International Journal of Engineering Sciences & Research Technology

(A Peer Reviewed Online Journal)
Impact Factor: 5.164

IJESRT

RESEARCHERID
THOMSON REUTERS

[Purohit * *et al.*, 8(1): January, 2019]
IC™ Value: 3.00

ISSN: 2277-9655
Impact Factor: 5.164
CODEN: IJESS7

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INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH TECHNOLOGY

ANALYTICAL STUDY FOR DIFFERENT GRADES OF CONCRETE ON PARTIAL REPLACEMENT OF CEMENT BY MDP

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DOI: 10.5281/zenodo.2532196

ABSTRACT

Concrete is the most widely used construction product because of its high structural strength and stability. Its main constituents are cement, sand, aggregates and water. Nowadays it has been comes in miscellaneous researches that to bypass these conventional ingredients in the evolution of sustainable development. These dissertation work covers the experimental study to observe the behaviour of marble dust powder on replacement with cement for M25, M40 & M50 grade concrete, in this process we replace cement with marble dust powder at 0% to 15% with a constant interval of 2.50%, we made 7 batches including the batch of conventional mix also, the concrete was design mix for M40 & M50 grade, while M25 grade concrete was nominally mix, further we compare the properties of fresh concrete such as workability etc. observations were made that initial setting time and workability both increases for fresh concrete for all mixes, on the other hand when Physical properties of concrete were tested & compressive, flexural and split tensile strength achieved at 10% replacement of cement for M25 & M40 concrete, while this replacement limited up to 5% for M50 grade concrete, with this results we could say that this replacement is limited up to a small extent for high performance concrete. All specimens were tested at 7, 14 & 28 days curing age. It can be conclude that we can limit the use of cement content up to a certain extent to save both environment and economy, the later is very vital for any developing country.

KEYWORDS: Concrete, Cement, Marble Dust Powder, Compressive Strength, Flexural Strength, Split Tensile Strength.

1. INTRODUCTION

Concrete is widely used manufacturing material which is a composed of cement, sand, jelly & water. Nowadays we can see the continuous development at everywhere at each corner of world for civilization. The endless growth of population is not a mainline problem; issue arises when it seems the necessity of shelter for public and connectivity between them for in phase of urbanization. The daily operation of such material rising huge issue among intellectuals, to resolve this something innovative thing are required, to bypass the conventional additive of this item we opted for some newly introduced particulars which are appropriate fit the processing criteria of concrete, few different kind objects are silica fume, fly ash micro silica etc. in this context here marble dust powder being experimented and further observation arises. It's obtained primarily as a waste substantial material and the proper disposal is dilemma so we can handle it in the creation of concrete. Scrutinize and approach to a decision that this has to be use replacement to cement at some extent.

2. LITERATURE REVIEW

Jashandeep Singh[1], Er. R S Bansal[2] (2015) - The study the behavior of concrete, having partial replacement of cement with waste marble powder M25 grade for which the marble powder is replaced by an experimental study was carried out and the effect on compressive strength and split tensile strength characteristics (0%, 4%, 8%, 12%, 16%, 20%)was studied. The result of this present investigation indicates that the replacement of 12% of cement with waste marble powder attains maximum compressive and tensile strength. The optimum

ISSN: 2277-9655
Impact Factor: 5.164
CODEN: IJESS7

percentage for replacement of marble powder with cement and it is almost 12%cement for both cubes and cylinders and it also minimize the costs for construction with usage of marble powder which is freely or cheaply available more importantly.

Mr.Ranjan Kumar[1], ShyamKishor Kumar[2] (2015) - The waste generated from the industries cause environmental problems. Hence the reuse of this waste material can be emphasized. Marble Dust Powder (MDP) is a developing composite material that will allow the concrete industry to optimise materiel use, generate economic benefits and build structures that will strong, durable and sensitive to environment. MDP is by-product obtained during the quarrying process from the parent marble rock; which contains high calcium oxide content of more than 50%. The potential use of MDP can be an ideal choice for substituting in a cement binder as the reactivity efficiency increases due to the presence of lime. In this research work, the waste MDP passing through 90 microns, has used for investigating of hardened concrete properties. Furthermore, the effect of different percentage replacement of MDP on the compressive strength, splitting tensile strength (Indirect tensile strength) & flexural strength has been observed. In this experimental study, the effect of MDP in concrete on strength is presented. Five concrete mixtures containing 0%, 5%, 10%, and 20% MDP as cement replacement by weight basis has been prepared. Water/cement ratio (0.43) was kept constant, in all the concrete mixes. Compressive strength, split tensile strength & flexural strength of the concrete mixtures has been obtained at 7 and 28 days. The results of the laboratory work showed that replacement of cement with MDP increase, up to 10% for compressive strength, & up to 15% for split tensile strength & flexural strength of concrete.

