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# **A BRIEF STUDY ON THE STRENGTH PARAMETERS OF CONCRETE USING MARBLE SLURRY AND CERAMIC WASTE AGGREGATE AS PARTIAL SUBSTITUTION OF OPC-43 AND COARSE AGGREGATE**

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## **ABSTRACT**

*Marble waste powder is waste material which is derived during the cutting and polishing of marble. While ceramic waste is obtained from various construction wastes. This experimental work is conducted to develop recycled (marble powder-ceramic waste aggregate) concrete by using marble waste powder as percentage substitution of OPC-43 and ceramic waste aggregate as percentage substitution of Natural aggregate. OPC-43 was partially replaced at different ratios of Marble powder (10%, 20%, and 30%) and coarse aggregate was replaced at different ratios of Ceramic (20%, 40%). In all the concrete mix, the water-binder ratio of 0.40 and slump of (50-90mm) is used. Different tests were performed, so to evaluate various mechanical properties of concrete.*

*It was observed that the strength of concrete containing Marble slurry and ceramics tend to decline over 20% substitution of Marble slurry and 20% substitution of CWP and gives satisfactory results below that level. The main purpose of using ceramic aggregate and marble powder in concrete is to utilize various environmental hazardous waste materials such as marble waste and ceramic waste in making Recycled concrete.*

**Key words:** Recycled Waste Concrete, Marble Waste Powder, Ceramic Waste Aggregate.

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## 1. INTRODUCTION

**Recycled Concrete** or recycled waste concrete is a certain type of concrete in which various kinds of construction as well as industrial wastes are used so as to improve the quality and strength of concrete. It mainly involves the substitution of binding material or natural aggregate with various waste materials. This paper involves usage of marble slurry and waste ceramic aggregate as percentage substitution of OPC-43 and coarse aggregate respectively. In the present era, huge amount of marble and ceramic is used which simultaneously lead to huge amount of marble and ceramic waste and this waste is very much harmful from the environmental point of view. Marble slurry is generally derived throughout the wounding and polishing of marble.

**Marble Slurry** is generally the waste generated by Marble industry. Marble Slurry is obtained either in powder form or in the form of coarse aggregate. This marble slurry can be used in concrete to enhance its properties.



**Figure 1** Waste Marble Powder

**Ceramic Coarse Aggregate** is basically derived from the ceramic industry where huge amount of ceramic waste is originated and is then dumped in rivers or various other dumping sites. This waste is very much harmful from the environmental point of view.



**Figure 2** Ceramic Waste

## 2. MATERIALS AND METHODS

**Marble Waste Powder:** Marble waste powder was obtained as a waste from the marble industry through the wounding, crushing and polishing of marble. Various properties of marble waste powder or marble slurry are shown in Table A.

**Table 1** Properties of Marble Powder

Details	Values
Specific gravity	2.51
Water absorption (%)	0.82
Specific surface area(m <sup>2</sup> /kg)	535
Partial retain of 75 micron IS sieve	1.23

**Ordinary Portland cement:** Binding Material used for this study was OPC of 43 grade confirming to IS: 8112-2013. After performing several tests certain properties were obtained which are shown in Table B.

**Table 2** Properties of OPC 43 Grades

Details	Values	Requirement as per IS: 8112-2013
Precise gravity	2.99	3.11-3.14
Primary setting time	34 minutes	30 minutes
Concluding setting time	187 minutes	600 minutes
Consistency	32%	30-35%

**Ceramic Coarse Aggregate:** Ceramic aggregate was obtained from various construction sites as a waste, during the cutting and placing of tiles. These ceramic tiles can be used in concrete as percentage substitution of natural aggregate. Various tests were performed on ceramic aggregate and certain properties were determined which are shown in Table C.

**Table 3** Properties of Ceramic:

Details	Value
Precise gravity(g/cm <sup>3</sup> )	2.31
Water absorption (%)	0.55
Crushing worth	20.88
Impact worth	23.42

**Aggregates:** Natural coarse and fine aggregate ranging from 2.36 mm to 20mm was involved in this study. Various Substantial properties of coarse aggregate are shown in Table D.

**Table 4** Properties of Aggregate:

Details	Value	Requirement as per IS:2386-1963
Specific gravity(g/cm <sup>3</sup> )	2.80	NA
Water absorption	0.18	Maximum 2%
Impact value	18.31%	<24%
Abrasion value	20.8%	<30%

**Admixture:** Super plasticizer type retarding admixture conforming to IS 9103-1999 was used in the concrete samples at certain percentages. properties of admixture are shown in Table E.

