International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395 -0056
Volume: 02 Issue: 04 | July-2015 www.irjet.net p-ISSN: 2395-0072

TILE POWDER AS PARTIAL REPLACEMENT OF CEMENT IN CONCRETE

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Abstract - Tile powder is one of the most active research areas that encompass a number of disciplines including civil engineering and construction materials. The tile industry inevitably produces wastes, irrespective of the improvements introduced in manufacturing processes. In the tile industry, about 15%-30% production goes as waste. These wastes creates a problem in present-day society, requiring a suitable form of management in order to achieve sustainable development. In this thesis it illustrates about the behavior of concrete with partial replacement of tile powder in cement accordingly in the range of 0%, 10%, 20%, 30%, 40%, and 50% by weight for M30 grade of concrete. For this purpose the tile concrete samples are tested and compared with the conventional concrete. The following tests are carried out, i.e., compressive strength, tensile strength and flexural strength for 7, 28 and 56 days. The test results shows that the compressive strength, split-tensile strength and flexural strengths are achieved up to 30% replacement of cement with tile powder without affecting the characteristic strength of M30 grade concrete.

Key Words: *Tile Powder, Strength, Concrete.*

1. INTRODUCTION

The advancement of concrete technology can reduce the consumption of natural resources, which can be reused and find other alternatives. In India numbers of waste materials are produced by different manufacturing companies, thermal power plant, municipal solid wastes and other wastes. Solid as well as liquid waste management is one of the biggest problems of the whole world. Disposal of waste in to the land causes serious impact on environment. Now a day's large amount of tile powder is generated in tile industries with an impact on environment and humans. By using the replacement materials offers cost reduction, energy savings and few hazards in the environment. In India ceramic production is 100 million ton per year. The tile industry has about 15%-30% waste material generated from the total production. The tile waste which is dumped in land filling and pit or vacant spaces causes the environmental pollution which is dangerous for human health. This waste is not recycled in any form at present. However, the tile waste is durable, hard and highly resistant to biological, chemical, and physical degradation forces. The tile waste which is dumped in land filling and pit or vacant spaces causes the environmental and dust pollution which is dangerous for human health. As the ceramic waste is piling up every day, there is a pressure on tile industries to find a solution for its disposal.

2. EXPERIMENTAL MATERIALS

2.1 Cement (OPC)

Ordinary Portland cement of 53 grade cement (Brand-MAHAGOLD cement) confirming to IS 8112:1989 was used in this study. The specific gravity of cement is 3.15. The initial and final setting time were found to be 55 minutes and 210 minutes respectively.

2.2 Tile powder

The tile dust is obtained from RAK ceramics. The specific gravity of tile dust is found to be 2.62 and the fineness is found to be 7.5%.

2.3 Fine aggregate

The locally available river sand conforming to zone-II of IS 383-1970 has been used as fine aggregate. The specific gravity of sand is 2.64 and fineness modulus is 3.69. The bulk density (dry Rodded) value obtained is 1718 Kg/m3 and water absorption is 0.4%.

2.4 Coarse aggregate

The locally available crushed granite stone is used as coarse aggregate. The coarse aggregate with a maximum size 20mm having a specific gravity 2.67 and fineness modulus of 7.357 is used. The bulk density value obtained is 1605 Kg/m3 respectively, and water absorption is 3.72%. The coarse aggregate with a size of 10mm having specific gravity 2.76 and fineness modulus of 6.073 is used. The bulk density and water absorption values obtained are 1561 kg/m^3 and 0.4%.

2.5 Water

Water is an important ingredient of concrete as it actually participates in the chemical reaction with cement. Since it helps to from the strength giving cement gel, the quantity

and quality of water are required to be looked into very carefully.

2.6 Super plasticizer

Conplast SP430 is used as the admixture. It is high performance super plasticizing admixture which has the appearance of Brown liquid having the specific gravity of 1.18 in which alkali content is typically less than 55g.

