Use of Tile Dust as Partial Replacemnt for Cement in Concrete

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Abstract

Owing to globalization, privatization and liberalization, the construction of important infrastructure projects are increasing in developing countries like India. Such development activities require large quantities of natural resources. This leads to faster depletion of natural resources on one side and manifold increase in cost of construction of structures on the other side, which is a major problem in construction sector today. In view of this people have started searching for suitable alternate materials which can be used either as an additive or as a partial replacement to conventional ingredients of concrete. Use of tile dust as partial replacement for cement in concrete is one such economical method. In the laboratory tests were conducted by partially replacing cement in concrete by tile dust as 0%, 10%, 20%, 30%, 40% & 50%. The development of compressive strength, split tensile strength and flexural strength of concrete at the age of 7, 28, 56 days are investigated. These strengths are compared with conventional concrete of the same mix proportions.

Key words: *Tile dust, super plasticizer, ceramic waste, strength, concrete.*

I. Introduction

Concrete is one of the most widely used construction materials in the world. The production of Portland cement as the essential constituent of concrete requires a considerable energy level and also releases a significant amount of chemical carbon dioxide emissions and other greenhouse gases (GHGs) into the Atmosphere. Thus, seeking an eco-efficient and sustainable concrete may be one of the main roles that construction industry should play in sustainable construction. To make the concrete more eco-efficient, different life cycle phases of concrete products can be brought to bear such as extraction of raw material, production of constituents, production of concrete, transportation, erection, maintenance, demolition and recycling.

Portland cement can be partially replaced by cementitious and pozzolanic materials especially those of industry by-products such as fly ash, GGBS, silica fume, ceramic waste powder and metamorphic rock dust form stone cutting industry. The aggregates are also conserved by replacing them with recycled or waste materials among which recycled concrete, ceramic waste, post consumer glass, and recycled tires are the most used.

Waste ceramic materials may become a cheaper but almost equivalent alternative to metakaolin or ground granulated blast furnace slag, fly ash and other materials as supplementary binder in concrete. The ceramic industry often produces calcined clays that result from burning illite-group clays which are commonly used in the production of red-clay ceramic products. A portion of these products is discarded as scrap, thus constitutes industrial waste. The residues of ceramic bricks, floor and roof tiles ground to a suitable fineness can though become active pozzolans. So, they have a potential to be used in mortar and concrete.

II. Materials

A. Cement:

The cement used in all mixtures was commercially available Portland cement of 53 grade manufactured by Zuvari Portland cement company confirming to IS 8112:1989 was used in this study. The specific gravity of cement is 3.03. The initial and final setting time were found to be 77 minutes and 211 minutes respectively.

B. Fine aggregate:

Locally available river sand passed through 4.75mm IS sieve is used as fine aggregate. The specific gravity of sand is 2.637 and fineness modulus is 3.64. The loose and compacted bulk density values obtained are 1496.29 Kg/m^3 and 1614.81 Kg/m^3 and water absorption is 1.10%.

C. Coarse aggregate:

The Coarse aggregate is obtained from a local quarry. The coarse aggregate with a maximum size 20mm having a specific gravity 2.828 and fineness modulus of 5.77 is used. The loose and compacted bulk density values obtained are 1377.78 Kg/m^3 and 1496.29 Kg/m^3 respectively, water absorption is 1.10%.

D. Tile dust:

The tile dust is obtained from RAK ceramics. The specific gravity of tile dust is found to be 2.5 and the fineness is found to be 7.5%.

E. Super plasticizer:

Conplast SP430 is used as the admixture. It is high performance super plasticizing admixture.

