"EXPERIMENTAL STUDY ON PARTIAL REPLACEMENT OF CEMENT BY MARBLE DUST AND COMPLETE REPLACEMENT OF NATURAL SAND BY M- SAND"

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Abstract In the present experimental study natural sand is completely replaced by manufactured sand and cement is replaced by marble dust at (5%, 10%, 15%, 20%) varying percentages. Marble dust is the by-product and waste produced after cutting the stones in industries which is the sludge form. Marble dust has pozzolonic properties therefore it can be replaced to cement. Due to constant sand mining, there is a shortage of natural river sand and more mining can lead to several environmental problems and therefore, it is necessary to find alternative to the river sand. M-sand has been introduced as a replacement to the river sand, which is a controlled end product and free from organic matter. Test on fresh and hardened properties of concrete was conducted. Superplasticizer was added to have good workability. The concrete with 10% MD and 100% M sand gave maximum compressive, split tensile and flexural strength. In the durability test, it is observed that the rate of water absorption increases as the substitution percentage in concrete mixes increases.
The mix design was carried out for M40 grade concrete as per IS: 10262-2009.

Keywords— M-Sand, Marble dust, superplasticizer.

I. INTRODUCTION

1.1 GENERAL**:** The mixture when placed in form and allowed to cure harden into rock-like mass is known as concrete. Concrete is the mix of cement, fine aggregate, coarse aggregate and water used for all construction purposes. It meets the requirement of globalization in the construction industry. Concrete can be cast in any shape as required since it is plastic in a fresh state. The advancement of concrete technology can reduce the consumption of natural assets and energy sources and decreases the pollutants on the environment. Leaving the waste materials to nature specifically can bring about an ecological issue. Henceforth the reuse of waste material has been stressed.
1.2 MARBLE DUST**:** Amount of marble dust is generated in natural stone processing plants with an important impact on the environment and humans. Marble is a mineral which is exceedingly utilized as a part of the development business. Marble Dust is acquired from pounding the marble into powdered form.
The project describes the probability of using the marble sludge dust in concrete production as partial replacement of cement. Test results show that industrial waste has capable of improving the performance of hardened concrete up to 10%, enhancing fresh concrete behavior .
1.3 M –SAND: M Sand is the manufactured fine aggregate, the product created by crushing of rocks to the size's required using mechanical crushers. The usage of M Sand is increasing rapidly as there is depletion of natural sand. It is widely used in all major construction projects around the world as it is available comprehensively and cost of m sand is less compared to natural river sand. Gradation of M Sand is 4.75mm, 2.36mm, 1.18mm, 600 microns, 300micron, 150micron, pan.
1.4 SCOPE: In the production of cement lot of carbon dioxide is emitted into the atmosphere which is harmful to the environment and creates unhealthy conditions. Since marble dust is a waste produced from cutting rocks in industries, it is used as an alternative to cement replacing it partially. As the natural river sand is scarce and is very costly to obtain for use in construction activities, so M sand is used as an alternative to fine aggregate replacing it completely. M sand is more economic than river sand

II. LITERATURE REVIEW

There are many studies made on marble dust and M sand in concrete researchers. The waste material marble dust and M sand were used for analyzing the properties of concrete. The optimum replacement percentage of MD and M sand is found such that it should not affect concrete properties.[1] Prof.P.A.Shirule et al. (2012) Study was