3. DESIGN MIX

A mix for M30 grade was designed as per IS 10262: 2009 and the same was used to prepare the test samples. The variation of strength of hardened concrete using tile dust as partial replacement of cement is studied by casting 3 cubes, 3 cylinders and 3 beams for each and every replacement. The specimens were tested for compression, split tensile and flexural strengths after curing period of 7days, 28 days and 56 days. As per the mix design, the quantities required for casting 9 cubes, 9 cylinders, 9 beams for each percentage replacement are computed. The design mix proportion is done in table 1 and table 2.

Table - 1: Design mix proportion for M30 mix

	W (l)	C (Kg/m^3)	F.A (Kg/m^3)	C.A (Kg/m^3)	Chemical Admixture
By weight (Kg)	157.5	350	723.04	1286.46	3.7
By Volume (m^3)	0.45	1	2.06	3.67	-

W = Water, C = Cement, F.A = Fine aggregate, C.A = Coarse aggregate

Table - 2 Concrete design mix (M30 mix) proportions

S.No	Concrete type	Concrete Design Mix Proportion				
		W/C ratio	C	F.A	C.A	Tile Powder
1	C0	0.45	1.00	2.06	3.67	-
2	C10	0.45	0.90	2.06	3.67	0.10
3	C20	0.45	0.80	2.06	3.67	0.20
4	C30	0.45	0.70	2.06	3.67	0.30
5	C40	0.45	0.60	2.06	3.67	0.40
6	C50	0.45	0.50	2.06	3.67	0.50

4. EXPERIMENTAL METHODOLOGY

The evaluation of tile powder which is used as a replacement of cement material begins with the concrete testing. With the conventional concrete, i.e. 10%, 20%, 30%, 40% and 50% of the tile powder replaced with cement. The results of tile powder concrete are compared with the results of conventional concrete. 3 cubes, 3 cylinders and 3 beams were casted for each and every replacement. After 24 hours the specimens were demoulded and curing was continued till the specimens were tested after 7, 28 and 56 days for compression, split-tensile and flexural strengths.

5. RESULTS AND DISCUSSIONS

Compressive strength test, split tensile strength test and flexural strength test were conducted at the end of 7, 28, 56 days on the concrete specimens. The results shows that the compressive strength, split-tensile strength and flexural strength of M30 grade concrete gradually decreases for 7 days testing. For 28 and 56 days the strength of concrete increases up to 30%. Beyond 30% the strengths are gradually decreases when compared to the conventional concrete. The test results and the corresponding graphs are as follows:

Table - 3 Compressive Strength of Cubes for M30 mix

Concrete type	Average Compressive Strength (N/mm^2)		
	7 days	28 days	56 days
C0	32.7	37.62	48.74
C10	31.8	48	55.35
C20	29.03	46.8	50.63
C30	24.88	39.85	44.14
C40	19.7	30.22	38.07
C50	16.88	29.03	31.85

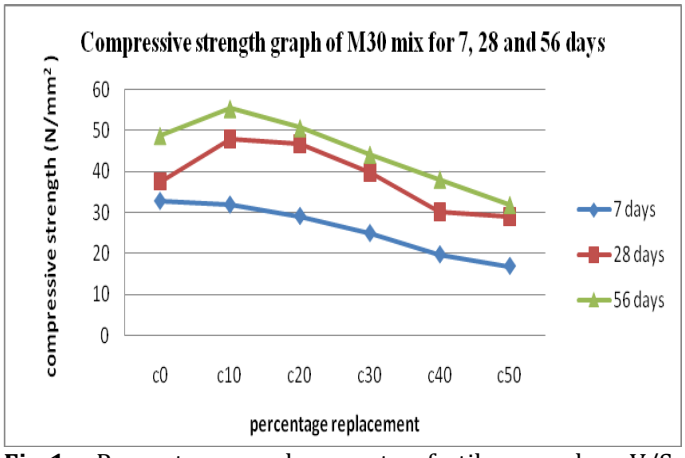

Fig-1: Percentage replacement of tile powder V/S Compressive strength (N/mm^2) of concrete for M30 mix

