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Mechanical Behaviour of Marble Dust in Partial Replacement of Cement and Sand in M-20 Grade Concrete

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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 cement and sand by marble fine aggregate with different proportions. 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. The replacement of sand by marble FA ratios which have been studied were 0%, 10%, 20%, 30%, 40%, and 50% by weight similarly the replacement of cement by marble dust which have been studied were 0%, 4%, 8%, 12%, 16% and 20%. Water – cement ratio kept 0.5. Ordinary Portland cement production is the major generator of carbon di oxide, which polluted the atmosphere. In addition to that large amount energy was also consumed for the cement production. Hence, it is essential to find an alternative material to the existing most expensive, most resource consuming Portland cement.

Keywords: Marble powder, Marble fine aggregate, Concrete modified with marble dust, cement & sand replacement, compressive strength, tensile strength

I. INTRODUCTION

A. General

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.

B. Introduction

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. The replacement of sand by marble FA ratios which have been studied were 0%, 10%, 20%, 30%, 40%, and 50% by weight similarly the replacement of cement by marble dust which have been studied were 0%, 4%, 8%, 12%, 16% and 20%. Water – cement ratio kept 0.5. Ordinary Portland cement production is the major generator of carbon di oxide, which polluted the atmosphere. In addition to that large amount energy was also consumed for the cement production. Hence, it is essential to find an alternative material to the existing most expensive, most resource consuming Portland cement.

C. Normal concrete

For our project we are using normal concrete & marble powder concrete for casting cubes and cylinders. For normal concrete we are using 1:1.5:3 proportions, i.e. M20 grade of concrete.

D. Necessity for Use of Marble Powder

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.

Leaving these waste materials to the environment directly can cause environmental problem. Hence the reuse of waste material has been emphasized. Waste can be used to produce new products or can be used as admixtures so that natural resources are used more efficiently and the environment is protected from waste deposits. This is relevant because the stone industry presents an annual output of 68 million tons of processed products. 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.

E. Importance of Use of Marble Powder

New developments in construction technologies and growing population give rise to more building constructions and thus cement consumption. Since the cement industry demands vast amount of energy, any increase in cement manufacturing also increase energy needs and causes additional environmental pollution.

The important portion of cost in cement manufacturing results from the energy consumption during the clinker production. Therefore, alternative investigations for solution have been ongoing in the ignition of clinker and raw material milling. The manufacturing of cement with additive is an economic and feasible method due to the decreasing of clinker ratio in cement and energy consumption in an oven and ball milling. For this purpose, generally pozzolana are used in the cement production. The studies on cement additives such as pumice, nut shell, wood and tea waste fly ash, blast furnace slag, silica fume, rice husk ash, diatomite, perlite and others were carried out by researchers.

F. Marble Used Concrete

From Design of M20 Cement Concrete, Cement and sand is to be replaced by marble material of specific Molarities. In this project we used admixture (Dr. Fixit). This experimental study is intended to identify the mix ratios for different grades of Marble used Concrete by trial and error method Casting of test cubes and cylinders is to be done by using different mix proportions of marble dust and marble fine aggregate.

G. Chemical Properties

Oxide Compounds (%)	Cement	Marble Powder
SiO ₂	21.12	28.35
Al ₂ O ₃	5.60	0.42
Fe ₂ O ₃	3.24	9.70
CaO	62.94	40.45
MgO	2.73	16.25
Density	3.10	2.8

Table No. 1

H. Physical Properties

Some researchers say that blain fineness for WMP is much more than Portland cement i.e. 5960 cm²/g against 4375 cm²/g. Due to high degree of fineness of WMP it has resulted to be very effective in providing very good cohesiveness of mortar and concrete. It also results in decreasing porosity. However the fineness reported by other researches is comparable to sand and can be used as replacement of sand.

II. COLLECTION OF MATERIAL

A. Marble Dust & Marble Fine Aggregate

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.

B. Cement

Portland Pozzolona cement of Birla gold conforming to IS 269-1976 and IS 4031-1968 was adopted in this work. The cement used is 43 grade.

C. Coarse Aggregate

The aggregate used in this project mainly of basalt rock which comes under normal weight category. The aggregates are locally available. 50% of the aggregate used are of 10-12 mm size and remaining 50% are of 20mm size. The coarse aggregate was also tested for various properties like impact value test, crushing value test, elongation and flakiness index test to check their suitability for the experiment.

D. Sand

Natural sand which is easily available and low in price was used in the work. It has cubical or rounded shape with smooth surface texture. Being cubical, rounded and smooth texture it give good workability.

