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Compressive Strength Characteristic of Concrete Incorporating Marble Powder and Stone Dust as Partial Replacement of Cement and Natural Sand

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Abstract: The current work is carried out to compare the Compressive strength characteristic of conventional concrete with the concrete replaced with marble powder as partial replacement of cement and natural sand by stone dust. The work is carried out with M_{20} and M_{30} grade concrete with w/c ratio of 0.55 and 0.45 respectively as a control specimen and the cement is replaced by marble powder in the range of 0%, 10% and 20% by weight of cement and natural sand is replaced by stone dust in the range of 10%, 20% and 30% by weight. For all the mixes compressive strength is determined at 28 days of curing. The result of present investigation indicate that the incorporation of marble powder and stone dust as a partial replacement of cement and natural sand respectively showed significant improvements in the compressive strength of concrete for 10% replacement of marble powder and 20% replacement of stone dust.

Key Words: Marble Powder (MP), Stone Dust (SD), compressive strength, W/C Ratio, Concrete.

1. INTRODUCTION

Waste marble powder is generated as a by-product during cutting of marble. The waste is approximately in the range of 20% of the total marble handled. The amount of waste marble powder generated at the site every year is in the range of 250-400 tones. The marble cutting plants are dumping the powder in any nearby pit or vacant spaces, near their unit. This leads to serious environmental and dust pollution and occupation of vast area of land also leading to contamination of the underground water reserves. Leaving the waste materials to the environment directly can cause environmental problems. 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.

The global consumption of natural sand is very high, due to the extensive use of concrete. In general, the demand of natural sand is quite high in developing countries to satisfy the rapid infrastructural growth, in this situation developing country like India facing shortage in good quality natural sand. Particularly in India, natural sand deposits are being depleted and causing serious threat to environment as well as the society. Increasing extraction of natural sand from river beds causing many problems, loosing water retaining sand strata, deepening of the river courses and causing bank slides, loss of vegetation on the bank of rivers, exposing the intake well of water supply schemes, disturbs the aquatic life as well as affecting agriculture due to lowering the underground water table etc are few examples.

By using marble powder partially in place of cement and stone dust in place of sand we can achieve the economy because of low cost of these materials as compared to cement and sand. By using these materials we can reduce the demand for cement and sand we can also reduce the wastage of marble powder and stone dust, saving in abundant open space for storage or dumping.

2. MATERIALS

2.1 Cement

Ordinary Portland cement confirming to IS 12269-1987 was used. Ultratech cement 53 grade procured from single source, properties of which are tested in the laboratory are shown in Table 1.

Table 1: Physical properties of cement

Sl. No.	Properties	Cement
1	Specific gravity	3.1
2	Fineness	2%
3	Normal consistency	34%
4	Initial setting time	40minutes
5	Final setting time	2hours 45minutes

2.2. Fine aggregate (F.A)

Good quality zone-II fine aggregate were used, the various test results for fine aggregate are as shown in Table 2 and the sieve analysis results are shown in the Table 3.

Table 2: Physical properties of fine aggregate

Sl. No	Properties	Fine aggregate
1.	Specific gravity	2.61
2.	Bulk density	1704.6 Kg/m^3

Table 3: Sieve analysis results of sand and stone dust

Sieve size	Cumulative % finer for sand	Cumulative % finer for stone dust
4.75mm	99.20	99.60
2.36mm	91.80	75.50
1.18mm	76.80	60.44
600µ	35.30	48.39
300µ	8.30	29.32
150µ	2.40	4.42

As per IS 383-1970 the aggregate shall consist of naturally occurring (crushed or uncrushed) stones, gravel and sand or combination thereof. They shall be hard, strong, dense, clear, free from adherent coating and free from injurious amounts of disintegrated pieces, alkali ,vegetable matter and other deleterious substances as a possible flaky and elongated piece should be avoided.

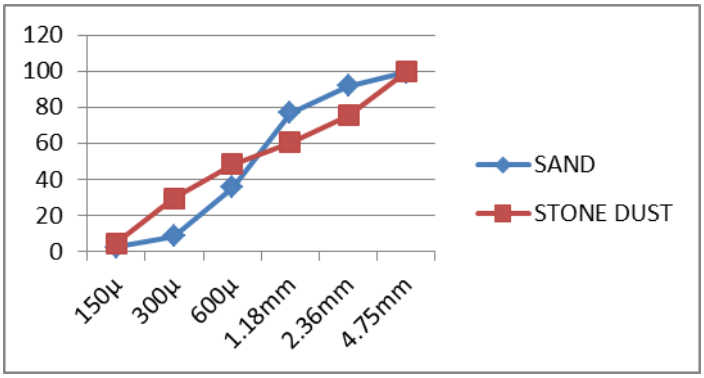

Fig 1: sieve analysis result of sand and stone dust

2.3. Basalt aggregate

In the present investigation basalt aggregate of sizes 20mm and 10mm available from local crusher were used. Different tests such as specific gravity, bulk density etc were carried out in laboratory for both the basalt coarse aggregate. The physical properties are shown in Table 4 and the sieve analysis results are shown in Table 5.