conducted replacing cement by marble dust at 0%,5%,10%,15%,20%. Tests were conducted on the comp. and split tensile strength. It was found that at 10% replacement there was more comp. and split tensile strength. [2] Vijaya Kumar et al. (2016**)** Cement was partially replaced by MD at 0%, 5%, 10%, 15%, 20% and 25%. The comp. and split tensile strength at 10% replacement was more than normal concrete.[3] Gopi R et al. (2015): In this study, the test was carried out for partially replacement cement by marble dust to 0%, 5%, 10%, 15%, 20% and 25% for M30 grade concrete. compaction factor and strength increased up to 15% replacement of cement by marble dust and slump decreased as a percentage increased. Marble dust recognized as low costing material and keeps environment safe.[4] Mr. Ranjan Kumar et al. (2015) Up to 10% cement replaced with marble dust has given goodresults to comp. test and up to 15% replacement split tensile and flexural strength increased thereafter reduced . [5] Martins Pilegis et al. (2016**):** This study shows that m sand requires higher w/c ratio for workability equal to natural river sand because of angular particles in the manufactured sand are high. The lowest w/c ratio of 0.48 for natural sand yielded the highest 28 days compressive strength, water reducing admixture is used to compensate for M sand does which not contain clay particles. At w/c ratio rate off 0.55 M sand mix attains strength in between 53 to 60.5N/mm^2. The long-term effects of MB value and clays on strength were not investigated in this study [6]. Yajurved Reddy M et al. (2015**):** In this study m sand is replaced to natural sand in percentages 0%, 20%, 40%, 60%, 100% and is studied for M20 and M30 concrete grade. Results show that the decrease in workability of concrete as a proportion of m sand increases. M sand is the best alternative for river sand in achieving workability, comp. strength, and durability. Due to the angularity of particles in manufactured sand yields low workability and compensated by adding admixtures to mix. At 60% replacement of m sand shown good resistance to acid attack in comp. strength, tensile strength, flexural strength.[7] Anjali Rathore et al. (2018**) :** In this study, the workability of concrete is low because of the use of m sand due to the shape of particles as it is angular, and due to the rough texture which improves the internal friction. concrete with M sand Flexural strength is increased compared to strength of river sand. M sand is free from chemicals like sulphates and chlorides in which helps in improving the properties of concrete. Since m sand is manufactured in required size i,e, below 4.75 mm, hence no wastage found.[8] C Sudha et al. (2016**):** In this study, the M sand is placed by river sand at 0%, 25%, 50%, 75%, 100%. It shows a linear rise in compressive-strength by replacing river sand with m sand. Split tensile strength has been increased by 44.0%compared with river sand for 56days, by complete replacement of M sand. [9] Chandrahas Sahu and M.K.Gupta (2013):Sikament170 was used as SP. There was more workability observed. Concrete with SP shows more comp. strength than C.C. With less W/C there was the easy placing of concrete.[10].I B. Muhit (2013**):**From the results of the study, it is decided that by addition of superplasticizer the workability of concrete can be enhanced. By using the proper dosage of chemical admixture slump loss can be reduced to a great extent. In superplasticizer, the concrete effect is too high. Up to a specific limit (1.0%) with the increment of superplasticizer dosage, the compressive strength is improved and it is compared with a control specimen which fabricated without any SP. The effective range of dosage is 0.6-1.0%.

III. OBJECTIVES

The main objectives of the study are as follows

[1] Partial replacement of marble dust by cement and full replacement of M sand to river sand.
[2] To determine the properties and behavior of concrete using marble dust.
[3] To find the properties of concrete using M sand.
[4] To find the workability of the concrete for different percentage replacement of materials with the addition of superplasticizer
[5] To determine the mechanical properties of concrete for all replacement percentages and compare with conventional concrete

IV. EXPERIMENTAL INVESTIGATION

A. Cement

Cement used for the project is ultra-tech OPC 53 grade confirming to IS 12269-1987. Tests are conducted to find the properties of the cement. Following are the test results listed below in table

Table no. 1. Basic test on cement.

Characteristics	Results
Fineness	3.4%
Initial Setting time	70min
Soundness	1 mm
Final Setting time	270 min
Normal consistency (%)	32%
Specific gravity	3.09

B. Coarse Aggregates

In this project the aggregates used is 20 mm downsize and 10 mm downsize which is brought from Lahoti stone crushers, Kalaburgi. The gradation of aggregates was according to IS: 2386 (Part 3). Trials were conducted for fixing the proportion of 20 mm and 10 mm coarse aggregate fraction. The proportion of 50:50 and 60:40 of 20 mm and 10 mm fraction was not well graded. The proportion of 40:60 fraction was well graded, hence 40:60 proportion was obtained.

