Strength analysis of Concrete by Replacement of cement with Ceramic waste powder

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Abstract- *Most broken ceramic tiles end up in garbage because of their physical and chemical makeup. These waste materials cannot be recycled or reused. Reusing scrap tiles in the construction sector contributes to a reduction in excessive aggregate quarrying and urban waste management. The goal of this experiment is to determine if used ceramic tile may be used in concrete. In this study, the physical characteristics of ceramic tile aggregate are measured. Among other things, ceramic materials are utilized increasingly often in modern constructions as electrical insulators, sanitary fittings, and tiles. However, a significant amount of ceramic materials are lost during manufacture, transit, and installation due to its brittle nature. As a consequence, using these wastes in the production of concrete may be an excellent approach to improve the concrete's properties and protect the environment. Therefore, concrete was made using the powder made from crushed waste ceramic tile as a 5 percent, 10 percent, 15 percent, and 20 percent cement replacement. After analyzing the results, it was found that 15% was the optimal amount of waste ceramic tile to use in concrete mix M30 with a water/cement ratio of 0.5. Ideal concrete has much higher compressive and flexural strengths than reference concrete. The results showed that using leftover ceramic tile enhanced the properties of concrete.*

Keywords- Ceramic Tile waste powder, Concrete, Recycling, Solid Waste, M30, Compression Strength**.**

I. INTRODUCTION

Since a very long time ago, studies have been conducted to identify how leftovers from different sectors may be used in the building industry. Recently, experts came to the conclusion that industrial waste materials might be used in the production of concrete and other civil uses. The capacity employs industrial waste as a fractional aggregate replacement or as a partial cement replacement in concrete, depending on chemical control and particle thickness. These materials are used in concrete because their safe disposal is subject to environmental regulations. There is a lot of focus on the environment, natural resource preservation, and garbage recycling. Every nation's or civilization's success and progress depend on its infrastructure. This skill also includes building houses, bridges, subways, and other systemic institutions as well as remodeling, repairing, and demolishing them. For reasons of safety, the dwellings that are still livable are demolished. Previously, locations with trenches and ditches were utilized for the demolition rubbish. The quantity of structure and devastation, however, has exponentially expanded with the amount of garbage created throughout time. Usually, it consists of inert, non-biodegradable substances including steel, glass, plastic, lumber, asphalt, and asphalt. Highways are littered with mountains of construction and demolition garbage from several large projects, which contributes to accidents and traffic issues. In India, there are thought to be 10–12 million tonnes of trash created annually. A popular construction material with numerous benefits is concrete. These qualities in the legislative process demand the ideal combination of chemicals, placement, and treatment.

Numerous benefits of superior concrete add to its reputation. It is fair in the first place because participants are ready to engage. Concrete has a higher financial return due to its extended lifetime and low maintenance needs. Compared to other construction materials, concrete is less prone to corrode, decay, or fester. Almost any desired form may be achieved by molding or casting concrete. Costs will be reduced by casting and building the castings on the worksite.

Concrete has a high fire resistance level and is fire effective due to the fact that it is not flammable. Mice, water, worms, and wind are antagonistic. Therefore, concrete is also utilized for flood management. While concrete substance has several drawbacks, it also offers certain positives. Concrete is prone to rupturing, has weak ductility, a low force-to-weight ratio, and is very tensile. Concrete.

