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STUDY ON PAVEMENT GRADE CONCRETE WITH PARTIAL REPLACEMENT OF CEMENT BY MARBLE DUST AND M-SAND AS FINE AGGREGATE

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Abstract − *This paper presents the strength (characteristic) properties of the concrete with partial replacement of cement by Marble dust and using M-Sand (quarry dust) as fine aggregate instead of natural river sand for M-40 grade rigid pavement concrete. Uses of waste materials in construction industry have two benefits: one is-it substitutes the nonrenewable resources and other is- the best utilization of the waste material and reduces problems of dumping, it also makes the concrete as Eco-Friendly as well as Economical one. The river sand is 100% replaced with M-sand, and the cement replacement is in different proportion that is 5%, 10%, 15%, & 20% by weight of cement with waste material Marble Dust powder.*

Properties of concrete are tested for fresh concrete and hardened concrete. For fresh concrete slump cone test is conducted and for hardened concrete compressive strength, Tensile strength and flexural strength test conducted after desired days of proper curing. The Design mix is done for M-40 grade pavement concrete & 1:2.3:3.02 is the adopted mix ratio. The results of desired concrete are compared with non-marble dust used concrete that is conventional concrete with 0% marble dust.

Key Words: **Marble Dust, M-sand, Compression Strength, Flexural Strength**

1. INTRODUCTION

In the present developing world construction takes the major part & we need so many materials for this construction process, in that concrete is the well-known material which is using in abundantly due to its strength and durability character. Concrete is made up of cement, fine aggregate, coarse aggregate and water, individual material has its unique property hence it is not easy to replace the material without proper examination.

Due to larger use of river sand we are facing scarcity of those materials so we need to find out substitute for the nonrenewable source with waste materials these are available in abundantly at quarries. M-Sand is the powdered waste material obtained after crushing of the granites at the stone crushers and Marble Dust produced from Marble cutting, processing, grinding and polishing industries, these powders can creates problem for the environment if it is not properly dumped or utilized. This paper is about to make a try on finding an alternative for the materials for cement and sand in concrete without compromising with its characters & this leads to the use of waste dumped materials which are left unused at open lands and makes the concrete eco-friendly.

1.1 Desired Concrete

Desired concrete is obtained by the addition of additives as partial replacements of the regular materials as a research material. Additives behaves as original material but only upto some extent may be because of its chemical composition, hence it is our duty to know upto what extent can we used as an alternative for that original material without reduction in its concrete strength. We can replace cement by Marble dust, fly ash, rice husk ash etc., Sand by M-sand, Pond ash, Copper slag, Foundry sand etc., Coarse aggregate by Recycled aggregates, Coconut shell, Laterites etc.

In this study we used additives Marble dust to partial replacement of cement by 5%, 10%, 15%, 20% of its weight. And river sand is fully replaced (100%) by M-sand.

1.2 Manufactured sand

Natural river sand is mainly used for construction works. Sand mining can causes calamitous issues to the environment. However, there is reduction in availability of the sand leads to finding an alternative becomes an inevitable. Now a day's M-sand was become the most preferable material for fine aggregate in place of naturally available sand.

Availability of M-sand is not much complicated as natural sand. M-sand can produce harsh mix with bleeding problem therefore to minimize voids and reduce water demand in concrete we choose the M-sand of our desired size by sieve analysis after that M-sand inhibits desirable properties within the permissible limits.

1.3 Marble Dust

The use of marble powder helps to reduce cost of construction, energy saving, and fewer hazards in the environment. This marble waste will not disturb in the

strength of concrete to larger extent. Aside from this, the marble waste study can be utilized for different purposes like brick formation, soil stabilization and it reduces this waste to make bearable environment.

2. Materials and methods

Cement- For present work cement is used of Ordinary Portland Cement of 53 grade basic tests conducted as per code IS-12269-1987.

Table -1: Physical properties of cement

Test	Results
Specific gravity	3.15
Initial setting time	40 min
Final setting time	420 min
Fineness	6%
Consistency (%)	31

Marble dust- Marble dust is collected from the nearby vicinity; marble dust passed in sieve IS 90micron is taken for the study. Basic tests are carried out as per IS-12269-1987.