**Table 5** Properties of Admixture:

Details	Value	Requirement as per IS: 9103-1999
Dry Material content (%)	29.72	Within $\pm 3\%$ as stated by the manufacturer
pH	6.59	Minimum 6.0
Relative density	1.08	Within $\pm 0.02\%$ as stated by the manufacturer
Appearance	Light Brown	Light brown

### 3. TESTS AND RESULTS

Various laboratory tests such as were executed so as to check various mechanical and durable properties of concrete. The detailed results of these tests and experiments are explained in this section.

**Concrete mix:** Several proportions of mix as per Indian standards were organized, to prepare various cubes for testing. The water cement ratio of 0.45 was taken for this study. All the mix are revealed in Table F.

**Table 6** Proportions of Concrete Mixes

Mix	Substitution of cement with marble powder (%)	Substitution of Natural aggregate with ceramic (%)	Water-binder ratio
N0	0	0	0.45
N1	10	20	0.45
N2	10	40	0.45
N3	20	20	0.45
N4	20	40	0.45
N5	30	20	0.45
N6	30	40	0.45

**Compressive Strength Test:** The samples of size (150mmX150mmX150mm) were casted and the compressive strength test as per IS: 516-1959 was executed over the past 7 days and 28 days. It was noticed that the N3 mix has the highest compressive strength as compared to all other mixes. The Compressive strength of all concrete mixes is shown in Table G and Figure C.

**Table 7** Compressive Strength Outcomes

Mix	Water- binder ratio	Compressive strength past 7 days(N/mm <sup>2</sup> )	Compressive strength past 28 days(N/mm <sup>2</sup> )
N0	0.45	22.35	33.37
N1	0.45	22.69	33.87
N2	0.45	23.20	34.63
<b>N3</b>	<b>0.45</b>	<b>25.08</b>	<b>37.44</b>
N4	0.45	24.81	37.04
N5	0.45	23.66	35.32
N6	0.45	22.19	33.12

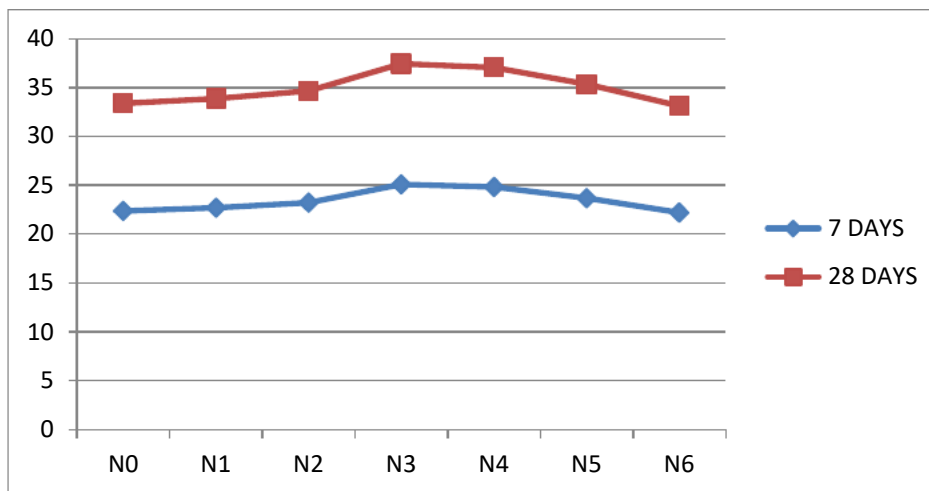


Figure 3 Variation of Compressive Strength

**Flexural Strength Test:** After compressive strength test, several beams of size (500mmX100mmX100mm) were casted so as to perform flexural strength test as per IS: 516-1959 past 7 days and 28 days. It was noticed that the N3 mix has higher flexural strength as of other mix. Test results of flexural strength are shown in Table G and Figure D.

Table 8 Flexural Strength Outcomes

Mix	Water- binder ratio	Flexural strength past 7 days(N/mm <sup>2</sup> )	Flexural strength past 28 days(N/mm <sup>2</sup> )
N0	0.45	5.19	5.77
N1	0.45	5.22	5.81
N2	0.45	5.29	5.88
N3	0.45	5.49	6.11
N4	0.45	5.47	6.08
N5	0.45	5.34	5.94
N6	0.45	5.17	5.75