II. RELATED WORKS OF LITERATURE

Sr. No.	Authors Name	Name of Journals, Vol., Issue, Year	Grade of Concrete	Material used	Cement	Percentage Replacement	Optimum Percentage	Compression Strength(N/mm^2)	Flexural Strength(N/mm^2)
1	Janarthanan R et. al.	IJSRD, Vol. 3, Issue 01, 2015	M 30	Ceramic waste	PPC	0% - 100 %	25%	34.31	-
3	Athulya Sugathan	IRJET, Volume: 03, Issue: 05, May-2016	M20	Broken Marble Tiles	OPC (53 Grade)	5%-50%	50%	27.57	-
4	J.P. Chotaliya	IJEDR, Volume 4, Issue 3, 2016	M25	Waste Marble Chips	OPC	0%-100%	100%	45.33	5.02
5	A. gopalsamy	ICRTCETM-2017 Special Issue	-	Flooring tiles	PPC,OPC 53 Grade	30%, 60%, 90%		-	3.61
6	Jagadeesh Bommisetty et, al.	Materials Today: Proceedings2019	M 25	Ceramic Tiles waste	OPC (43 Grade)	0% - 25 %	20%	35.55	-
8	Daniyal et, al.	IJIRSET, Vol. 4, Issue.12, 2015	M 30	Recycled Coarse Aggregates	OPC (43 Grade)	10% - 50%	40%	33.24	-
9	Sayyam D. Raigandhi et. al.	IJRASET, Volume 3, Issue VII, July 2015	M 25	Recycled Coarse Aggregates	OPC (43 Grade)	0% - 75 %	50%	49.13	-
10	Prakash Parasivamurthy et al.	Advanced Materials Research Vols. 15-17 (2007), pp 220-224	M 20	Plastic Waste	Portland cement	2%-8%	6%	28.51	-
11	Venkata atkuri et. al	JETIR, Vol. 9, No. 6, March 2022	M 20, M40	Ceramic waste	OPC 53	10 to 50%	40%	34.89	-

III. MATERIALS AND METHODOLOGY

Cement, fine aggregate, coarse aggregate, and ceramic tile powder are the materials used in the projects to make concrete mixtures, and they are described in detail below:

Cement: Cement is the most important part of concrete since it acts as a binding medium for the various components. Natural raw materials are used, and industrial wastes are sometimes combined or ground together. This study made use of Ordinary Portland cement (OPC 43).

Table 2: Properties of cement

S. No.	Properties	Result values
1.	Standard consistency %	33%
2.	Initial setting time	45 min
3.	Final setting time	300 min
4.	Specific gravity	3.15
5.	Fineness	2%

Fine Aggregate: This study proposal made use of fine aggregate from a sand river that was clean of any natural pollutants. The sand was mostly dry, with no additional material and a specific gravity of 2.6. The sand was transferred into a sieve with a mesh size of 4.75 mm.

According to the IS criteria, the fine aggregate grading region was zone II. However, the physical, chemical, and thermal properties of aggregates are also being used to further explain the characteristics and performance of concrete.

Table 3: Properties of fine aggregate

Properties	Value
S.G.	2.6
F.M.	3.75
W.A.	0.6%

Coarse Aggregate: Ground compounds are used for concrete production. They may be stone or gravel that is naturally present, eroded irregularly. Gross compounds are classified as gross materials to be held at a size of 4.75 mm. Up to 20 mm may be completed.

Table 4: Properties of coarse aggregate

Properties	Values
S.G.	2.94
Size of Aggregates	20mm
F.M.	7.07
W.A.	0.22%

Ceramic Tiles Powder: Waste developed in the stone-processing industries during forming, cutting and cleaning ceramic tiles. This process transforms approximately 15-20% of ceramic waste technology into the powder kind.

Ceramic waste is from the ceramic sector, which considers that ceramic dust is a non-hazardous solid waste preserving pozzolanic roles as the sheets, sanitary facilities, bricks and roofing tiles are removed. Ceramic wastes are robust and robust. Ceramic waste can be used as a substitute for cement or a substitute for fine aggregates.

