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PARTIAL REPLACEMENT OF CEMENT WITH TILE POWDER IN M40 GRADE CONCRETE

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ABSTRACT

Ceramic waste deposit causes different types of environmental pollution like air, water and soil pollution. Tile powder is a fine residue after manufacturing of tiles. Chemical composition tests conducted on the ceramic tile proved that it contains 64.56% silica, which is a predominent feature of pozzolans. The use of waste products produced by tile industries has been focused to reduce it for industries and economical reasons. The usage of more cement in concrete becomes uneconomical which is partially replaced with tile powder in cement concrete. For this purpose, the concrete specimens are prepared by partially replacing the cement with tile powder at different percentages like 10%, 20%, 30%, 40% and 50% (by weight). These specimens are tested for compressive strength, split tensile strength and flexural strength after 7, 28 and 56 days of curing. These values are compared with the test values of conventional concrete. The test results proves that the average compressive strength, split-tensile strength and flexural strength of the concrete are achieved up to 30 % replacement of cement with tile powder without affecting the characteristics of M40 grade concrete.

1. INTRODUCTION

1.1 GENERAL

Use of disposal of waste materials as partial replacement of cement in civil engineering applications is beneficial because it reduces the environmental impact and economic cost of quarrying operations, processing and transport. Reuse of waste materials is extremely desirable due to rising of lead (like transport) costs and tipping fees for placing this material into landfills. In recent years, sustainable construction initiatives have also made reuse of waste materials from industries as an appealing option in construction.

1.2 INTRODUCTION TO CEMENT CONCRETE

In the most general sense of the word, cement is a binding material, a substance which solidifies and hardens independently, and can bind other materials together. Cements used in construction are characterised as hydraulic and non hydraulic. The predominant feature of the cement is the production of binding mortar and concrete. Cement binds all the aggregates to form a hard building material which is durable infront of normal environmental effects. Concrete is the word which should not be confused with the word cement because the term cement refers only to the dry powder substance used to bind the aggregate materials of concrete.

Concrete is a construction material composed of cement (commonly Portland cement) as well as other cementitious materials such as fly ash, slag cement, ceramic powder and aggregate water and may be admixtures. Cement solidifies and hardens after combines with water due to a chemical process known as hydration. The water reacts with the cement, which bonds the other components together, eventually creating a stone-like material and the reaction is exothermic.

1.3 TILE POWDER

In India, The tile industry has about 15%-30% waste material generated from the production. Waste tile materials may become cheaper but the equivalent alternative to metakaolin or ground granulated blast furnace fly ash and other materials as supplementary binder in concrete. Tile industry often produces calcined clays that results from burning illiterate clays which are commonly used in the production of red-clay products. A portion of these products is leaves as scrap, thus it produces industrial waste. The waste materials of ceramic blocks, roof and floor tiles milled to a suitable fineness can though become active pozzolan. So, they are desirable to be used in mortar and concrete. However, the tile waste is durable, strong and highly resistant to physical, chemical and biological degradation forces. The new technologies in concrete can reduce the burden of pollutants on the environment. The cost of natural resources is increasing day by day. This scenario has forced to focus on recovery, reuse of natural resources and find other alternatives. The use of the replacement materials reduces production cost. They are also used to save energy and natural resources which also helps in the prevention of the environmental hazards. They decrease the emission of carbon dioxide and help in the production of sustainable concrete which is eco-friendly. These replacement materials are mostly industrial wastes and their usage also improves land management for dumping.

2. EXPERIMENTAL INVESTIGATIONS ON MATERIALS

2.1 CEMENT

Ordinary Portland cement of 53grade cement (Brand-ULTRATECH Cement) was used in this study. The cement used was fresh and without lumps. Many tests were conducted on cement, some of them are specific gravity test, consistency tests, setting tests, soundness tests etc., These tests results conducted on the cement are reported below.

Table-1. Properties of cement

S.No.	Particulars of test	Test results
1	Specific gravity	3.15
2	Fineness	8.53
3	Soundness	2.33
4	Standard Consistency	33%
5	Initial setting time	55 min
6	Final setting time	210 min
7	@ 3-Days (MPa)	25.3 N/mm^2
	@ 7-Days (MPa)	36.4 N/mm^2
	@ 28-Days (MPa)	54.33 N/mm^2

2.2 TILE POWDER

Tile waste is produced from tile industry at the end process of polishing and finishing. This waste is collected in the form of pest and after drying and hand crushing it passing through 90 microns and replaced by cement. The properties of the tile powder like specific gravity and fineness are as follows.

Table-2. Properties of tile powder

S.No.	Properties of tile	Test results
1	Specific gravity	2.62
2	Fineness	7.5

2.3 FINE AGGREGATE

One of the most important factors for producing workable concrete is a good gradation of fine aggregates. Good grading implies that a sample fraction of aggregates in required proportion such that the sample contains minimum voids. Samples of the well graded aggregate containing minimum voids require minimum paste to fill up the voids in the aggregates. The properties of fine aggregate taken are as follows.