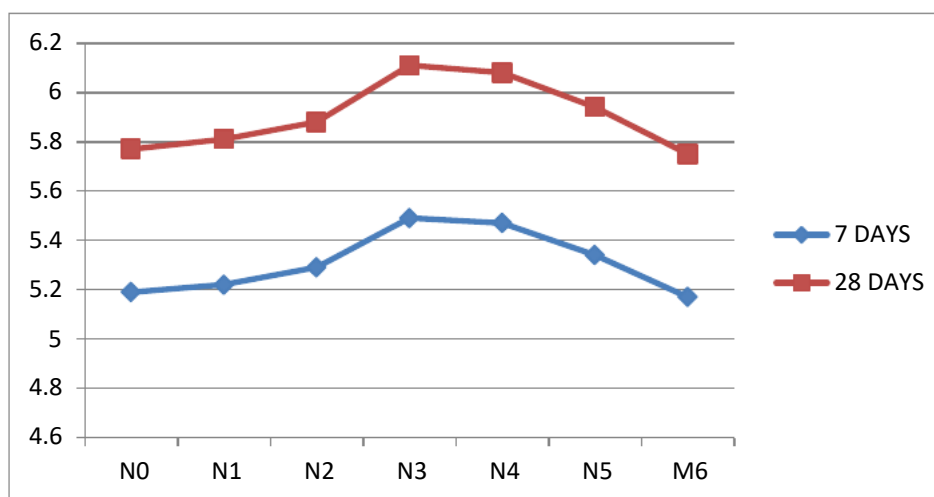


Figure 4 Variation of Flexural Strength

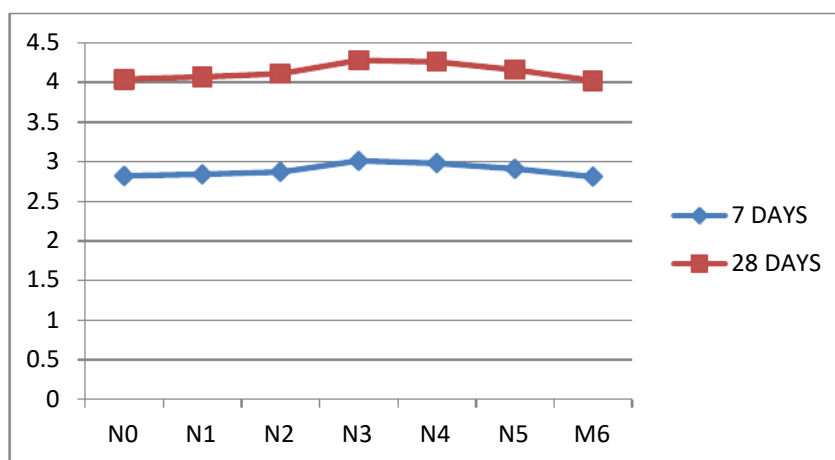
**Split Tensile Strength Test:** After completion of flexural strength test, cylinders of various concrete mixes were casted so as to perform split tensile strength test as per IS: 5816-1999 past 7 days and 28 days. This test was performed so as to make sure the tensile strength of the concrete. It was observed that the N3 mix samples has higher split tensile strength as of other

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mix such as N0,N1,N2,N4,N5,N6. The test results and observations are shown in Figure E and Table H.

**Table 9** Split Tensile Strength Outcomes

Mix	Water- binder ratio	Split tensile strength past 7 days(N/mm <sup>2</sup> )	Split tensile strength past 28 days(N/mm <sup>2</sup> )
N0	0.45	2.82	4.04
N1	0.45	2.84	4.07
N2	0.45	2.87	4.11
N3	0.45	3.01	4.28
N4	0.45	2.98	4.26
N5	0.45	2.91	4.16
N6	0.45	2.81	4.02



**Figure 5** Variation of Split Tensile Strength

### Ultrasonic Pulse Rate Test

An ultrasonic pulse velocity (UPV) test as per IS: 13311.1-1992 is an in-situ, Non-destructive type of test which was majorly used to check the excellence of concrete. Specimen of size 15cmx15cmx15cm was casted and then ultrasonic pulse velocity test was performed over it. Test results are shown in Figure F and Table I.

**Table 10** Ultrasonic Pulse Velocity Outcomes

Mix	Split tensile strength past 28 days(N/mm <sup>2</sup> )	Quality of concrete
N0	4.04	Good
N1	4.07	Good
N2	4.11	Good
N3	4.58	Excellent
N4	4.56	Excellent
N5	4.16	Good
N6	4.02	Good