Sand which is used here is taken from Girna River. Particles of this sand have smooth texture and are blackish. Sieve analysis was done to find out fineness modulus which comes out to be 3.14% which is under limit as per IS 383-1970.

III. TESTING WORK

A. Testing Of The Cubes

Cubes were tested under compression testing machine to know and verify the grade of concrete used. Average of the strength was taken as crushing strength of cubes and hence grade of concrete used.

B. Testing of Cylinders

Cylinders were tested under split tensile testing machine to know and verify the tensile strength of concrete. Average of the strength was taken as tensile strength of concrete.

IV. PLOTTING OF RESULTS

Compressive strength for 28 days

Sr. No.	Proportion in %		Max. Comp. Strength (mpa)
	Marble dust	Marble fine agg.	
1	0 %	0%	32.13
2	4%	10%	34.13
3	8%	20%	33.15
4	12%	30%	32.3
5	16%	40%	30.7
6	20%	50%	26.4

Table No. 2

Split tensile strength for 28 days

Sr. No.	Proportion in %		Max. Split Tensile. Strength (mpa)
	Marble dust	Marble fine agg.	
1	0 %	0%	2.53
2	4%	10%	2.99
3	8%	20%	2.76
4	12%	30%	2.81
5	16%	40%	2.08
6	20%	50%	2.10