Table No. 2. Test Results of CA

Sl. No	Properties	Values
1.	The shape of the coarse aggregate	Angular
2.	Sp.gr	2.65
3.	F.M	7.01
4.	Bulk density a)Loose condition b)Compacted condition	 1.40g/cc 1.59g/cc
5.	Crushing test	17.40%
6.	Impact Value	16.10%
7.	Water absorption	1.10%

C. Marble Dust

The material used is from locally available granite and marble industry, Kalaburgi. The marble dust was sieved in 90-micron sieve before it was added to the mix.

Fig 2: Marble Dust

Table No.3. Chemical Composition of MD

Oxide compounds (mass %)	Marble Dust
SiO_2	28.25
Al_2O_3	0.52
Fe_2O_3	9.60
CaO	40.45
MgO	16.35
Density g/cm^3	2.80

D. M-Sand

M sand used for the project was brought from Lahoti crushers, Kalaburgi. The gradation was as per IS: 2386 (part-2). The M sand was in dry state and free from vegetation and dust before. Table 4 shows the test results of m sand.

Fig 3: M sand

Table No.4. Test results of M-sand Aggregate

Properties	**Results**
Sp.gr	2.82
F.M	3.73
Water absorption	3%
Bulk density a)Loose condition b)Compacted condition	(g/cc) 1.80 1.97
Moisture content	Nil

Table No. 5. shows the gradation of m sand

Sieve size	**Percentage of passing**	**Requirement Gr -I**
4.75mm	93.45	90-100%
2.36mm	61.65	60-95%
1.18mm	34.65	30-70%
600mic	19.85	15-34%
300mic	10.65	5-20%
150mic	6.45	0-10%

E. WATER

According to IS: 456-2000, potable water is used for the mixing of concrete.

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F. SUPERPLASTICIZER (CONPLAST SP430)

Superplasticizer used in the investigation is Fosroc Conplast SP430.The dosage of superplasticizer is fixed based on trials conducted using slump cone test. The SP430 was brought from Pallavi marketing, Kalaburgi

FiG 4: Conplast SP430 Superplasticizer

G. Mix Proportion of Design

Table No. 6. Mix proportion

Grade	Cement (kg/m^3)	M-sand (kg/m^3)	Coarse Aggregate (kg/m^3)	Water (lit./m^3)
M_{40}	350	776.785	1219.097	172.22
	1	2.218	3.483	0.492

Table No. 7. Type of Different Mix

Designation of concrete mix. Grade	M-sand (%)	PPF (%)	LMWSS (%)
Normal CC	0	0	0
FRCMS-I	50	1	0.5
FRCMS-II	50	1	1.0
FRCMS-III	50	1	1.5
FRCMS-IV	50	1	2.0

V. RESULTS

- Slump cone Tests
- Compaction factor Tests
- Compression Tests
- Split tensile Tests
- Flexural Tests
- Durability Tests

I. Slump and Compaction factor results

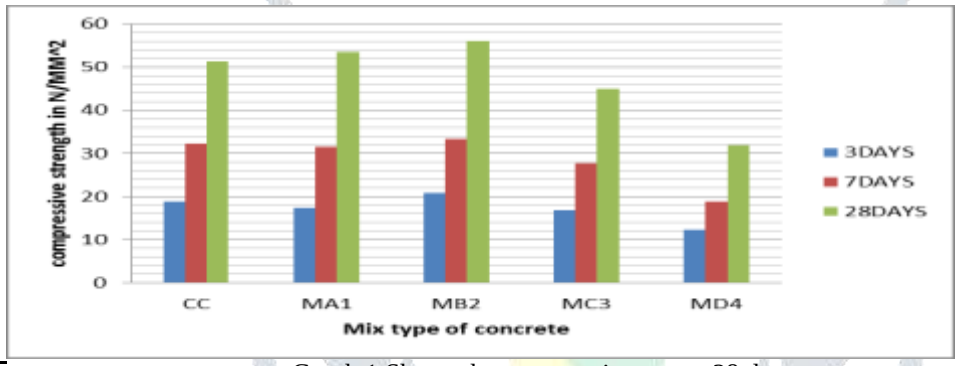
Table No.8. Shows the result of workability test.