MdMahboob Ali[1], Prof. S.M.Hashmi[2] - The present work is directed towards developing a better understanding on strengths characteristics of concrete using marble dust powder as a partial replacement of cement. The Dissertation work is carried out with M30 grade concrete for which the marble powder is replaced by 0%, 5%, 10%, 15%, 20% by weight of cement. For all the mixes compressive, flexural and split tensile strengths are determined at different days of curing. In addition to this, sand is replaced with stone dust (SD) by 10%, 20% and 30% along with cement is replaced with MP by 0%, 10% and 20% by weight for M30 grades of concrete. Only 3 cubes were casted for various percentage replacements of sand with SD and cement with MP for 7days and 28 days. The results of the present investigation indicate that marble dusts incorporation results insignificant improvements in the compressive, flexural and split tensile strengths of concrete upto 10% of replacement and also the results of the present investigation indicate that stone dusts and marble dust incorporation results insignificant improvements in the compressive strengths of concrete upto 20% of SD and 10% of MP of replacement.

Shilpa Jain[1], Prof. Anubhav Rai[2], Prof. Yogesh Bajpai[3] - This following work is to Design M40 concrete with marble dust and clay as a partial replacement of cement by 5%, 10%, 15%,and 20%. The compressive strength test after 7 days and 28 days have also been performed. The result on the basis of compressive strength of the 150mm standard cube has been shown by the graph between varying percentage of marble dust and clay and compressive strength. The idea is to achieve higher strength concrete in economical manner by finding the substitute of cement to some extent.

Sona K Raju[1], Basil Johny[2]-Concrete is the most widely used construction material because of its high structural strength and stability. Its main constituents are cement, sand, fine, coarse aggregates, and water. Most of the aggregates and raw materials for cement used in the manufacture of concrete come from quarries oralluvial rivers. Production of cement also involves large amount of carbon dioxide gas into the atmosphere, a major contributor for greenhouse effect and the global warming. It is important to optimize the consumption of aggregates and also enhance their replacement by other alternative sources. The Marble industry has major environmental problems due to waste generation at different stages of mining and processing operation. It can be can be use as admixtures or used instead of cement so that resources are used more efficiently and the environment is protected from waste deposits. Dredged sandwhich is obtained from the removal of sediments and debrisfrom the bottom of lakes, rivers, harbors, and other water bodies is used as a partial replacement for fine aggregate. The Dissertation work is carried out with M40 grade concrete for which the marble powder is replaced by 5%, 10%, 15%, by weight of cement and dredged sand replaced by10%,15%,20%,25% by weight of

ISSN: 2277-9655
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CODEN: IJESS7

fine aggregate The fresh properties and mechanical properties for all the mixes were studied. The aim of this work is to study the possible use of Marble powder and dredged sand in concrete production, which would reduce both the environmental impact and the production cost.

3. METHODOLOGY

Methodology involves the formulation of experimental work, and this section include the adoption of appropriate amount of quantity of different ingredients, which will be further consume in making concrete of different grades and for subsequent testing approaches.

Project Objective

In the present Experimental Investigation the following objectives are aimed.

- Analysis for strength of concrete by using MDP.
- Evaluate compressive strength, flexural strength and split tensile strength of the Concrete made by using MDP as a part replacement of cement.
- To study the properties of fresh concrete using marble dust powder, and its effect on strength characteristics of concrete.
- To find the optimum percentage of marble dust powder for obtaining the maximum strength of concrete.

Research Formulation

In this stage of work cement is partially replaced by Marble powder in different percentages, 7 batches were prepared in different proportions including conventional concrete mix (Cement as binder, Sand as fine aggregates & Coarse Aggregates). Cubes and beams are casted for determining compressive and flexural strengths and Cylinder was casted to find split tensile strength respectively at 7, 14 and 28 days.