Table - 4 Split-Tensile Strength of Cylinders for M30 mix

Concrete type	Average Split-Tensile Strength (N/mm²)		
	7 days	28 days	56 days
C0	4.0	4.29	4.88
C10	3.94	4.82	5.2
C20	3.77	4.78	4.91
C30	3.49	4.41	4.63
C40	3.1	3.84	4.47
C50	2.87	3.77	3.9

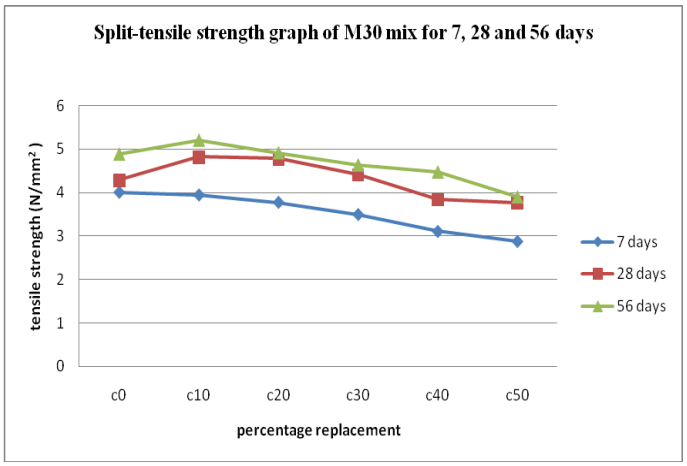

Fig-2: Percentage replacement of tile powder V/S Split-Tensile strength (N/mm²) of concrete for M30 mix

Table - 5 Flexural Strength of Beams for M30 mix

Concrete type	Average Flexural Strength (N/mm²)		
	7 days	28 days	56 days
C0	4.23	4.72	5.23
C10	3.95	4.88	5.46
C20	3.83	4.71	5.18
C30	3.79	4.56	5.06
C40	3.56	4.43	4.92
C50	3.39	4.12	4.88

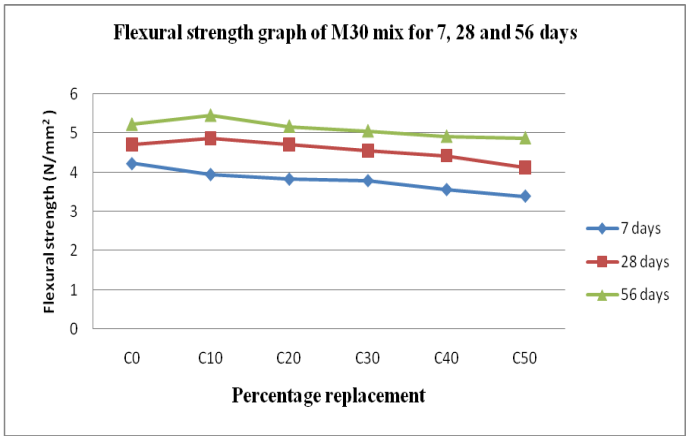

Fig-2: Percentage replacement of tile powder V/S Flexural strength (N/mm²) of concrete for M30 mix

6. CONCLUSIONS

Based on the experimental study the following are the observations made:

1. The compression, split tensile and flexural strength of M30 grade concrete increases when the cement is replaced with tile powder up to 30% and further replacement of cement with tile powder decreases the strength gradually.
2. Tile powder concrete has increased durability performance.
3. It is the possible alternative solution of safe disposal of tile waste. By adopting such methods we can overcome problems such as waste disposal crisis.
4. Utilization of tile powder and its application for the sustainable development of the construction industry is the most efficient solution and also address the high value application of such waste.
5. By using the replacement materials offers cost reduction and can overcome few environmental hazards.

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