Table-3. Properties of fine aggregate

S.No.	Particulars of Test	Fine aggregate
1	Specific gravity	2.64
2	Water absorption	0.4%
3	Bulk density (Dry Rodded)	1718 kg/m^3
4	Aggregate crushing value	-
5	Aggregate impact value	-
6	Fineness	3.69 Zone-II

2.4 COARSE AGGREGATE

These coarse aggregates having the maximum size of 10mm and 20mm were used in the present work. At the first, the 10mm aggregates used were sieved through 10mm sieve and then through 4.75mm sieve and 20mm aggregates were sieved through 20mm sieve. They were then cleaned with water to remove dust and dirt and were dried to surface dry condition. The properties of coarse aggregate like Specific gravity, water absorption, bulk density, aggregate crushing value, aggregate impact vaue and fineness are as follows.

Table-4. Properties of coarse aggregate

S.No.	Particulars of Test	10mm Coarse aggregate	20mm Coarse aggregate
1	Specific gravity	2.76	2.67
2	Water absorption	0.4%	3.72%
3	Bulk density (Dry Rodded)	1561 kg/m^3	1605 kg/m^3
4	Aggregate crushing value	26.13%	-
5	Aggregate impact value	17.4%	-
6	Fineness	6.073	7.357

2.5 WATER

Water is the key ingredient, which when mixed with cement, forms a paste that binds the aggregate together. The water causes the hardening of concrete through a process called hydration. Hydration is a chemical reaction in which the major compounds in cement form chemical bonds with water molecules and become hydrates or hydration products.

2.6 SUPER PLASTICIZER

Conplast SP430 is a chloride free, superplasticising admixture based on selected sulphonated napthalene polymers. It appears as brown liquid which reduces the water content in design mix. The amount of admixture used is 3.7 kg/m^3.
Specific gravity: 1.22
Appearance: Brown liquid

3. METHODOLOGY

A mix design for M40 grade concrete was done according to the IS 10262:2009. The design samples like cubes, cylinders and beams are prepared by replacing the cement with tile powder at different percentages like 10%, 20%, 30%, 40% and 50%, and tested after 7, 28 and 56 days. The test values obtained in compression strength test, split tensile strength test and flexural strength test are compared with test values for conventional concrete. The design mix proportions for M40 grade concrete are obtained as shown in below tables.

Table-5. Design mix proportions (M40 grade)

	Water	Cement	F.A	C.A
Volume (m^3)	0.4	1	1.961	3.64
Weight (kg/m^3)	145.0	362.7	711.3	1321.3

Table-6. Mix proportions for concrete with tile powder (M40 grade)

Concrete	Mix proportions				
	C	F.A	C.A	Tile powder	W
C0	1	1.961	3.64	-	0.4
C10	0.9	1.961	3.64	0.1	0.4
C20	0.8	1.961	3.64	0.2	0.4
C30	0.7	1.961	3.64	0.3	0.4
C40	0.6	1.961	3.64	0.4	0.4
C50	0.5	1.961	3.64	0.5	0.4

4. RESULTS AND DISCUSSIONS

The test values for different concrete with M40 grade are as follows.

4.1 COMPRESSIVE STRENGTH

Table-7. Compressive strength of cubes for M40 mix

Concrete type	Compressive Strength (N/mm²)		
	7 days	28 days	56 days
C0	43.62	47.1	48.52
C10	42.42	49.58	55.1
C20	38.7	47.09	52.39
C30	33.08	42.47	48.92
C40	26.26	36.51	37.89
C50	22.52	30.07	31.7

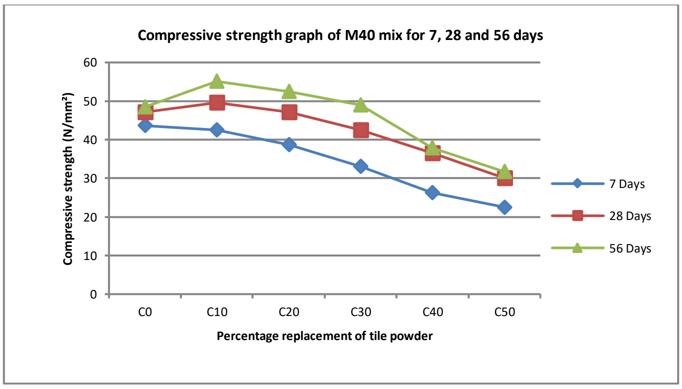

Fig.1 Compressive strength graph for M40 mix

4.2 SPLIT TENSILE STRENGTH

Table-8. Split tensile strength of cylinders for M40 mix

Concrete type	Split tensile Strength (N/mm²)		
	7 days	28 days	56 days
C0	5	5.33	5.8
C10	4.93	5.98	6.18
C20	4.71	5.93	6.07
C30	4.36	5.48	5.84
C40	3.88	4.9	5.19
C50	3.58	4.44	4.64