Table 4: Physical properties of coarse aggregate

Sl. No	Properties	Basalt aggregate
1.	Shape of coarse aggregate	Angular
2.	Specific Gravity	2.80
3.	Free surface moisture	Nil
4.	Bulk density(20mm)	1433.45 Kg/m^3
5.	Bulk density(10mm)	1335.6 Kg/m^3

Table 5: Sieve analysis results of basalt aggregate

Sieve sizes	Cumulative % passing finer for basalt aggregate
40mm	100
20mm	82.50
12.5mm	21.80
10mm	7.25
4.75mm	3.1

2.4 Marble powder

The marble powder required was brought from the local stone polishing unit, in this experimental study marble powder passing IS 90 micron sieve is used and having specific gravity 2.91. The chemical composition of cement and marble powder are shown in table 6.

Table 6: Chemical composition of cement and marble powder (X-ray analysis spectrometry)

Constituents	Cement %	Marble powder %
Cao	36.60	26.28
Al_2O_3	2.96	14.22
Fe_2O_3	2.33	6.84
SiO_2	22.40	22.61
MgO	2.95	5.55

2.5 Stone dust

It is the residue material which is the extraction of basalt rocks to form the fine particles less than 4.75mm through the IS sieve. Locally available stone dust was used in the present study for replacement of fine aggregate (sand).

Different test such as specific gravity and bulk density were carried out in laboratory for stone dust results are shown in Table 7 and the sieve analysis result in Table 3.

Table 7: Physical Properties of stone dust

Properties	Values
Bulk density	1500Kg/m^3
Specific gravity	2.63

3. METHODOLOGY

3.1 Mix Design

Mix design is carried out by IS 10262:2009 for M_{20} and M_{30} grade concrete yielded a mix proportion as shown in Table 8.

Table 8: Mix Proportions.

Grade of Concrete	W/C	Cement	FA	CA (20 mm)	CA (10 mm)
M_{20}	0.55	1	2.119	1.956	1.6
M_{30}	0.45	1	1.588	1.596	1.305

3.2 Casting and Testing

To find out the Compressive strength, specimens of dimensions 150X150X150mm were cast and tested under UTM as per IS 9013-1978 after 28 days of curing.

4. RESULTS & DISCUSSION

From the test results of compressive strength for M_{20} and M_{30} grade concrete, it is found that the strength increases with the increase in marble powder and stone dust. It is found that the optimum percentage replacement of cement by marble powder and sand by stone dust which gives the maximum strength for M_{20} and M_{30} grade concrete is 10% marble powder and 20% stone dust.

At 28 days of curing the compressive strength of M_{20} grade concrete increases from 31.64 N/mm² to 36.48 N/mm² and for M_{30} grade concrete increases from 38.80 N/mm² to 42.29 N/mm² for 10% marble powder and 20% stone dust replacement. It is found that there was 15 % and 9% increment in compressive strength for M_{20} and M_{30} grade concrete respectively at 28 days of curing. The results are tabulated below.

Table 9: Results of M_{20} and M_{30} grade conventional concrete

Grade of Concrete	Compressive strengths in N/mm²
M_{20}	31.64
M_{30}	38.80

4.1 Results of M_{20} grade concrete for various percentage replacements of MP and SD

Table 10: Compressive Strength of concrete

Replacement of stone dust and marble powder	Compressive strengths in N/mm²
10%(SD)-0%(MP)	32.26
10%(SD)-10%(MP)	34.88
10%(SD)-20%(MP)	31.68