Table -2: Physical properties of Marble dust

Test	Results
Specific gravity	2.63
Fineness	3%
Consistency (replace with 10% of marble dust)	27

M- Sand- Locally available M-sand is procured for the present work; its size is less than 4.75mm basic testes are carried out as per IS-2720.

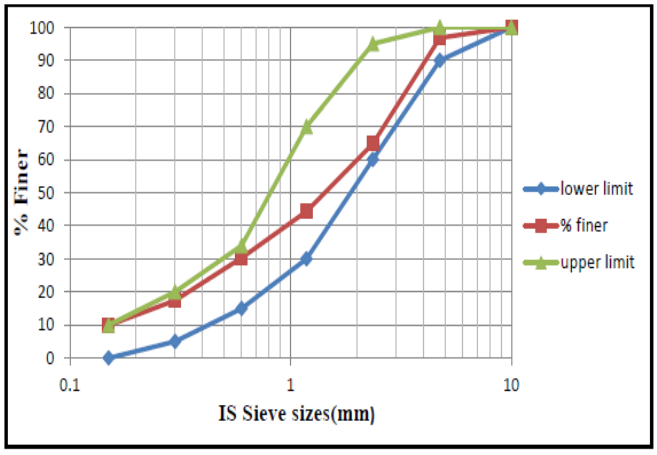

Chart -1: Gradation of M-sand.

Coarse aggregate- locally available coarse aggregate is procured from the nearest quarry. 20mm down sized aggregates are preferred, Basic tests were conducted as per IS-2386-1963.

Table -3: Physical properties of Marble dust

Test	M-Sand	Coarse Aggregate
Specific gravity	2.67	2.71
Water absorption	1.74%	0.8%
Fineness modulus	3.35%	8.26%
Abrasion value	–	21.3%

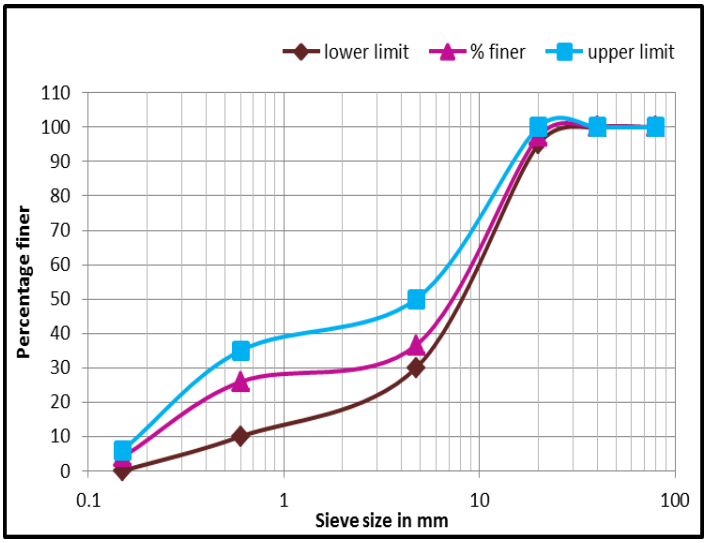

Chart -2: Gradation of coarse aggregate.

Super plasticizer - CONPLAST SP-430 of BASF chemicals is used in present study. It is a water retarder necessary for mixing of concrete of high strength. It provides improved workability and minimizes segregation.

Water- it is cleaned and free from any type of impurities with drinking quality standards. It is in permissible limits as per IS 456:2000.

3. Results and discussion

3.1 Chemical composition of Marble dust consist the major component of Calcium oxide (CaO). Chemical composition is shown in table-1

Table -4: Chemical composition of the marble dust

Chemical Compounds	Composition in %
Silica(SiO2)	22-29
Calcium Oxide(CaO)	31-57
Magnesia(Mg O)	1.5-2.2
Alumina (Al2O3)	5.2-8.8
Iron Oxide(Fe2O3)	1.2-3.2

Source: Internet

3.2 Concrete specimen

According to IS 10262 concrete of grade M-40 was designed and the adopted mix ratio is 1:2.3:3.02.

Concrete is manually mixed for calculated quantities of all materials, as per IS-516 specification cubes, cylinders and beams are casted and after 24 hours of setting time, specimens are placed in a clean water tank & allowed for curing up-to 7 days and 28days.