4. EXPERIMENTAL WORK

General

This research work is carried out in single stage, in which I had partially replaced cement by Marble powder varying from 0-15% in different proportions.9 cubes, 6 cylinder and 6 beams with conventional concrete i.e. concrete having Cement (C), Sand (S) and Aggregate have been casted and then % of cement is reduce up to 85% and remaining 15% binder (Cement) is replaced by different amount of Marble powder.

Testing of materials

- **Cement**
  - ✓ Fineness
  - ✓ Consistency test
  - ✓ Initial and Final setting time test

Table No. 1 Fineness of cement

Sample No.	Wt. of material passing	Wt. of material retained	% of retained
1	98	2	2
2	98.5	1.5	1.5
3	92.4	7.6	7.6

Result: - Fineness of cement was found to be 3.7

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Table No. 2 Consistency Test of Cement

S. No.	Wt. of Cement (gm)	Qty. of Water added (gm)	Penetration (mm) from bottom	% of Water
1	400	120	16	30%
2	400	140	10	35%
3	400	152	6	38%

Result: - Consistency of cement was found to be 38%**.**

Table No. 3 Initial and Final setting time Test of Cement

S. No.	Setting Time (minutes)		Depth of penetration (mm)
	Initial	Final	
1	32 minutes	591 minutes	5 mm

Result:-1. The initial setting time of the cement sample is found to be 32 minutes.
2. The final setting time of the cement sample is found to be 591 minutes.

- **Sand**
- ✓ Gradation

Table No. 4 Particle size distribution (gradation) observations

S. No.	IS Sieve	% Passing	Limits
1	10 mm	100	**100**
2	4.75 mm	92.43	**90-100**
3	2.36 mm	78.32	**75-100**
4	1.18 mm	62.87	**55-90**
5	600 µ	38.15	**35-59**
6	300 µ	16.74	**8-30**
7	150 µ	1.35	**0-10**
	Pan		

- **Aggregate**
- ✓ Particle Size Distribution
- ✓ Aggregate Impact Value

Table No. 5 Gradation of aggregate (maximum particle size 40 mm)

S. No.	Sieves Nos.	% Passing	Limits
1	80 mm	100	**100**
2	40 mm	98.45	**95-100**
3	20 mm	46.82	**30-70**
4	10 mm	11.27	**10-35**
5	4.75 mm	0	**0-5**
	Pan		

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Table No. 6 Gradation of aggregate (maximum particle size 20 mm)

S. No.	Sieves Nos.	% Passing	Limits
1	40 mm	100	**100**
2	20 mm	95.63	**95-100**
3	10 mm	28.72	**25-55**
4	4.75 mm	2.31	**0-10**
	Pan		

Table No. 7 Gradation of aggregate (maximum particle size 12.5 mm)

S. No.	Sieves Nos.	% Passing	Limits
1	20 mm	100	**100**
2	12.5 mm	98.73	**90-100**
3	10 mm	52.28	**40-95**
4	4.75 mm	0.68	**0-10**
	Pan		

Table No. 8 Aggregate Impact Value results

S. No.	Quantity of aggregate of 10 mm - 12.5 mm size, (in gms.)	Quantity of sample passing 2.36 mm IS sieve, (in gms.)	Percentage passing
1	350	48	13.71
2	360	55	15.28
3	380	68	17.89
4	350	45	12.86
5	370	62	16.76
Results: -		**Avg. Value of AIV**	**15.30**

- **Marble Dust Powder**
- ✓ **Grading**

Table No. 9 Grading/Fineness test for Marble Dust Powder

S. No.	IS Sieve	Wt. of Passing	Wt. of Retained	% Passing	Cumulative Retained
1	1.18 mm	400	0	100	0
2	600 µ	398	2	99.50	2
3	425 µ	384	14	96	16

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4	300 µ	368	16	92	32
5	150 µ	272	96	68	128
6	**90 µ**	**192**	**80**	**48**	**208**
7	75 µ	16	176	4	384
	Pan				

- **Concrete**

✓ **Compressive Strength Test**

According to IS: 516-1959, test specimen for determining compressive strength of concrete of cubical shape should be 15 cm*15cm*15cm. If maximum size of aggregate is not more than 2 cm then a cubical shape of 10cm*10cm*10cm may be used as an alternative, In this research work I have used a cubical shaped specimen

of size 15cm*15cm*15cm. During casting of cubes, mixing of materials and proportioning is done as per IS: 516-1959 as specified in clause in 2. Page no 4, mix proportion of 1:1:2 of binder, fine aggregate and coarse aggregate respectively is adopted for this work.