It has the following properties:

Appearance	:	Brown liquid
Specific gravity	:	1.18
Water soluble chloride	:	Nil
Alkali content	:	Typically less

than 55g

III. Experimental Program

The mix design is produced for maximum size of aggregate is 20mm conventional aggregate. The variation of strength of hardened concrete using tile dust as partial replacement for cement is studied by casting cubes, cylinders and beams until 50%. The concrete was prepared in the laboratory using mixer. The cement, fine aggregate and coarse aggregate and tile dust are mixed in dry state and then the desired quantity of water and admixture is added and the whole concrete is mixed for five minutes, the concrete is poured in the moulds which are screwed tightly. The concrete is poured into the moulds in three layers by tamping with tamping rod for cubes of 150x150x150 mm size and cylinders of 150mm diameter 300mm height and beams of 100x100x500 mm size were tested for compression, split tensile and flexural strengths. The casted specimens are removed after 24 hours and these are immersed in a water tank. After a curing period of 7, 28, 56 days the specimens are removed and these are tested for compression, split and flexural strengths and the results are compared with conventional concrete.

IV. Mix Design

Bureau of Indian Standards has recommended step by step procedure for mix design. Here the mix design procedure given in IS: 10262:2009 is adopted. 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.

V. 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 compressive strength of the tile dust concrete has varied from 29.20-38.27MPa and the split tensile strength is varied from 2.49-3.02MPa and flexural strength is varied from 4.26-4.88MPa for 28 days for different percentage replacements. After the comparison of properties the tile dust can be used as partial replacement for cement in concrete up to 30% replacement. But it is observed that the strength decreased slightly for 30% replacement so, the strength loss is almost negligible and the decrement of strength is more for 40% and 50% replacements. Hence up to 30% replacement of cement in concrete by tile dust is considerable. The test results and the corresponding graphs are as follows:

Table 1: Compressive, Split tensile and Flexural strength results

Mix.Id NCC	Compressive strength (MPa)			Split tensile strength (MPa)			Flexural strength (MPa)		
	7 days	28 days	56 days	7 days	28 days	56 days	7 days	28 days	56 days
M_1	27.19	38.27	41.88	2.33	3.02	3.18	4.11	4.88	5.12
M_2	25.52	37.08	41.36	2.22	2.92	3.16	3.99	4.81	5.07
M_3	23.97	36.88	40.81	2.12	2.91	3.13	3.86	4.79	5.04
M_4	22.43	33.43	36.74	2.01	2.73	2.92	3.74	4.56	4.78
M_5	20.95	31.88	32.52	1.93	2.65	2.67	3.61	4.45	4.50
M_6	18.88	29.20	29.93	1.78	2.49	2.51	3.44	4.26	4.32