Table 5: Properties of Ceramic waste

S. No.	Properties	Result
1.	Specific gravity	4
2.	Colour	brown
3.	Form	Powder
4.	Odour	Odourless

3.1. Methodology

In particular, the researchers needed to investigate the compressive strength, bending strength, and tensile splitting strength of concrete made with fine aggregates and waste ceramic tile, as well as the properties of a concrete cube built from various components and to replace waste ceramic tile powder with various percentages of cement and fine aggregates, respectively. Working parameters have been put to the test in a brand-new condition, like the cone-test. Strength parameters such pressure tolerance, split tensile strength, and bending strength were examined in a hardened condition. The research used a mixed configuration of concrete classes from IS 10262:2009 and M30. In this investigation, a concrete beam measuring 500x100x100mm was produced with six numerals. The 50 cubes used in the compression test had sizes ranging from 150 x 150 x 150 mm. The whole research for the project is based on experimental work. The whole technique, or, in other words, the phase-by-stage experimental form, is described in this portion of the dissertation by a single statement. The following guidelines are followed during the testing:

Table 6: Details of Concrete Mix Proportions

Percentage ceramic tiles powder	Weight of Cement (kg/m^3)	Weight of Ceramic tiles powder (kg/m^3)	Weight of Water (kg/m^3)	Weight of C.A. (kg/m^3)	Weight of F.A. (kg/m^3)
0%	360	0	180	1277	693
5%	342	18	180	1277	693
10%	324	36	180	1277	693
15%	306	54	180	1277	693
20%	288	72	180	1277	693

Testing of Specimens

On freshly mixed concrete, the characteristics of measuring the slump values have been examined. It was accomplished in accordance with the ASTM C-231 American Society's testing and material criteria. At ages 3, 7, and 28 days, concrete cubes in the hardened state were tested for a maximum compressive strength of 2.000 Kn, and at ages 28 years, concrete beams were used to assess bend strength.

Various concrete qualities tested in this experimental investigation are specified-

Examples are created using the mix. The size and quantity of research specimens are shown in Table 4. The flexural beams are made using a mild steel mold and have a cross-sectional size of 150x150 mm and a length of 700 mm. Mild steel rods with a diameter of 10 mm are utilized as the top and bottom supports. In the 100 mm gap (cc) and the bend in the 200 mm distance, 8mm bar diameter stirring is employed.

Table 7: Size of the specimen

Name of the specimen	Name of the test	Size of the specimen (In mm)	Number of specimens
Concrete cubes	Compression strength	150 x 150 x 150	50
Flexural beams	Flexural strength	150 x 150 x 700	6

IV. RESULTS AND DISCUSSION

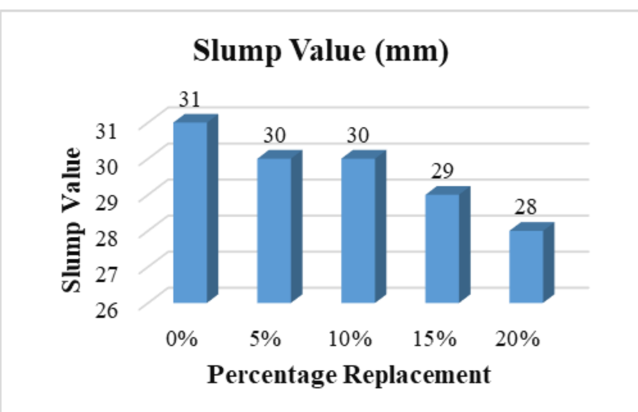
In this research, several tests are performed on concrete-cast cubes to determine their intensity and other characteristics. The investigation's main objective is to increase the concrete's shown strength after many research days of curing. In certain circumstances, properly casting and curing concrete cubes may improve the concrete's strength. For this experimental inquiry, separate tests are carried out on three samples for each mix ratio and at the required curing days. The research then considers the average values. Below is a detailed list of the tests' findings:

Slump Cone Test

This test is done to make that newly cast concrete is secure for usage once it has been installed. Before being replaced with Ceramic Tiles Powder, this test was conducted independently on newly poured concrete to make sure it worked well. The droop is a reliable indication of the nature of a new concrete mix and is especially effective for identifying consistency differences in a mix that seem to be of varied degrees. The solid is put through this test as soon as feasible after being formed. Each mix percent is subjected to a total of three tests, with the outcomes decided at the appropriate repair time for this task. After then, the requests are based on the previously determined composite qualities. A little further down the page, you may discover additional details about the test demonstrations:

Table 8: Slump value

% Replacement	Slump Value (mm)
0%	31
5%	30
10%	30
15%	29
20%	28



Compressive Strength Test

When applied, ceramic tile powder's compressive quality first increases, but when it is applied further, the compressive quality rapidly decreases. The effects of various rates of compressive force are presented in Table 4.2. Three samples of each blend were examined, and their normal power was compared to the apparent M30 combination, according to the conclusions of this inquiry. The findings of the compressive force testing at ages 7, 14, and 28 are shown in Table 4.2.

