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Strength Evaluation of Concrete Incorporating Marble Waste Powder and Ceramic waste powder

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Abstract*: Cement is a major construction material worldwide. Cement manufacturing industry is one of the carbon dioxides emitting sources besides deforestation and burning of fossil fuels. The global warming is caused by the emission of greenhouse gases, such as CO2 to the atmosphere. And the increase in the concrete demand due to the rapid industrialization and urbanization may lead to a shortage of natural resources. Therefore, the use of recycled material in the batching of concrete will be helpful to meet the demands of the time without compromising the quality of concrete production. One such waste material produced in India is Marble Waste Powder (MWP) that is generated from the marble factories during cutting of the marble stones. Second is the Ceramic Waste Powder (CWP), the ceramic industry inevitable generates wastes, irrespective of the improvements introduced in the manufacturing process. In the ceramic industry, about 15%-30% production goes as waste, which in turn have a damaging effect on the environment. In this project, the cement has been combined replaced by ceramic waste powder and marble waste powder accordingly in the range of 0%, 5%, 10%, 15% & 20% by weight for M-20 grade concrete and their compressive, split tensile and flexure strength of mix is compared.*

Keywords: Marble waste powder, Ceramic waste powder, concrete, etc

I. INTRODUCTION

1.1Marble Waste Powder

The estimated values for the world's marble reserves is approximately 15 billion cubic meters, and marble industries are working in almost fifty countries globally. The factories in India utilize water for the cutting of the marble stones, which in turn generate a significant amount ofmarble slurry.Upon drying, this slurry transforms into marble waste powder (MWP), with 90 percent of the particles being smaller than 200 µm. The accumulation of such waste powder is harmful to the environment.

Marble blocks are extracted from the quarries and processed at marble factories. Dust and broken aggregates are the by-products of marble, produced in the marble processing like cutting and polishing stages. Around 20–30% of the marble blocks transform into powder residue. Millions of tons of waste material are produced in this process which is blindly disposed of to a nearby environment. The waste slurry created is aimlessly dumped on empty land, waterway banks, and wood regions. Due to the high degree of fineness of the slurry particles, pores within fertile soil are filled by these particles which prevent the water percolation in the soil and reduce its fertility. Slurry particles when dried are lifted into the air, by winds, and can bring about respiratory issues to nearby people.

To cope with such overexploitation of the resources and negative impacts of MWP on the environment, it is therefore important to consume and treat these wastes in a well-planned manner and legitimize the use of MWP in the development of auxiliary concrete mixes.

1.2 Ceramic Waste Powder

Ceramic waste from factories producing materials for the construction industry has been accumulating frequently, creating increasingly large piles. Although they are usually chemically inert, the waste accumulates depending upon

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their size and the scant environmental control exercised, have a significant visual impact that destroys the intrinsic quality of the Landscape.

Indian ceramic production is 100 Million ton per year. In ceramic industry, about 15%-30% waste Material generated from the total production. This waste Is not recycled in any form at present. However, the Ceramic waste is durable, hard and highly resistant to Biological, chemical, and physical degradation forces. In addition to helping protect the environment, use of such waste offers a series of advantages such as a reduction in the use of other raw materials, contributing to an economy of natural resources. Moreover, reuse also offers benefits in terms of energy, primarily when the waste is from kiln industries (the ceramics industry) Where highly endothermic decomposition reactions have already taken place, thus recovering the energy previously incorporated during production.

Factors associated with the large-scale use of the resources are the growth of population, technological advancement, industrialization, and the desire to arrive at a better quality of life for the people. As an outcome, the idea of manageability has developed, characterized as a harmony between the utilization and assurance of a good future life. Therefore, the usage of some alternative resources is the utmost need of the hour to maintain natural quarries.

II. EXPERIMENTAL PROGRAM

Materials Used

Cement: Portland Pozzolana Cement of Coromandel King Company is used in present research.

Coarse Aggregate: The fractions from 10 mm to 8 mm are used as coarse aggregate. The Coarse Aggregates from crushed Basalt rock, conforming to IS: 383 is being use.