Sl. No	Mix ID	Slump value in mm	Compaction Factor
1	Normal CC	105	0.95
2	MA1	103	0.92
3	MB2	95	0.90
4	MC3	76	0.86
5	MD4	70	0.82

II. Compressive strength

Table No.9. Compressive strength results at 3, 7 &28 days.

CURING PERIOD	Designation of CC mix. grade M40	AVG. COMPRESSIVE STRENGTH N/mm^2
3 days	NORMAL CC	18.81
	FRCMS-I	17.32
	FRCMS-II	20.86
	FRCMS-III	16.73
	FRCMS-IV	12.36
7 days	NORMAL CC	32.29
	FRCMS-I	31.55
	FRCMS-II	33.4
	FRCMS-III	27.70
	FRCMS-IV	18.88
28 days	NORMAL CC	51.40
	FRCMS-I	53.40
	FRCMS-II	55.99
	FRCMS-III	45.03
	FRCMS-IV	31.8

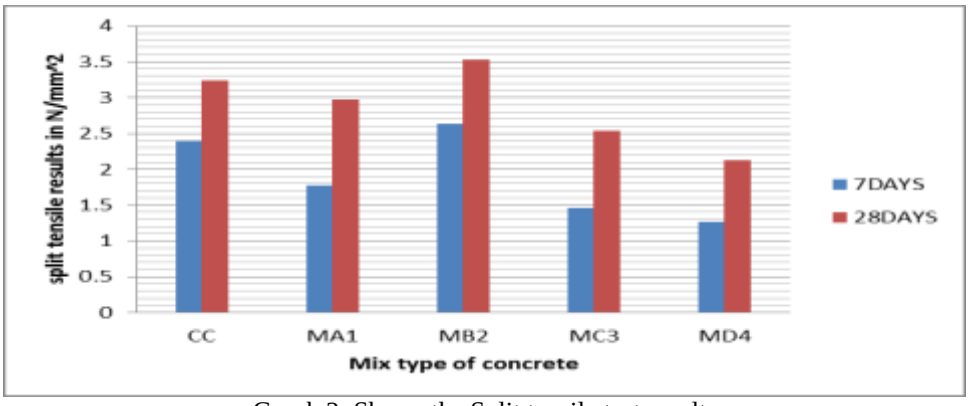


Graph 1 Shows the compression test at 28 days.

III. Split Tensile Strength

Table No. 10. Split Tensile strength results at 7&28 days.

Curing Period	Designation of CC mix. grade M40	Avg. Split Tensile Strength N/Mm^2
7 days	NORMAL CC	2.39
	FRCMS-I	1.78
	FRCMS-II	2.63
	FRCMS-III	1.46
	FRCMS-IV	1.27
28 days	NORMAL CC	3.24
	FRCMS-I	2.97
	FRCMS-II	3.53
	FRCMS-III	2.54
	FRCMS-IV	2.12