Tab No. 3

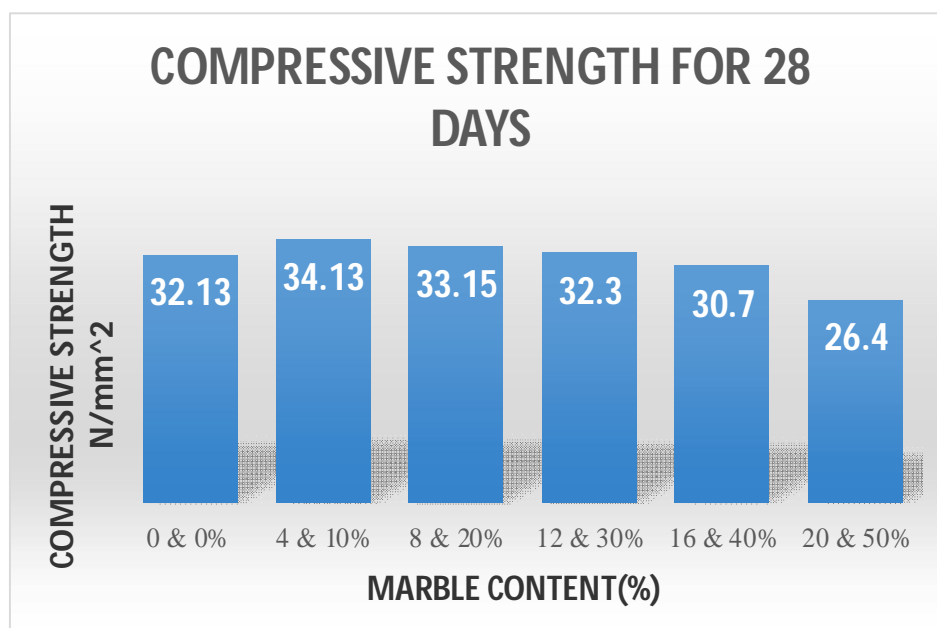


Fig No.1

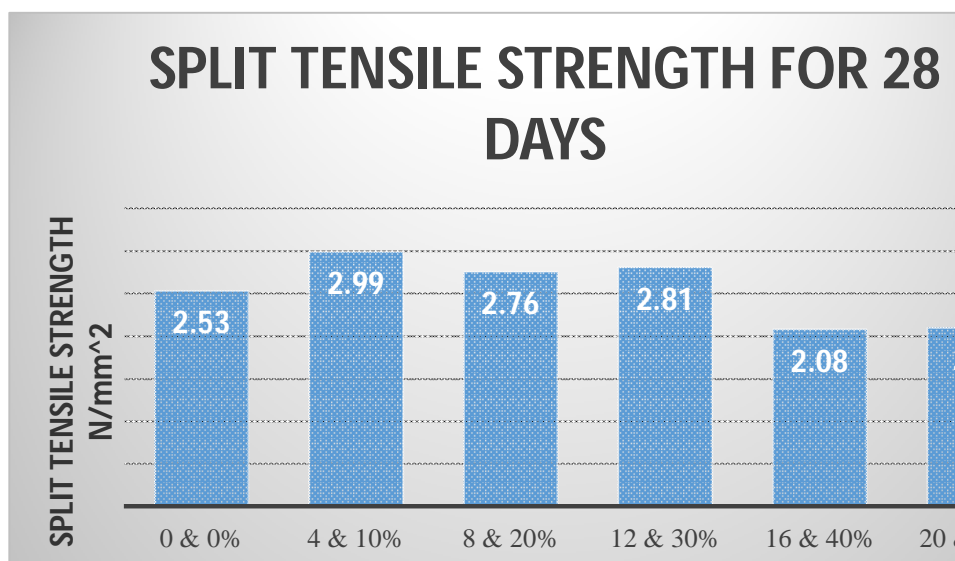


Fig.No.2

Comparison of comp. Strengths of various proportion

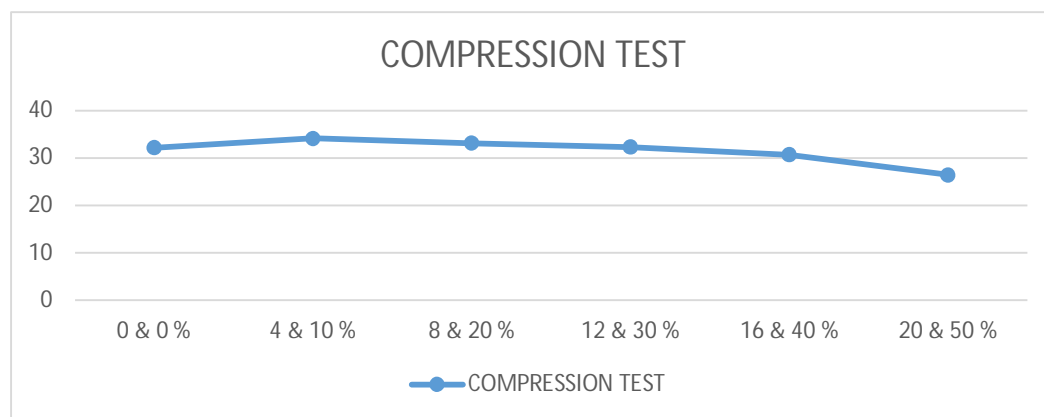


FIG. 3 COMPRESSION STRENGTH GRAPH

Comparison Of Split Tensile Strength Of Various Proportion

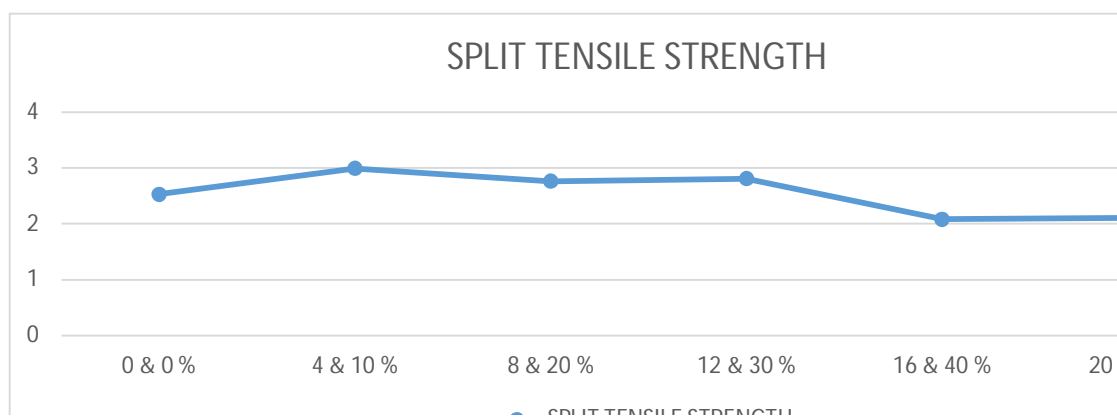


Fig. 4 split tensile strength graph

V. CONCLUSION

The experimental investigation carried out to study the mechanical properties of marble used concrete & conventional

A. Concrete and concluded the following:

- 1) From referring Table No.2 & Fig.No.1 is to be conclude that 4 % replacement of cement and 10 % of fine aggregate by marble dust and marble fine aggregate got more Compressive strength compared to 0 % replacement of cement and fine aggregate.
- 2) From referring Table No.3 & Fig.No.2 is to be conclude that 4 % replacement of cement and 10 % of fine aggregate by marble dust and marble fine aggregate got more split tensile strength compared to 0 % replacement of cement and fine aggregate
- 3) Similarly as replacement of 8% and 20% i.e: cement and fine aggregate has got approximately same compressive strength and split tensile strength of 0% replacement
- 4) We can conclude that more replacement i.e: 20% cement by marble dust and 50% sand by marble fine aggregate strength Will reduce drastically. As compared to cost of material usage it is more economical and environmental friendly
- 5) By conducting experimental work observation it is giving more workable and good for pavement work.

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