cement with marble powder and fine aggregates with a stone dust, and to compare it with the compressive and tensile strength of ordinary M30 concrete.

4.We are also trying to find the percentage of marble powder and stone dust replaced in concretethat makes the strength of the concrete maximum.

III. MIX DESIGN:

2.1 Design of Concrete Mix:

Design of concrete mixes involves determination of the proportions of the given constituents namely, cement, water, coarse aggregate and fine aggregate. Workability is specified as the important property of concrete in the fresh state. For hardened state compressive strength and durability will be considered. In this chapter the details of concrete mixes are discussed. In the present work M30 grade of concrete were carried out.

2.2 Factors to be Considered In Mix Design:(As per SP23-1982)

The design of concrete mix will be based on the following factors.

(a) Grade of concrete (b) Type of cement c) Maximum nominal size of aggregated) Minimum water cement ratio e) Workability

III. EXPERMENTAL WORK

3.1. Casting of Specimens:

The cement and sand were first added and mixed thoroughly in the dry state until homogeneity was achieved. The dry coarse aggregate were added to the mixture and again mixed thoroughly. Water was slowly added and mixed thoroughly for 3 min. After mixing all

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the ingredients, concrete specimens were cast using steel moulds and compacted with a table vibrator in three layers. For each mix, six 150*150*150 mm cubes and cylinders of 150mm diameter and 300mm length were produced for measurement of the compressive strength and split tensile strength respectively.

Figure –3.1 Casting of Specimens

3.1.1 Marble powder Concrete mix:

Based on the Indian Standard (IS: 10262 - 1982), design mix for M30 grade of concrete was prepared by partially replacing cement with five different percentages by wei ght of marble granules (0%, 5%, 10%, 15%, and 20%). The mix proportion for M30 Grades of concrete with var ying percentage of marble granules is presented in Table 3.1

Mix	Material by Weight		
	% Marble	Cement (kg)	Waste Marble (kg)
M30	0%	413	0
	5%	392.35	20.65
	10%	371.7	41.3
	15%	351.05	61.95
	20%	330.4	82.6

Table 3.1: Marble powder Concrete mix

IV. RESULTS AND ANALYSIS:

This chapter deals with the observation of the results from the various tests conducted onconcrete for use as reducing the quantities concrete. The results are compared with the control of different Concrete mixes for the various percentage replacement levels of cement with marble dust and Fine aggregate with Stone aggregate. The strength characteristics of concrete containing marble dust and Stone dust are discussed in this chapter. Tests were performed on hard concrete cured under Standard laboratory conditions, and compressive and spilt tensile strengths were observed at Curing ages of 7, 28, days.

4.1 Test procedure and results for compressive strengths:

Test specimens of size 150×150×150 mm were prepared for testing the compressive Strength of both controlled as well as marble dust and stone dust based concretes.

The Modified mixture with varying percentage of stone dust and marble dust as apartialReplacement of sand and cement were prepared and cast intocubes. Compressive strength test results at curing ages of 7 and 28 days for control mix as well as for theModifiedmixes are shown in the Table. For testing in compression, no cushioningMaterial was placed between the specimen and the plates of the machine. The load was applied axially without shock till the specimen was crushed. Fig shows the test setup for the compressive strength. Three specimens for each mix were tested and the corresponding values were observed and average value were taken for discussion.

Table **4.1** Shows the variation of compressive strength with varying percentage replacement of Cement with marble dust, and fine aggregate with stone dust. Variations with both materials being used as replacements of cement and fine aggregates in the concrete

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4.2 Compressive Strength Test Result:

Mix Designation	Concrete mix		7 days(N/mm2)	28day(N/mm2)
CM	Control mix		28.88	34.6
	Stone dust	Marble powder		
M1	0%	5%	30.66	35.55
M2	0%	10%	32.22	36.45
M3	0%	15%	30.53	36.05
M4	0%	20%	28.88	34.22
S1	5%	0%	20.22	36.3
S2	10%	0%	23.33	38
S3	15%	0%	27.55	39.11
S4	20%	0%	31.55	40.23
S5	25%	0%	28.44	34.89
C1	10%	10%	32.89	49.33
C2	10%	20%	36.67	55
C3	10%	30%	35.55	53.325

Table 4.1 Compressive Strength Test Result

4.2.1 Compressive strength graph:

Compressive Strength Test Result for marble dust used as partial replacement of cement:

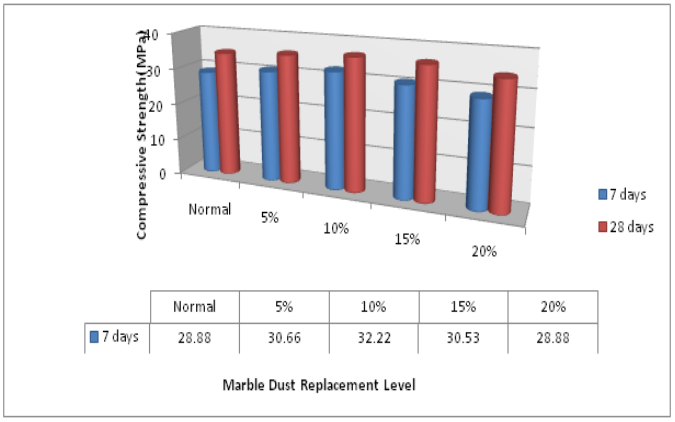

Figure – 4.1(i) Compressive strength graph

Compressive Strength Test Result for stone dust used as partial replacement of fine aggregates:

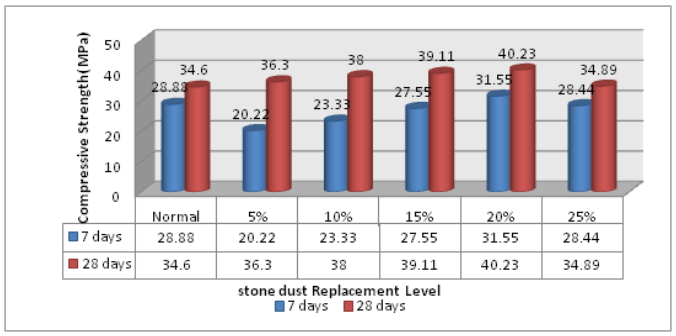

Figure – 4.2(ii) Compressive strengthgraph

Compressive Strength test result for Marble dust 10% is replaced in cement and stone dust used as partial replacement of fine aggregates:

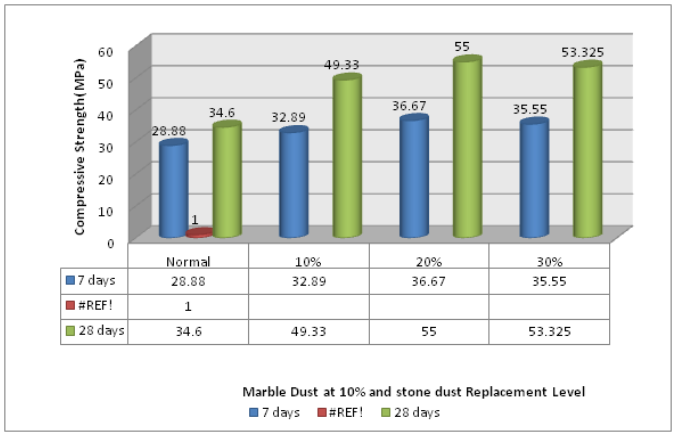

Figure – 4.3(iii) Compressive strength graph

The concrete mix is prepared for M30 grade and cement is replaced by marble dust and fine aggregate with a stone dust as certain percentage. These are the graphs which shows the 7 days and 28days strength of the concrete mix, graph also says, there is increase in strength as compared to conventional concrete. However there is a decrease in compressive strength value concrete mix when 20% stone dust is used as compared with that of 30%stone dust and cement is replaced partially with a marble powder up to 10%.

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4.3 Split Tensile Test:

Type of Mix		7Days(N/MM2)	28Days(N/MM2
Marble Dust	Stone dust		
0%	0%	175	272
10%	0%	192	292
15%	0%	172	267
10%	20%	180	270
10%	30%	230	330
0%	20%	255	378
0%	25%	249	344

Table 4.2 Split Tensile Test

The concrete mix is prepared for M30 grade and cement is replaced by marble dust and fine aggregate with a stone dust as certain percentage.The Split Tensile Test is done graphs which shows the 7 days and 28days strength of the concrete mix, graph also says, there is increase in strength as compared to conventional concrete.

4.3.1 Split Tensile Test graph:

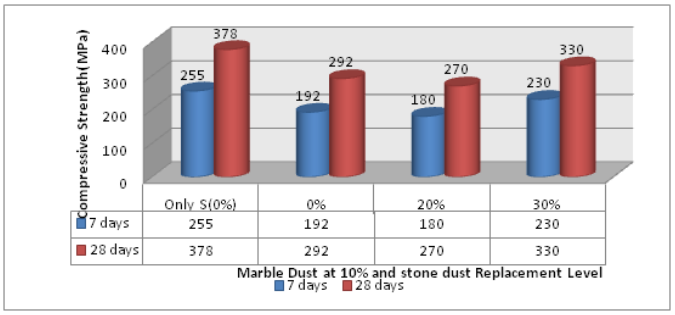

Figure 4.4 Split Tensile Test graph

V. CONCLUSION:

The following conclusion was drawn from the above experimental study:

The following conclusions can be made from the results of compressive strengths and from the analysis of the graph

- The optimum percentage of compressive strength of concrete for 28days with 10%cement replaced with marble powder is found to be given **5%** increment in normal cube strength.
- The optimum percentage of compressive strength of concrete for 28days with 20%fine aggregate replaced with stone dust is found to be given **16.27%** increment in normal cube strength.
- The optimumpercentage ofcombined 10%cement replaced with marble dust and 20%fine aggregate with stone dustis found to be given **58.95%** increment in normal cubestrength.
- The optimum percentage ofsplit tensile strength of concrete for 28days with 10%cement replaced with marble powder is found to be given **7.35%** increment in normal cylinder strength.
- The optimumpercentage ofsplit tensile strength of concrete for 28days with 20%cement replaced with marble powder is found to be given **38.97%** increment in normal cylinder strength.
- The optimumpercentage ofcombined 10%cement replaced with marble dust and 30%fine aggregate with stone dustis found to be given **21.32%** increment in normal cylinder strength.

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