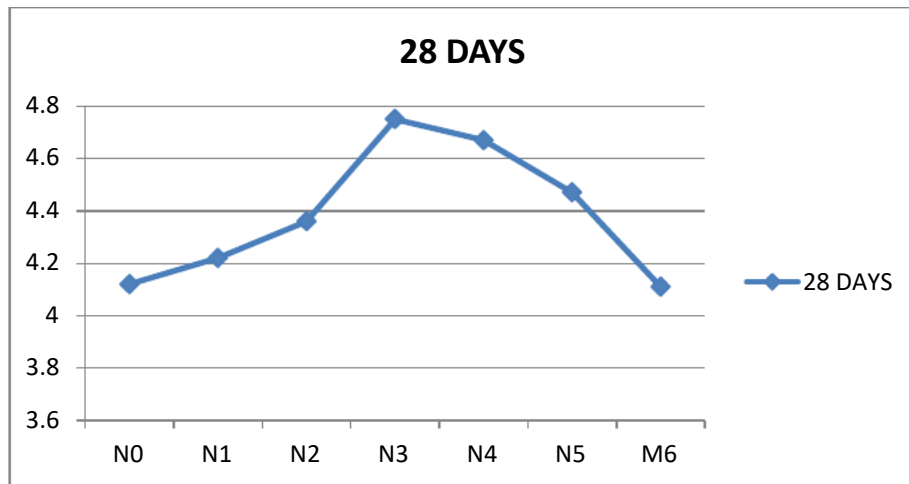


Figure 6 Variation of Ultrasonic Pulse Velocity

#### 4. CONCLUSIONS

Based on the various experimental investigations for compressive strength, flexural strength, split tensile strength, following observations are drawn:

- The compressive strength of concrete starts declining significantly after 20% substitution of OPC-43 with marble waste powder. The rate of declining increases with the amplification of marble waste powder.
- It was noticed that the 20% substitution of OPC-43 with marble powder and 20% substitution of ceramic waste aggregate give satisfactory results.
- The specimen with 20% substitution of both marble waste powder and ceramic aggregate had highest split tensile strength than that of managed concrete.
- Results of flexural strength showed increase of strength of specimen with 20% substitution of MWP. However further boost of marble slurry will reduce the strength gradually.
- The ultrasonic pulse velocity of all specimens apart from the concrete mix where OPC-43 was replaced by 30% of marble waste powder and coarse aggregate was replaced by 40% ceramic waste aggregate is higher than the ultrasonic pulse velocity of control concrete.

In general terms, it was established that the involuntary properties of concrete will tend to turn down after 20% substitution of marble slurry. Concerning the use of ceramic waste aggregate it generally enhances the involuntary properties of concrete.

#### REFERENCES

- [1] Ashish, Deepankar Kumar. "Concrete made with waste marble powder and supplementary cementitious material for sustainable development." *Journal of Cleaner Production* 211 (2019): 716-729.
- [2] Singh, Manpreet, Anshuman Srivastava, and Dipendu Bhunia. "Long term strength and durability parameters of hardened concrete on partially replacing cement by dried waste marble powder slurry." *Construction and Building Materials* 198 (2019): 553-569.
- [3] Vardhan, Kirti, Rafat Siddique, and Shweta Goyal. "Strength, permeation and micro-structural characteristics of concrete incorporating waste marble." *Construction and Building Materials* 203 (2019): 45-55.

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- [4] Phagwara, R. I. E. T. "Partial Replacement Of Cement With Waste Marble Powder With M25 Grade."
- [5] Rao, B. Krishna. "A Study on Performance of Concrete Containing Marble Powder and Quarry Dust."
- [6] Patnaik, G. Binaya, and T. Seshadri Sekhar. "Behavior Aspects of Copper Slag Admixed Concrete Subjected to Destructive and Non-Destructive Tests." *i-Manager's Journal on Civil Engineering* 5.4 (2015): 10.
- [7] Naik, M. Jagadeesh, and S. M. Gupta. *Experimental Investigation on the Properties of Concrete Replacing Cement and Natural Sand with Metakaolin and Robo-Sand*. Diss. National Institute of Technology Kurukshetra, 2016.
- [8] Ghannam, Shehdeh. "Comparison between Concrete with Granite Powder and Concrete with Iron Powder." *International Journal of Applied Engineering Research* 11.21 (2016): 10501-10515.
- [9] Aditya, G., and M. T. S. Lakshmayya. "Effective Utilization of Various Industrial Wastes in Concrete for Rigid Pavement Construction–A."
- [10] Gayarre, Fernando López, et al. "Mechanical properties of prestressed joists made using recycled ceramic aggregates." *Construction and Building Materials* 194 (2019): 132-142.
- [11] Keshavarz, Zahra, and Davood Mostofinejad. "Porcelain and red ceramic wastes used as replacements for coarse aggregate in concrete." *Construction and Building Materials* 195 (2019): 218-230.
- [12] Siddique, Salman, et al. "Sustainable utilisation of ceramic waste in concrete: Exposure to adverse conditions." *Journal of Cleaner Production* 210 (2019): 246-255.
- [13] Sekar, M. "Partial replacement of coarse aggregate by waste ceramic tile in concrete." *Int. J. Res. Appl. Sci. Eng* 5.3 (2017): 473-479.
- [14] Binici, Hanifi, and Orhan Aksogan. "Durability of concrete made with natural granular granite, silica sand and powders of waste marble and basalt as fine aggregate." *Journal of Building Engineering* 19 (2018): 109-121.