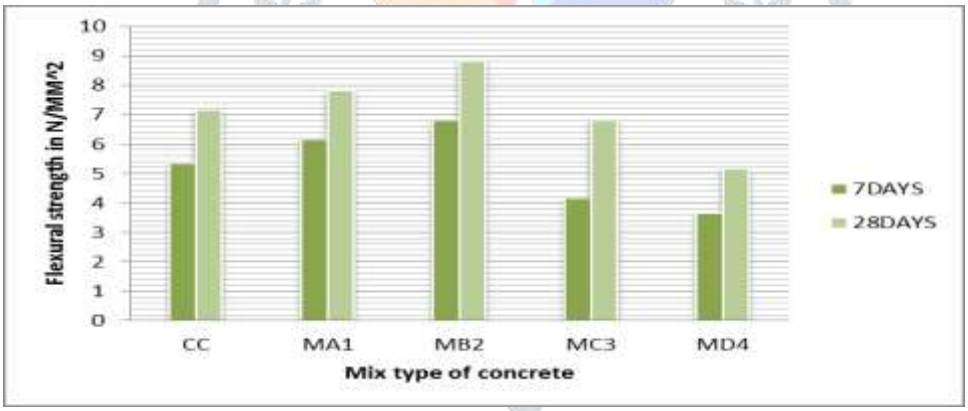


Graph 2: Shows the Split tensile test results

IV. Flexural Strength

Table No. 11. Flexural Strength results at 7&28 days.

Curing Period	Designation of CC mix. grade M40	Avg.Flexural Strength N/Mm^2
7 days	NORMAL CC	5.33
	FRCMS-I	6.16
	FRCMS-II	6.83
	FRCMS-III	4.16
	FRCMS-IV	3.66
28 days	NORMAL CC	7.16
	FRCMS-I	7.83
	FRCMS-II	8.83
	FRCMS-III	6.83
	FRCMS-IV	5.16



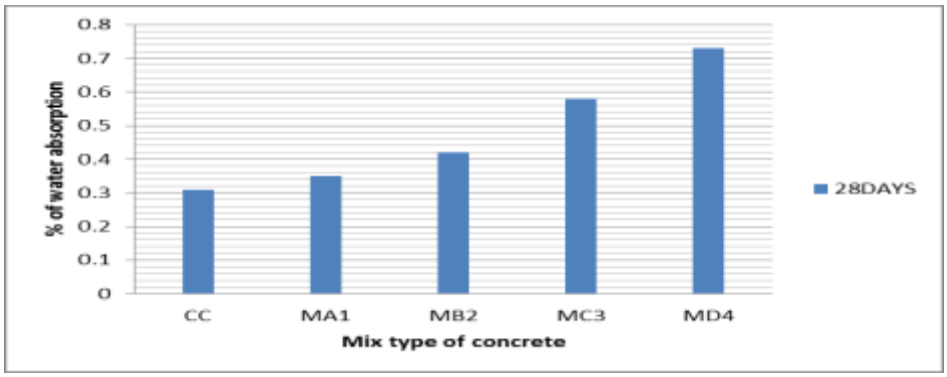
Graph 3: Shows the flexural strength results

V.Durability test

Table No.12. Water absorption results

Mix type	Dry weight in grams (W1)	Wet weight in grams (W2)	% of water absorption
C.C	8439.84	8466	0.31
MA1	8860.5	8891.5	0.35
MB2	8857	8894.19	0.42
MC3	8780	8830.92	0.58

MD4	8597	8659.75	0.73



Graph 4: Water absorption values

VI. CONCLUSION

1. Due to irregular texture and angular in size of M sand the workability decreases as compare to the river sand. As thereplacement percentage increases, workability reduces, therefore supersticizers has to be added to this mix concrete to achieve workability.

2. The optimum strength from all the mixes shows MB2 mix gives higher strength. It can be that more than 10% addition, the results indicate reduction in strength.

3. The compressive strength increased by 9.1% compared to normal concrete which indicates marble dust can be used as an alternative cementitious material.

4. The mix MB2 showed overall high performance with respect to compression, tensile and flexural tests when compared to other mix proportions

5. In the durability test the rate of water absorption increased as the MD mix proportion increased. It indicates that due to higher water absorption when compared to conventional concrete, this particular concrete mix cannot be used in marine areas or high moisture content areas unless water proofing mechanisms are used.

6. As the marble dust is incorporated in this experimental work, the problem associated with the marble industry for waste disposal can be solved and also can solution to environmental problem.

VIII. REFERENCES

[1]. “Properties of concrete” by A.M. Naville

[2]Prof. P.A. Shirulea, Ataur Rahman, Rakesh D. Gupta, “PARTIAL REPLACEMENT OF CEMENT WITH MARBLE DUST POWDER”MIJARES/Vol. I/ Issue III/April-June, 2012/175-177.