Figure No. 1 Compressive Strength Test

Figure No. 2:- Flexural Strength Test

✓ **Flexural Strength Test**

As we talk about casting of beams for determining Flexural strength of beams, according to IS: 516-1959, standard size of test specimen should be 15cm*15cm*70cm. If maximum size of aggregate does not exceed 19 mm, a beam of size 10cm*10cm*50cm may be used, In this research work I have used a beam of size 10cm*10cm*50cm for preparing specimen. Same mix proportion is adopted for beam casting as adopted in casting in cubes, fine aggregates and coarse aggregates respectively.

✓ **Split Tensile Test**

As we talk about casting of cylinders for determining split tensile strength of concrete, according to IS 5816 - 1970, standard size of test specimen should be 15cm diameter and 30cm height. The splitting tensile strength is calculated using the formula, Tsp = 2P/ pi DL, Where P = Applied load, D = Diameter of the sample and L = length of the specimen.

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Figure No. 3:- Split Tensile Strength Test of Concrete Cylinder

Table No. 10 Test results for M-25 grade concrete compressive strength

COMBINATION	Avg. Compressive Strength for 7 days in (N/mm^2)	Avg. Compressive strength for 14 days in (N/mm^2)	Avg. Compressive strength for 28 days in (N/mm^2)
A125	18.61	22.61	26.43
B125	18.28	21.24	25.93
C125	19.02	20.95	25.84
D125	19.56	21.45	26.22
E125	**19.88**	**22.73**	**27.02**
F125	18.34	21.24	26.81
G125	18.10	21.01	25.54

Table No. 11 Test results for M-25 grade concrete flexural strength

COMBINATION	Avg. Flexural Strength for 7 days in (N/mm^2)	Avg. Flexural Strength for 14 days in (N/mm^2)	Avg. Flexural Strength for 28 days in (N/mm^2)
A225	2.60	3.30	3.70
B225	2.40	3.20	3.50
C225	2.20	3.00	3.40
D225	2.50	3.30	3.60
E225	**2.80**	**3.60**	**3.90**
F225	2.60	3.40	3.70
G225	2.30	3.10	3.30

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Table No. 12 Test results for M-25 grade concrete Split tensile strength

COMBINATION	Avg. Split Tensile Strength for 7 days in (N/mm^2)	Avg. Split Tensile Strength for 14 days in (N/mm^2)	Avg. Split Tensile Strength for 28 days in (N/mm^2)
A325	1.68	2.32	2.62
B325	1.57	2.26	2.48
C325	1.53	2.21	2.42
D325	1.60	2.24	2.53
E325	**1.78**	**2.41**	**2.75**
F325	1.64	2.24	2.48
G325	1.57	2.11	2.34

Table No. 13 Test results for M-40 grade concrete compressive strength

COMBINATION	Average Compressive Strength for 7 days	Average Compressive strength for 14 days	Average Compressive strength for 28 days
A140	32.62	38.25	40.64
B140	28.49	36.50	38.46
C140	24.44	35.30	37.38
D140	25.72	34.87	38.68
E140	**29.42**	**37.02**	**40.22**
F140	26.87	34.56	37.23
G140	26.44	33.38	36.56

Achieved compressive strength from mix 90% OPC + 10% MP is **19.88, 22.73 & 27.02**N/mm^2, flexural strength from mix 90% OPC + 10% MP is **2.80, 3.60 & 3.90**N/mm^2, & split tensile strength from mix 90% OPC + 10% MP is **1.78, 2.41 & 2.75**N/mm^2 in 7, 14 and 28 respectively curing days for M-25 grade concrete.