Fine Aggregate: Those fractions from 2.36 mm to 150 microns are termed as fine aggregate. The river sand is used in combination as fine aggregate conforming to the requirements of IS: 383.

Table No. 2.1: Physical properties of cement &aggregates

Properties	Cement	Fine Aggregate	Coarse Aggregate
Specific Gravity	3.15	2.69	2.85
Initial Setting Time	32 Minutes	--	--
Final Setting Time	580 Minutes	--	--
Standard Consistency of Cement	30 %	--	--
Free Moisture Content	--	2 %	--
Water Absorption	--	1.2 %	0.5 %
Max. Size	--	2.36m	10m

Marble WastePowder: MWP used in this research is obtained from locally available marble quarrying factory.

Ceramic Waste Powder: CWP used in this research is obtained from indiamart.

Fig. No. 2.1: Marble Waste Powder

Fig. No. 2.2: Ceramic Waste Powder

Table No. 2.2: Physical properties of marble waste powder and ceramic waste powder

Physical Properties	Marble Powder	Ceramic Powder
Specific Gravity	2.71	3.11
Dry Moisture Content	1.58 %	1.62 %
Bulk Density (kg/m3)	1118	1323.43
Fineness Modulus	2.03	2.43

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Table No. 2.3: Chemical properties of marble waste powder and ceramic waste powder

Chemical Properties	Marble Powder(%)	Ceramic Powder (%)
SiO2	0.63	63.29
Al2O3	0.40	18.29
Fe2O3	0.20	4.32
CaO	55.6	4.46
MgO	0.10	0.72
CaCo3	90	--
P2O5	--	0.16
K2O	--	2.18
Na2O	--	0.75
SO3	--	0.10
CL	0.10	0.005
TiO2	--	0.61
SrO2	--	0.02
Mn2O3	--	0.05
L.O. I	43	1.61

Water: Free from deleterious matter and shall fulfil the requirement as per IS 456:2000.

Design Mix

A mix M20 grade was designed as per Indian Standard method (IS 10262-2009) and the same was used to prepare the test samples.

Water/Cement ratio: 0.5

Mix proportion: 1: 2.11: 2.07

Table No. 2.4: Mix proportion for 1 cubic meterTable No. 2.5: Mix proportion

Content	In Kg
Cement/ Marble/ Ceramic	416
Water	208
Fine aggregate	881.24
Coarse aggregate	861.84

Sr. No.	Concrete Type	Concrete Design Mix Proportion				
		C	MWP	CWP	FA	CA
1	M0	1.00	-	-	2.11	2.07
2	M1	0.95	0.025	0.025	2.11	2.07
3	M2	0.90	0.05	0.05	2.11	2.07
4	M3	0.85	0.075	0.075	2.11	2.07
5	M4	0.80	0.10	0.10	2.11	2.07

Table No. 2.6: Mix proportion

Sr. No.	Concrete Type	PPC cement Replacement with Ceramic waste powder	PPC cement Replacement with Marble waste powder
1	M0	0 %	0 %

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2	M1	2.5 %	2.5 %
3	M2	5 %	5 %
4	M3	7.5 %	7.5 %
5	M4	10 %	10 %

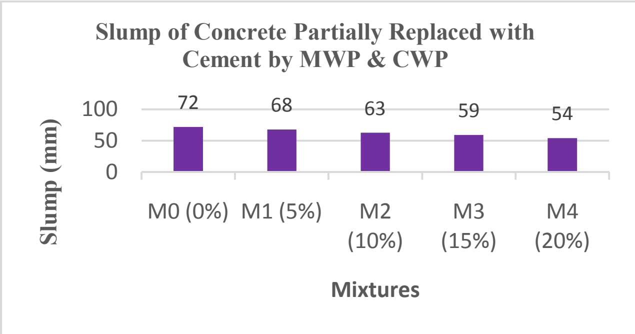
III. RESULTS AND DISCUSSION

Slump cone test

Slump cone test results were determined for concrete in which cement is partially replaced by marble waste powder and ceramic waste powder combined by 0%, 5%, 10%, 15%, 20%.