[3]Vijaya Kumar, Shruti D, Tharan SN, Sanjay SR, Sricharan PM, “Partial Replacement of Cement to Concrete by Marble Dust Powder” Volume: 2 / Issue: 05 / May 2016 / ISSN: 2455-3778 IJMTST

[4] Gopi R, Mrs. Kaleeswari. G, Dr. Dhanalakshmi. G, “Study on Marble Powder as Partial Replacement of Cement in Concrete” Volume 2 / Issue 7 / June 2017

[5]Mr. Ranjan Kumar, Shyam Kishor Kumar, “Partial Replacement of Cement with Marble Dust Powder” Volume 5/ Issue 8/ August 2015/ISSN: 2248-9622

[6] Martins Pilegis, Diane Gardner and Robert Lark, “An Investigation into the Use of Manufactured Sand asa100%ReplacementforFineAggregateinConcrete".

[7] Yajurved Reddy M, D.V. Swetha, S. K. Dhani, “ Study on Properties of concrete with Manufactured sand as Replacement to Natural sand ” Volume 6/ Issue 8/ Aug 2015/ pp. 29-42/ Article ID: IJCIET_06_08_004

[8]Anjali Rathore, Pushpendra Kumar Kushwaha, Dr. Mohit Gangwar, A review on the use of Manufactured sand in Concrete production" Volume 3/ Issue 1/ January 2018/ ISSN: 2455-4030

[9]C. Sudha, P. T. Ravichandran, K. Divya Krishnan, P. R. Kannan Rajkumar and A. Anand, "Study on Mechanical Properties of High-Performance Concrete using M-Sand " Volume 9/ DOI: 10.17485/ ijst/ 2016/ v9i5/87262/ February 2016

[10]I. B. Muhit, "Dosage Limit Determination of Superplasticizing Admixture and Effect Evaluation on Properties of Concrete" Volume 4/ Issue3/ March-2013/ ISSN 2229-5518

[11] Javed Ahmed Naqash, "Effect of different superplasticizers on properties of concrete".

[12] IS-12269:1987 codebook to conforming 53-grade cement.

[13] IS 2386 (part-2) codebook for tests on fine aggregate.

[14] IS 2386 (part-3) codebook for tests on coarse aggregate.

[15] IS-456: 2000 codebook for the reference of mix design.

[16] IS 10262 codebook for concrete mix design.

[17] IS 516-1959, Indian standard code of practice methods of test for strength of concrete.

[18] IS 5816-1999, Indian standard code for splitting tensile strength of concrete.

[19] Sagura, Jagadeesan " Experimental Study on Mechanical Properties of M-Sand Concrete by Different Curing Methods " ISSN: 2278-1684

[20] M.Adams Joe, A.Maria Rajesh, P.Brightson, M.Prem Anand, "Experimental Investigation on The Effect Of M-Sand In High Performance Concrete" e-ISSN: 2320-0847 / p-ISSN : 2320-0936 / Volume-02/2013

[21] U.Sridhar, B.Karthick, "Investigations On Recycled Concrete Aggregate And Msand As Aggregate Replacement In Concrete" ISSN: 2277-9655, 2015.

[22] Mani kandhan.K.U, Sathya kumar.N, Sakthivel.R, "Effect of replacement of River sand by M-sand in high strength concrete " Volume 02, Issue 02, [February - 2015]

[23] Chandrahas sahu and Dr. M.K.Gupta, "An experimental study of effects of superplasticizer on fresh and hardened properties of concrete.

[24] Jashandeep singh, Er. R S Bansal, "Partial Replacement of Cement with waste marble powder with 25 grade " Volume 3/ ISSN: 2320-8163/ April 2015.

[25] Raghvendra, M.K. Trivedi, " Partial Replacement Of Cement With Marble Dust Powder In Cement Concrete" Volume 5/ ISSN 2321-9653/ May 2017.