Table 9: Compressive Strength of Cubes

% Replacement	Compressive Strength (N/mm²)		
	7 Days	14 Days	28 Days
0%	18.44	24.11	34.45
5%	20.22	25.10	34.22
10%	20.26	25.48	36.61
15%	21.45	27.14	37.43
20%	19.52	26.22	35.41

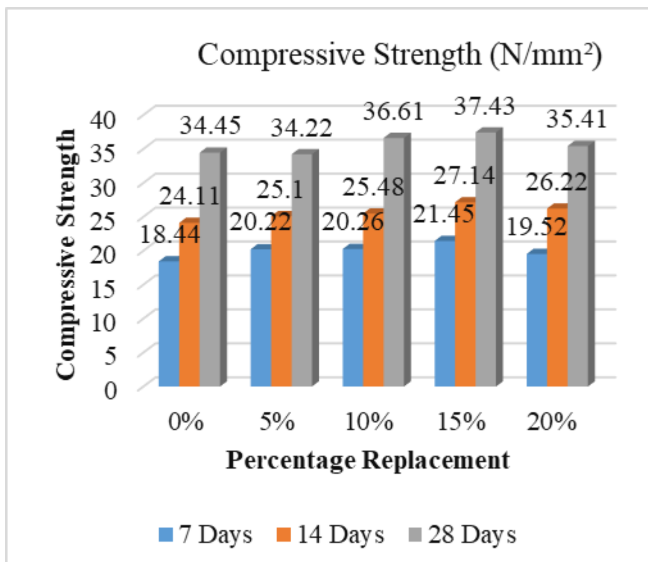


Figure 2: Compressive Strength of Concrete M30

Determination of weight loss of treated and normal cube

Table 10: Weight loss percentage of cube

Initial weight of concrete in Kg	Weight after 14 days in Kg	Weight after 28 days in Kg	% Of weight loss in cube measured	
			14 days	28 days
8.1	8	7.95	1.23	1.87
8.1	7.89	7.9	1.483	2.46

Waste Management

Ceramic tiles are used in a variety of situations. Powder or dust is used in lieu of mortar while producing concrete. It is a waste product produced in the building sector as a result of the polishing or tiling of several types of ceramic tiles. A pricey approach with the potential to harm the environment must be utilized to safely treat this garbage. Only sand or sand from ceramic tile constructions may be utilized in the building industry. It decreases the price of the finished product as a filler component in concrete by lowering noise emissions, space constraints, and cost. M30 grade concrete was packed for this inquiry, and trials were done using waste ceramic tile powder in place of cement at percentages of 0%, 5%, 10%, 15%, and 20% in cement-ready concrete.

V. CONCLUSIONS

The most significant results will be summarized in this section's last paragraph, along with suggestions for further study. In this study, we were able to identify the factors that influence whether leftover ceramic tile powder is substituted for cement while making concrete.

- Ceramic Tiles Powder is a kind of waste that may sometimes be used in lieu of cement in concrete.
- It is anticipated that the low-cost waste employed in this study, ceramic tile powder particles, will help with both the disposal of solid waste and the pollution control of the environment.
- Ceramic Tiles Powder reduces building expenses when it is employed as a cement-bonding agent.
- Utilizing tile powder has shown to be the most efficient solution for the growth of the sustainable construction sector since it also addresses the high value utilisation of such waste.
- Adding Ceramic Tile Powder to concrete increases its self-weight while also increasing its density.
- When cement is partially (up to 15%) substituted with ceramic tile powder, concrete's compressive strength may be equivalent to that of normal concrete.

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