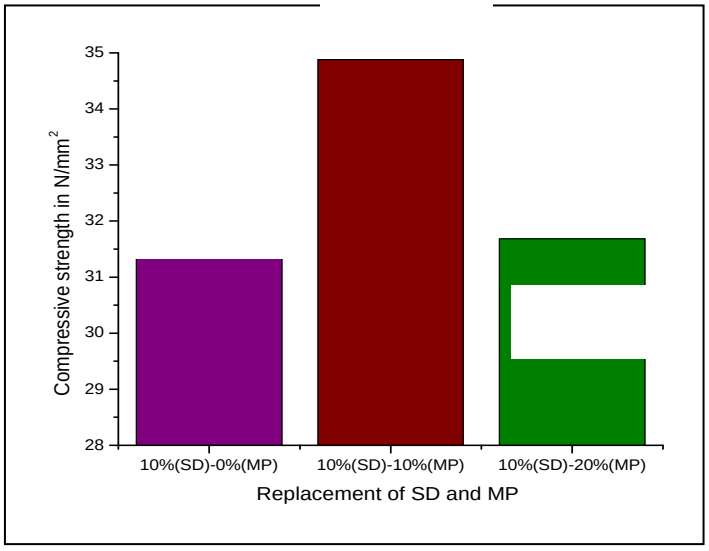

Fig 2: Compressive strength test results for M_{20} grade concrete

Table 11: Compressive Strength of concrete

Replacement of stone dust and marble powder	Compressive strengths in N/mm²
20%(SD)-0%(MP)	36.48
20%(SD)-10%(MP)	36.48
20%(SD)-20%(MP)	33.43

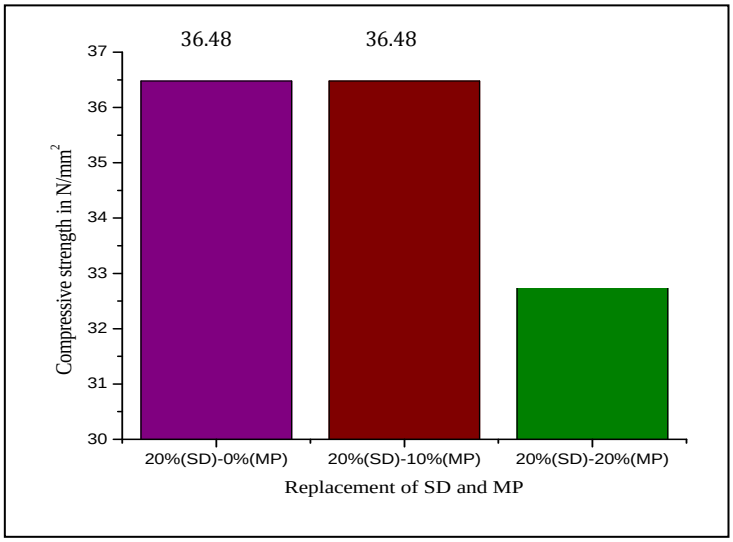

Fig 3: Compressive strength test results for M_{20} grade concrete

Table 12: Compressive Strength of concrete

Replacement of stone dust and marble powder	Compressive strengths in N/mm²
30%(SD)-0%(MP)	34
30%(SD)-10%(MP)	35.46
30%(SD)-20%(MP)	33.14

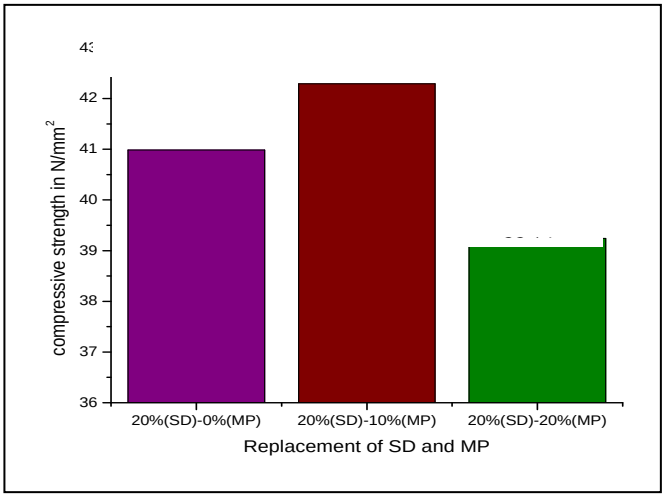

Fig 4: Compressive strength test results for M_{20} grade concrete

4.2 Results of M_{30} grade concrete for various percentage replacements of MP and SD

Table 13: Compressive Strength of concrete

Replacement for stone dust and marble powder	Compressive strengths in N/mm²
10%(SD)-0%(MP)	35.94
10%(SD)-10%(MP)	40.55
10%(SD)-20%(MP)	37.10