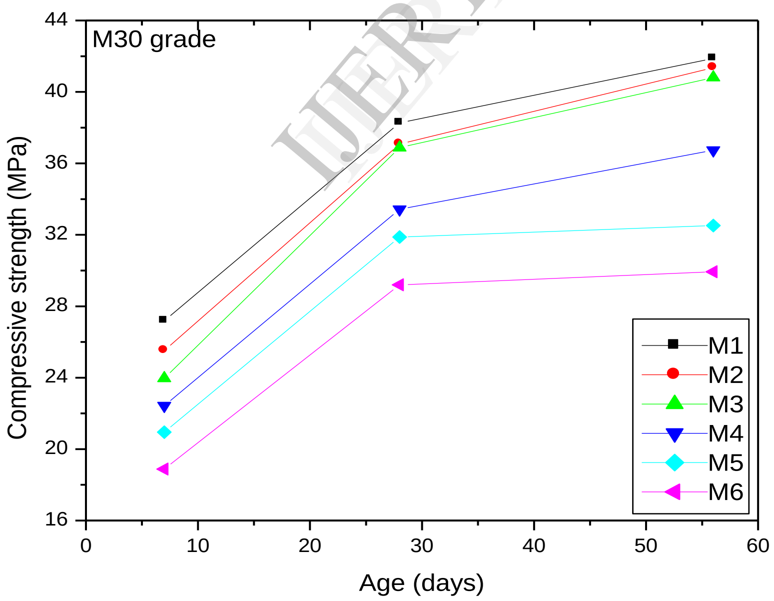

Fig.1: Variation of compressive strength

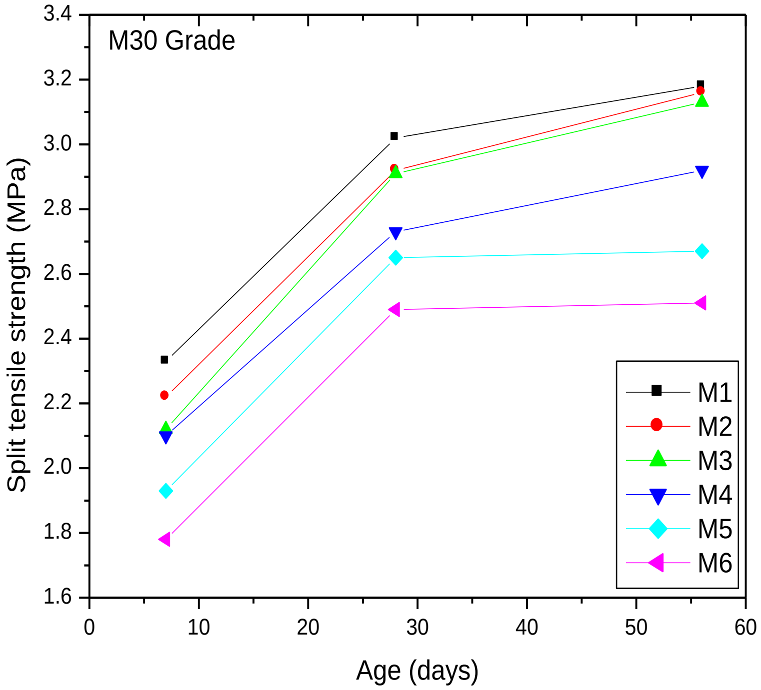

Fig.2:Variation of split tensile strength

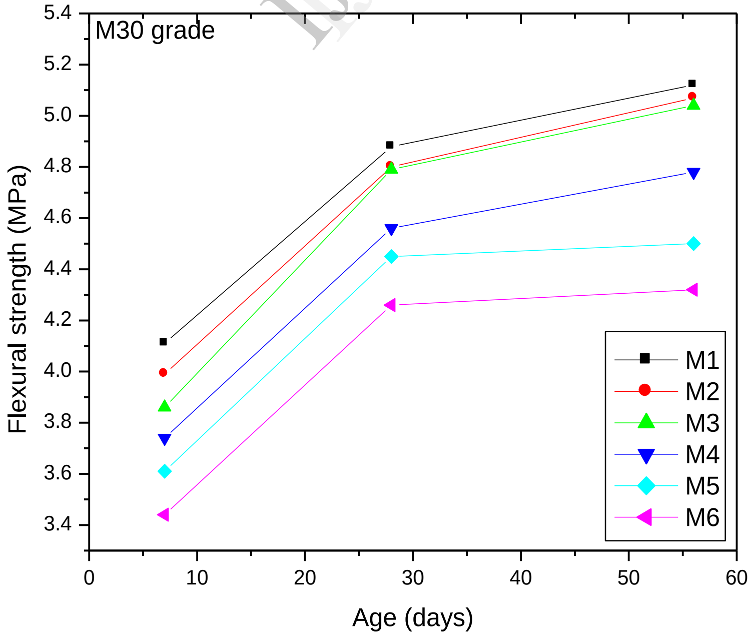

Fig.3: Variation of flexural strength

VI. Conclusions:

The following are the conclusions obtained on performing the experiments

- Using ceramic wastes in concrete can solve several environmental problems.
- Concrete with tile dust as partial replacement for cement has minor strength loss which can be negligible.
- Tile dust concrete has increased durability performance.
- There is not much remarkable decrease in strength of concrete up to 30% replacement. Further replacement of cement with tile dust decreases the compressive strength. Up to 30% replacement of cement with tile dust in concrete is technically and economically feasible and viable.
- It is the possible alternative solution of safe disposal of Ceramic waste. By adopting such methods we can overcome problems such as waste disposal crisis.
- For 20% cement replacement with tile dust indicates saving of around 17% in the cost of Portland cement in concrete. The cost of cement represents almost 45% of the concrete cost. Therefore, overall cost of the concrete will be reduced by more than 7.5%. Hence, the use of tile dust as partial replacement for cement in concrete is economical.