Table No. 3.1: Slump cone test results

Mix	Materials Replaced (%)		Slump (mm)
	MWP	CWP	
M0	0 %	0 %	72
M1	2.5 %	2.5 %	68
M2	5 %	5 %	63
M3	7.5 %	7.5 %	59
M4	10 %	10 %	54



Graph No. 3.1: Slump Cone Test Results

Compressive strength test

Compressive strength test results were determined at 7 days, 14 days and 28 days for concrete in which cement is partially replaced by marble waste powder and ceramic waste powder combined by 0%, 5%, 10%, 15%, 20%. For every proportion, 9 cubes were casted and average values are taken for their compressive strength.

Table No. 3.2: Compressive strength Result

Mix	Materials Replaced (%)		Average Compressive Strength (Mpa)		
	MWP	CWP	7 Days	14 Days	28 Days
M0	0 %	0 %	15.04	19.70	22.96
M1	2.5 %	2.5 %	15.41	20	23.55
M2	5 %	5 %	16.37	21.26	25.03
M3	7.5 %	7.5 %	17.04	22.15	26
M4	10 %	10 %	15.26	19.85	23.33

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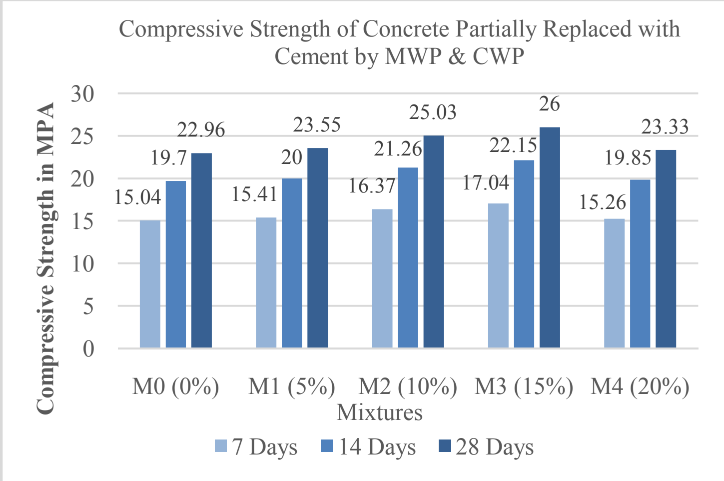


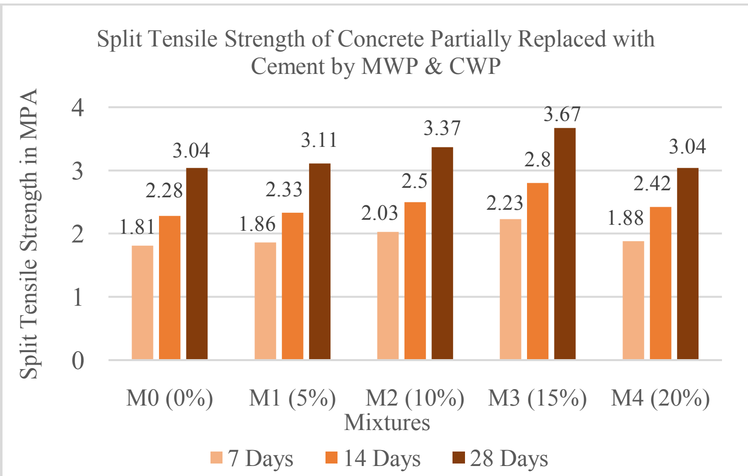
Graph No. 3.2: Compression Strength Test Results

Split tensile strength test

Split tensile strength test results were determined at 7 days, 14 days and 28 days for concrete in which cement is partially replaced by marble waste powder and ceramic waste powder combined by 0%, 5%, 10%, 15%, 20%. For every proportion, 9 cylindrical specimens were casted and average values are taken for their split tensile strength.