Specimens are removed from the tank after desired period of curing, they were left over for dry then allowed for testing - cubes for compression strength test and cylinders for split tensile test at CTM machine and beams for flexural strength test at UTM machine.

3.3 Tests on Fresh concrete

The main intensions of finding fresh concrete properties are to know the workability of the desired concrete. Since manual Mix is done for all the trials, the concrete has shown less workable with the increasing marble dust content. For M-40 grade concrete observed slump variation is true slump. By using marble dust will give lesser slump values - resulting concrete is less workable.

TABLE -5: Slump cone test results

Marble powder (%)	Slump value (mm)
0	15
5	14
10	12
15	11
20	10

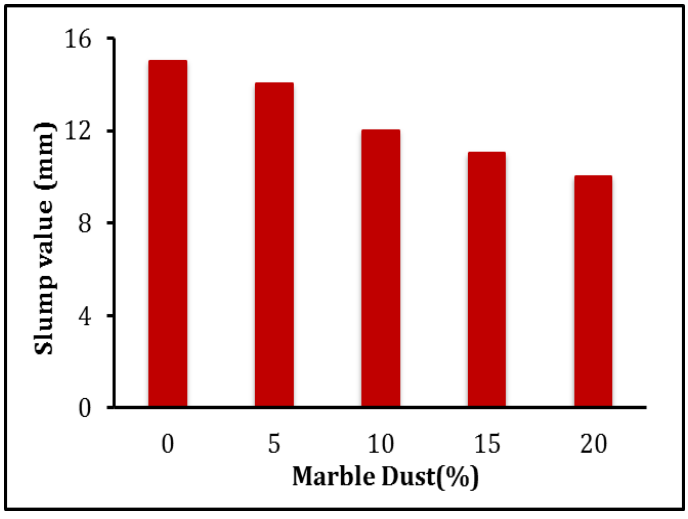

Chart -3: Slump cone test result

Fig-3: Testing of Slump using slump cone apparatus

3.4 Tests on Hard concrete

Tests on hard concrete are done to ensure the design strength and quality of the desired concrete. Here we conducted three destructive tests to know the compression, tension and flexural strength of the concrete.

Fig-2: Testing of cube specimen in CTM

Fig-3: Testing of beam specimen in UTM

Fig-4: Testing of cylindrical specimen in CTM

3.4.1 Compression strength

This test was conducted for the cubic specimen of size 150mm×150mm×150mm in compression testing machine. Result showed that maximum strength gained by concrete with 10% replacement of cement by marble dust.

TABLE - 6: Compression strength test results

Marble dust (%)	Compressive strength(N/mm2)	
	For 7days	For 28 days
0%	32.04	47.22
5%	33.59	49.25
10%	37.53	55.68
15%	34.92	52.03
20%	33.89	48.93

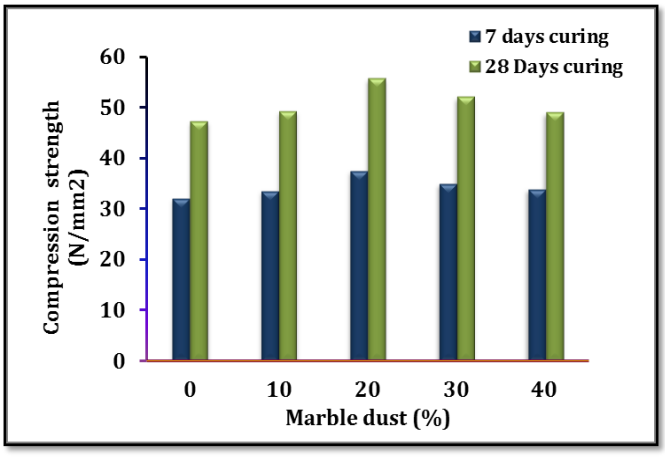

Chart -4: Compression strength test result

3.4.2 Split tensile strength

This test is for the cylindrical concrete specimen of size 150mm diameter and 300mm length in compression testing machine. Result showed that maximum strength gained by concrete with 10% replacement of cement by marble dust.