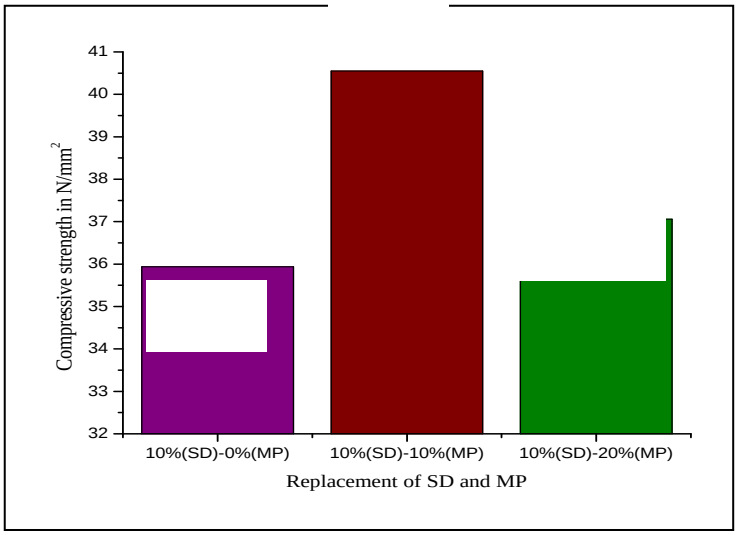

Fig 5: Compressive strength test results for M_{30} grade concrete

Table 14: Compressive Strength of concrete

Replacement for stone dust and marble powder	Compressive strengths in N/mm²
20%(SD)-0%(MP)	40.98
20%(SD)-10%(MP)	42.29
20%(SD)-20%(MP)	39.24

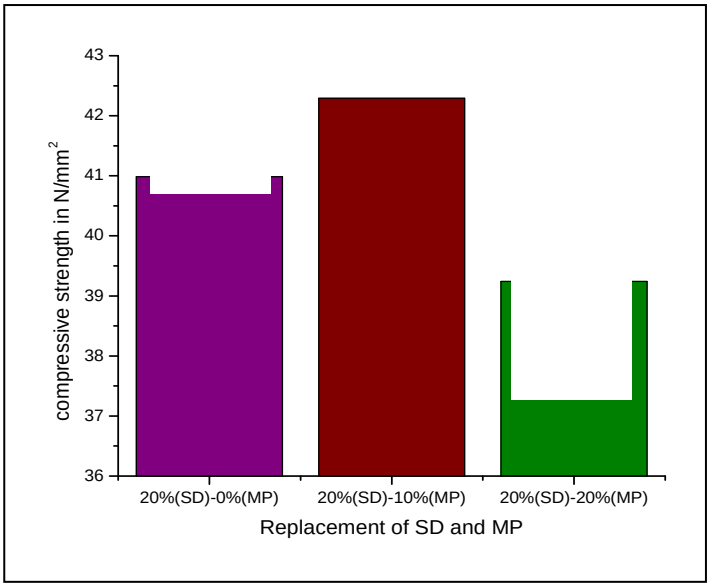

Fig 6: Compressive strength test results for M_{30} grade Concrete

Table 15: Compressive Strength of concrete

Replacement for stone dust and marble powder	Compressive strengths in N/mm²
30%(SD)-0%(MP)	40.55
30%(SD)-10%(MP)	41.42
30%(SD)-20%(MP)	34.59

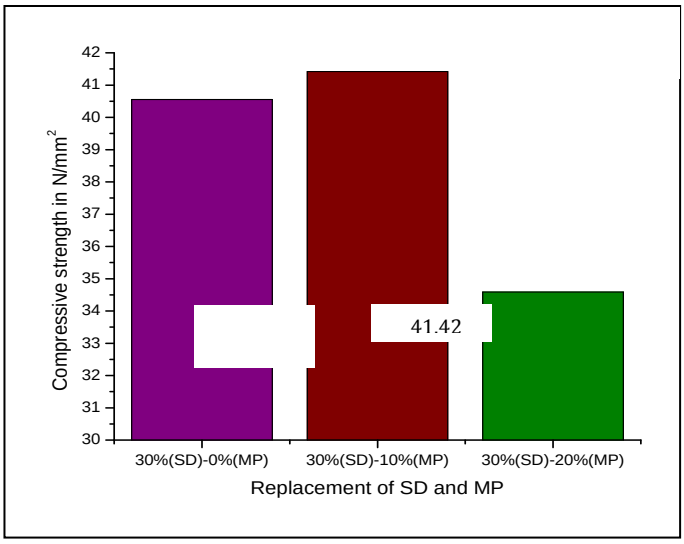

Fig 7: Compressive strength test results for M_{30} grade concrete

CONCLUSIONS

1. The optimum percentage replacement of cement by marble powder is 10% and sand by stone dust is 20% by weight which showed increment in compressive strength for M_{20} and M_{30} grade concrete.
2. It is found that there was 15% increment in compressive strength for M_{20} grade concrete for optimum percentage replacement.
3. It is found that there was 9% increment in compressive strength for M_{30} grade concrete for optimum percentage replacement.
4. We have put forth a simple step to minimize the costs for construction with usage of marble powder and stone dust which is freely or cheaply available.