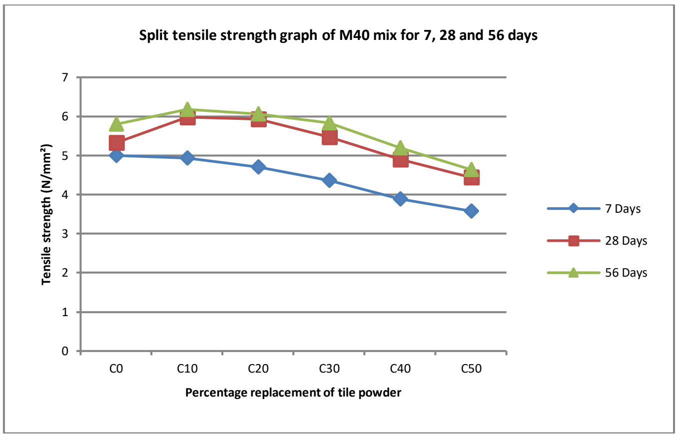

Fig.2 Split tensile strength graph for M40 mix

4.3 FLEXURAL STRENGTH

Table-9. Flexural strength of beams for M40 mix

Concrete type	Flexural Strength (N/mm²)		
	7 dayps	28 days	56 days
C0	4.16	4.4	4.82
C10	3.88	4.64	5.03
C20	3.76	4.5	4.89
C30	3.72	4.43	4.86
C40	3.5	4.13	4.53
C50	3.33	3.84	4.31

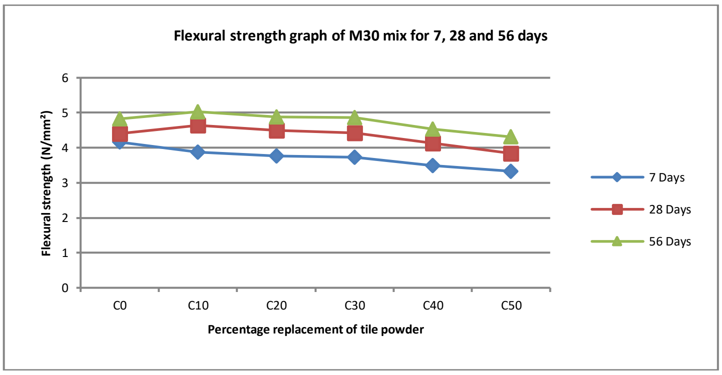

Fig.3 Flexural strength graph for M40 mix

5. CONCLUSIONS

i. By conducting different strength test of M40 grade concrete in which the cement is replaced with tile powder, the strengths are more than required up to 30%. Beyond 30%, the strengths are gradually decreasing when compared to the conventional concrete.

ii. On replacing the cement in concrete with 10% of tile powder, the maximum compressive strength of 49.58 N/mm^2, maximum split-tensile strength of 5.98 N/mm^2 and maximum flexural strength of 4.64 N/mm^2 for 28 days.

iii. It is the possible alternative solution of safe disposal of tile powder. By adopting such methods, we can overcome problems such as waste disposal crisis.

iv. For 20% cement replacement with tile powder represents economical saving in the cost of Portland cement in concrete. The cost of cement represents almost 45% of the concrete cost. Therefore, the total amount of concrete to be made will be much reduced. Hence, the use of tile powder as partial replacement for cement in concrete is economical.

REFERENCES

I. Amitkumar D. Raval, Dr. Indrajit N. Patel, Prof. Jayeshkumarpitroda, "Ceramic Waste Effective Replacement of Cement for Establishing Sustainable Concrete". International Journal Of Engineering Trends and Technology, Vol.4, Issue 6, June-2013, PP.2324-2329.

II. Dr. B. Krishna Rao, Manthena Sri lakshmi, "Use of Tile Dust as Partial Replacement for Cement in Concrete". International Journal of Engineering Research and Technology (IJERT), ISSN: 2278-0181, Vol. 2, Issue 12, December 2013.

III. Hafiz Waheed-ulHasan, SabahatAlamgir, Humera Ahmed and SajjadMubin, "Experimental Investigation of Tensile and Flexural Strength of Ceramic Waste Concrete". Pakistan Journal of Science, Vol. 66, No. 1, March 2014, PP. 67-73.

IV. Jay Patel, Dr. (Smt.) B. K. Shah, Prof. P. J. Patel, "Ceramic Powder in Concrete By Partial Replacement Of Cement-A Literature Analysis". Journal of International Academic Research For Multidisciplinary Impact Factor 1.393, ISSN: 2320-5083, Vol. 2, Issue 3, April 2014.

V. LaljiPrajapati, I. N. Patel, V. V. Agarwal, "Analysis Of The Strength And Durability Of The Concrete With Partially Replaced By The Ceramic Slurry Waste Powder". IJETAE: International Emerging Technology and Advanced Engineering, Vol. 4, Issue 3,March-2014, PP.725-729.