Table No. 14 Test results for M-40 grade concrete flexural strength

COMBINATION	Average Flexural Strength for 7 days	Average Flexural Strength for 14 days	Average Flexural Strength for 28 days
A240	3.20	4.30	4.70
B240	3.00	4.20	4.50
C240	2.90	4.10	4.20
D240	3.10	4.20	4.40
E240	**3.40**	**4.50**	**4.80**
F240	3.10	4.30	4.50
G240	2.80	4.10	4.30

Achieved compressive strength from mix 90% OPC + 10% MP is **29.42, 37.02 & 40.22** N/mm^2, flexural strength from mix 90% OPC + 10% MP is **3.40, 4.50 & 4.80**N/mm^2 & split tensile strength from mix 90% OPC + 10% MP is **2.38, 3.03 & 3.40**N/mm^2 in 7, 14 and 28 respectively curing days.

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Table No. 15 Test results for M-40 grade concrete Split tensile strength

COMBINATION	Average Split Tensile Strength for 7 days	Average Split Tensile Strength for 14 days	Average Split Tensile Strength for 28 days
A340	2.26	2.87	3.26
B340	2.18	2.82	3.06
C340	2.11	2.76	2.97
D340	2.15	2.80	3.10
E340	**2.38**	**3.03**	**3.40**
F340	2.24	2.82	3.11
G340	2.14	2.75	3.01

Table No. 16 Test results for M-50 grade concrete compressive strength

COMBINATION	Average Compressive Strength for 7 days	Average Compressive strength for 14 days	Average Compressive strength for 28 days
A150	36.04	45.78	51.67
B150	34.73	44.58	50.62
C150	**31.78**	**45.57**	**51.35**
D150	31.21	39.10	48.25
E150	28.62	37.47	47.96
F150	28.44	35.20	45.08
G150	28.01	34.58	43.60

Table No. 17 Test results for M-50 grade concrete flexural strength

COMBINATION	Average Flexural Strength for 7 days	Average Flexural Strength for 14 days	Average Flexural Strength for 28 days
A250	3.80	4.70	5.20
B250	3.50	4.60	5.10
C250	3.20	4.40	4.70
D250	3.60	4.70	5.00
E250	**4.10**	**4.80**	**5.30**
F250	3.90	4.50	4.90
G250	3.40	4.30	4.60

Table No. 18 Test results for M-50 grade concrete Split tensile strength

COMBINATION	Average Split Tensile Strength for 7 days	Average Split Tensile Strength for 14 days	Average Split Tensile Strength for 28 days
A350	2.65	3.43	3.71
B350	2.60	3.35	3.58
C350	2.52	3.21	3.50
D350	2.62	3.38	3.57
E350	**2.72**	**3.52**	**3.81**

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F350	2.66	3.40	3.48
G350	2.55	3.30	3.28

Achieved compressive strength from mix 95% OPC + 5% MP is **31.78, 45.57 & 51.35**N/mm^2, The maximum Flexural strength from mix 90% OPC + 10% MP is **4.10, 4.80 & 5.30**N/mm^2 & split tensile strength from mix 90% OPC + 10% MP is **2.72, 3.52 & 3.81**N/mm^2 in 7, 14 and 28 respectively curing days.

5. CONCLUSION

- Maximum compressive strength was observed when cement replaced by Marble powder at 10% for M25 & M40 grade and at 5% for M50 grade.
- Maximum flexural strength was observed when cement replaced by Marble powder at 10% for M25, M40 &M50 grade.
- Maximum split tensile strength was observed when cement replaced by Marble powder at 10% for M25, M40 &M50 grade.

  Replacement of cement for high performance concrete is limited, because binding of marble powder particle with other constituents of concrete arises predominantly and this resists the concrete to attain a homogeneous mass.

6. FUTURE SCOPE

From this research, there are few recommendations to develop, to extend and to explore the usage of Marble powder in concrete:

i. Analyze the effect of partial replacement of fine aggregate with MDP for M40 & above concrete grades.
ii. Replacement of cement with MDP in different water cements ratio & influence of admixtures on same for high performance concrete.
iii. Further strength optimization for accurate amount of part replacement.
iv. Partially replace cement with MDP have particle size 90 microns or less.
v. Replace the other ingredients of concrete in combination with MDP with other waste products for high performance concrete.

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