REFERENCES

1. P.A. Shirulea, Ataur Rahman, Rakesh D. Gupta, *"PARTIAL REPLACEMENT OF CEMENT WITH MARBLE DUST POWDER"*, International Journal of Advanced Engineering Research and Studies E-ISSN2249–8974, IJAERS/Vol. I/ Issue III/April-June, 2012/175-177.
2. Ahmed N. Bdour and Mohammad S. Al-Juhani, *"UTILIZATION OF WASTE MARBLE POWDER IN CEMENT INDUSTRY"*, December 2011,Associate Professor, Civil Engineering Department, College of Engineering, University of Tabuk, Saudi Arabia Corresponding Author Dean, College of Engineering, University of Tabuk, Saudi Arabia.
3. Omar M. Omar a, Ghada D. AbdElhameed b,, Mohamed A. Sherif a, Hassan A. Mohamadien c *"INFLUENCE OF LIMESTONE WASTE AS PARTIAL REPLACEMENT MATERIAL FOR SAND AND MARBLE POWDER IN CONCRETE PROPERTIES"*, Housing and Building National Research Center Received 14 May 2012; accepted 10 June 2012.
4. BaharDemirel, *"THE EFFECT OF THE USING WASTE MARBLE DUST AS FINE SAND ON THE MECHANICAL PROPERTIES OF THE CONCRETE"*, International Journal of the Physical Sciences Vol. 5(9), pp. 1372-1380, 18 August, 2010,Available online at http://www.academicjournals.org/IJPS,ISSN 1992 - 1950 ©2010 Academic Journals, Department of Construction, Faculty of Technical Education, Firat University, Elazig, 23119, Turkey.
5. Valeria Corinaldesi, Giacomo Moriconi, and Tarun R.naik,"*CHARACTERIZATION OF MARBLE POWDER FOR ITS USE IN MORTAR AND CONCRETE"*, Report No. CBU-2005-09 REP-580 August 2005 For Presentation and Publication at the CANMET/ACI Three-Day International Symposium on Sustainable Development of Cement and Concrete, October 5-7, 2005, Toronto, CANADA.
6. Priyanka A. Jadhava and Dilip K. Kulkarni, *"AN EXPERIMENTAL INVESTIGATION ON THE PROPERTIES OF CONCRETE CONTAINING MANUFACTURED SAND",* International Journal of Advanced Engineering Technology E-ISSN 0976-3945.
7. Er. Lakhan Nagpal, Arvind Dewangan, Er. Sandeep Dhiman, Er. Sumit Kumar, *"EVALUATION OF STRENGTH CHARACTERISTICS OF CONCRETE USING CRUSHED STONE DUST AS FINE AGGREGATE*", International Journal of Innovative Technology and Exploring Engineering (IJITEE) ISSN: 2278-3075, Volume-2, Issue-6, May 2013.
8. G. Marras, N. Careddu, C. Internicola, G. Siotto, *"RECOVERY AND REUSE OF MARBLE POWDER BY-PRODUCT"*, Global Stone Congress 2010, Department of Geoengineering and Environmental Technologies – University of Cagliari, Via Marengo, 3 -09123 Cagliari (Italy).
9. Mahesh Patel, Prof. P. S. Rao and T. N. Patel, *"EXPERIMENTAL INVESTIGATION ON STRENGTH OF HIGH PERFORMANCE CONCRETE WITH GGBS AND CRUSHER SAND"*, Volume: 3 | Issue: 4 | May 2013 ISSN - 2250-1991.

10. IS-12269-1987-Ordinary Portland cement 53 grade
11. IS-383-Indian Standard (1970),"Method for testing of aggregates".
12. IS-10262-Indian Standard (2009),"Concrete Mix Design".
13. IS 9013 – Indian standard (1978),"Method of test for compressive strength".
14. IS: 456 – 2000 "Plain and reinforced concrete code of practice Concrete technology by M.S Shetty