TABLE -7: Split tensile strength test results

Marble dust (%)	Split tensile strength (N/mm2)	
	For 7days	For 28 days
0%	1.97	2.93
5%	2.08	2.99
10%	2.23	3.35
15%	2.1	3.1
20%	1.99	2.98

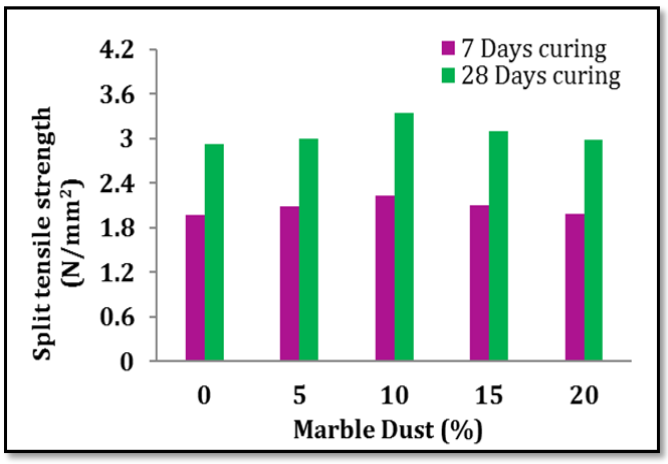

Chart -5: Split tensile strength test result

3.4.3 Flexural strength

This Test was done for the beam specimen of size 100mm×100mm×500mm in Universal testing machine. Results were showed that maximum strength gained by concrete with 10% replacement of cement by marble dust.

TABLE -8: Flexural strength test results

Marble Powder (%)	Flexural Strength (N/mm2)
0%	7.35
5%	7.45
10%	7.95
15%	7.7
20%	7.4

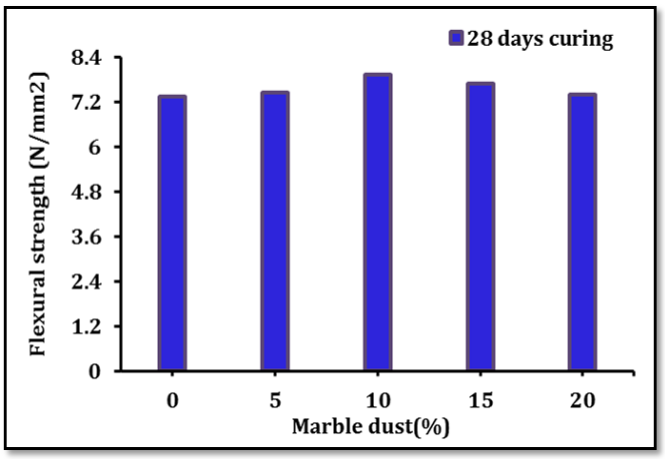

Chart -6: Flexural strength test result

4. CONCLUSIONS

An experimental work was devise to investigate the effect of substituent of cement with marble powder on different proportion of cement and concrete. An investigation of the results was carried out and the main observations from this study are expanding below:

- Procured materials Cement, M-sand, Marble dust, coarse aggregate, obeys the standard specifications as per respective IS codes.
- Mix design is considered for M-40 grade concrete and proportion was 387 kg/m^3 of cement, 844kg/m^3 of fine aggregate, 1107 kg/m^3 with 1**:** 2.3**:** 3.02 concrete mix ratio.
- Test results on fresh concrete properties slump cone test shows that workability decreases with increase in marble powder content in the range of 15-10mm.
- From compression strength test, Results for 28 days shows maximum compression at 10% replacement of cement with marble powder by 55.68N/mm^2 with nearly 18% more on compared to conventional concrete
- From split tensile strength test, Results for 28 days shows maximum compression at 10% replacement of cement with marble powder by 3.35N/mm^2 with nearly 14% more on compared to conventional concrete.
- From flexural strength test for 28 days it is observed that maximum strength of 7.95N/mm^2 is obtained at 10% replacement of cement by marble powder, which is nearly, 8% more on compared to conventional concrete.
- Results of tests on hardened concrete shows replacement of cement with marble dust of 10% (by weight of cement) gains maximum strength in all the three tests compression, tensile and Flexural strength on compared to normal conventional concrete. Hence replacement of cement by marble powder with 10% is the optimum replacement.
- If marble dust is used as replacement for cement makes concrete eco-friendly as well as low cost because Marble dust is a waste material and cost is much lesser than cement. It leads to greater reduction in construction cost of highway rigid pavement.

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