Mix	Materials Replaced (%)		Average Split Tensile Strength (Mpa)		
	MWP	CWP	7 Days	14 Days	28 Days
M0	0 %	0 %	1.81	2.28	3.04
M1	2.5 %	2.5 %	1.86	2.33	3.11
M2	5 %	5 %	2.03	2.03	3.37
M3	7.5 %	7.5 %	2.23	2.23	3.67
M4	10 %	10 %	1.88	1.88	3.04

Table No. 3.3: Split Tensile Strength Result



Graph No. 3.3: Split Tensile Strength Result

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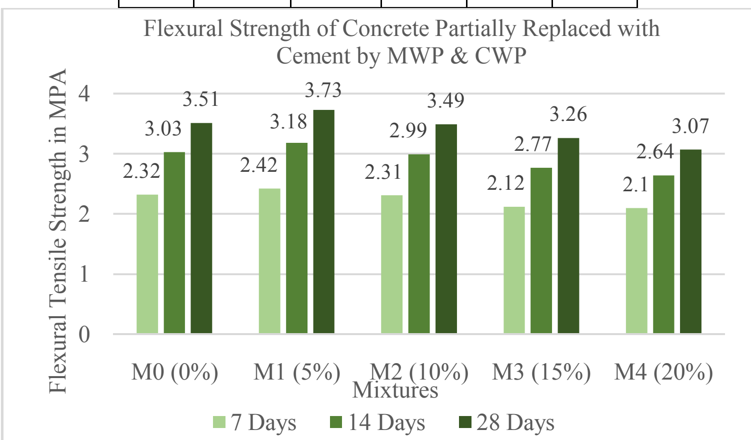
Flexural strength test

Flexural strength test results were determined at 7 days, 14 days and 28 days for concrete in which cement is partially replaced by marble waste powder and ceramic waste powder combined by 0%, 5%, 10%, 15%, 20%. For every proportion, 9 beams were casted and average values are taken for their flexural tensile strength.

Table No. 3.4: Flexural Strength Results

Mix	Materials Replaced (%)		Average Flexural Strength (Mpa)		
	MWP	CWP	7 Days	14 Days	28 Days
M0	0 %	0 %	2.23	3.03	3.51
M1	2.5 %	2.5 %	2.42	3.18	3.73
M2	5 %	5 %	2.31	2.99	3.49
M3	7.5 %	7.5 %	2.12	2.77	3.26
M4	10 %	10 %	2.10	2.64	3.07



Graph No. 3.4: Flexural Strength Results

Fig. No. 3.1: Compression& Split Tensile Strength Test on CTM Fig. No. 3.2: Flexural Strength Test on UTM

IV. CONCLUSION

From the experimental work carried out following results were achieved:

- Slump value is decreased with increase in percentage replaced. Slump value is inversely proportional to cement replaced.

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- The Compressive Strength of M20 grade concrete increases when the replacement of cement by combined ceramic waste powder and marble waste powder up to 15% by weight of cement is done.
- Strength loss in compressive strength starts after more than 15% replacement of cement by combined ceramic waste powder and marble waste powder.At 15% replacement of cement we have seen the maximum increase in compressive strength which is 13.24% as compared to normal concrete mix specimen. At 20% replacement of cement there is loss in compressive strength as compared to 15% replacement of cement.
- Split tensile strength of concrete specimen is gradually increased till 15% replacement of cement and above that there is a loss of strength.At 15% replacement of cement we have seen the maximum increase in split tensile strength which is 20.7% as compared to normal concrete mix specimen.
- Flexural strength of concrete specimen is increased at 5% replacement of cement and above that there is a gradual loss of strength.At 5% replacement of cement we have seen the maximum increase in flexural strength which is 6.26% as compared to normal concrete mix specimen.
- It is the possible alternative solution of safe disposal of MWP and CWP.
- Compressive strength, flexural strength, split tensile strength of concrete specimens is directly proportional to percentage of cement replaced till a certain point.

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