VII. References:

[1] Fatima, Ankit Jhamb, Rakesh Kumar. Ceramic Dust as Construction Material in Rigid Pavement. American Journal of Civil Engineering and Architecture, 2013, Vol. 1, No. 5, 112-116

[2] Eva Vejmelková, Tereza Kulovaná, Martin Keppert, Peter Konvalinka, Michal Ondráček, Martin Sedlmajer and Robert Černý. Application of Waste Ceramics as Active Pozzolana in Concrete Production. 2012 IACSIT Coimbatore Conferences IPCSIT vol. 28 (2012) © (2012) IACSIT Press, Singapore

[3] A. Shasavandi1, F.Pacheco-Torgal, Said Jalali. Eco-Efficient Concrete Using Industrial Wastes: A Review. 123Research Unit C-TAC, Sustainable Construction Group, University of Minho, Guimarães, Portugal. 2009

[4] Amit kumar D. Raval, Indrajit N. Patel, Jayeshkumar Pitroda. Eco-Efficient Concretes: Use Of Ceramic Powder As A Partial Replacement Of Cement. International Journal of Innovative Technology and Exploring Engineering (IJITEE) ISSN: 2278-3075, Volume-3, Issue-2, July 2013

[5] Suresh Chandra Pattanaik. A study of present status of waste materials in the state of Orissa for utilization in making of green building. Paper published in proceedings of "All India Seminar on Eco friendly Materials and Techniques for Green Building Technology" by Institution of Engineers (India) Berhampur Local Center, at Berhampur, Orissa from 13th-15th September, 2010

[6] Amitkumar D. Raval, Dr.Indrajit N. Patel, Prof. Jayeshkumar Pitroda. Ceramic Waste : Effective Replacement Of Cement For Establishing Sustainable Concrete. International Journal of Engineering Trends and Technology (IJETT) - Volume4 Issue6- June 2013

[7] Chandana Sukesh, Bala Krishna Katakam, P Saha and K. Shyam Chamberlin. A Study of Sustainable Industrial Waste Materials as Partial Replacement of Cement. 2012 IACSIT Coimbatore Conferences IPCSIT vol. 28 (2012) © (2012) IACSIT Press, Singapore

[8] F.Pacheco Torgal, A. Shahsavandi and S. Jalali. Mechanical properties and durability of concrete with partial replacement of Portland cement by ceramic wastes. WASTES: Solutions, Treatments and Opportunities, 1St International Conference, September 12th – 14th ,2011

[9] Md. Safiuddin, Mohd Zamin Jumaat, M. A. Salam, M. S. Islam and R.Hashim. Utilization of solid wastes in construction materials. International Journal of the Physical Sciences Vol. 5(13), pp. 1952-1963, 18 October, 2010

[10] R. Kamala, B. Krishna Rao. Reuse of Solid Waste from Building Demolition for the Replacement of Natural Aggregates. International Journal of Engineering and Advanced Technology (IJEAT) ISSN: 2249 – 8958, Volume-2, Issue-1, October 2012

[11] IS 383-1970, Specifications for coarse and fine aggregate from natural sources for concrete.

[12] IS 10262: 2009 recommended guidelines for concrete mix design, BIS. New Delhi, India, 2009.

[13] IS 8112: 1989, Specifications for 53grade Portland Cement, BIS, New Delhi.