



iJRASET

International Journal For Research in
Applied Science and Engineering Technology



INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 5 Issue: X Month of publication: October 2017

DOI: <http://doi.org/10.22214/ijraset.2017.10266>

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Experimental Study on Replacement of Cement with Ceramic Tile Powder in Concrete

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Abstract: Concrete is the widely used material in construction around the world and cement, a major constituent of concrete is being costly and only moderately available, researches or experiments are conducted to study the variations in the strength characteristics of concrete by replacement of cement partially or fully by cheaper or locally available materials. Ceramic waste powder is settled by alleviation and then dumped away which results in environmental pollution, in addition to forming dust in summer and menacing both agriculture and public health. Therefore, utilization of the ceramic waste powder in various industrial sectors especially the construction, agriculture, glass and paper industries would help to protect the environment. In this research study the cement has been replaced by ceramic waste powder accordingly in the range of 10% 15%, 20% by weight of M30 grade. Concrete mixtures were produced, tested and compared in terms of compressive strength, split tensile strength and flexural strength to the conventional concrete. These tests were carried out to evaluate the mechanical properties for 7, 14 and 28 days. This research work is concerned with the experimental investigation on strength of concrete and optimum percentage of the partial replacement by replacing cement via 10%, 15%, 20%, of ceramic waste. Keeping all this view, the aim of the analysis is to study the performance of concrete while replacing the ceramic waste with different proportions in concrete.

Keywords: Ceramic waste powder, Compressive strength, Mechanical properties, Conventional concrete.

I. 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. Concrete is nothing but a combination of aggregates both fine and coarse, Cement and water. Comparing to all other ingredients in concrete, cement is considered to be the expensive material. This is because cement is manufactured using energy-intensive process. Cement is one of the major producers of carbon dioxide, which is the main cause of global warming. During the manufacturing process of cement the formation of clinker can be achieved only by heating the cement at very high temperature. This leads to the release of enormous amounts of carbon in the atmosphere. This was one among the major problems identified for climatic changes. Various research works has been carried out for the cost reduction in construction with some of the locally available materials as partial or full replacement material for cement. Over the last few decades supplementary materials like fly ash, rice husk, silica fume, egg shell, groundnut shell, etc. are used as a replacing material. These supplementary materials have proven to be successful in meeting the needs of the concrete in construction. In India ceramic production is 100 million ton per year. The tile industry has about 15% to 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, 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. Concrete is considerably the world's largely adaptable and well-liked material produced each year in the construction.

II. MATERIALS

A. Cement

In this work the Ordinary Portland Cement 53 grade was used. Cement is affine, grey powder. It is mixed with water and materials such as sand, pozzolanas to make mortar and concrete. The cement and water forms a paste that binds the other materials together.

B. Coarse aggregate

Locally available crushed stones confirming to graded aggregate of nominal size of 20mm as per IS 383-1970 are adopted. The physical properties of coarse aggregate like specific gravity, gradation and fineness modulus are tested.

C. Fine aggregate

Locally available river sand confirming to grading zone II of nominal size 1.18 mm as per IS 383-1970.

D. Water

The water, which is used for making concrete and for curing, should be clean and free from harmful impurities such as oil, alkali, acid, etc. In general, colorless, odorless portable fresh water was used for mixing the concrete.

E. Ceramic tile powder

The ceramic powder is obtained from the industrial by-products or as the solid waste dumped in any major city. As the ceramic in landfill it takes thousands of years to degrade and cause land pollution. So some of the not recycled ceramic can be converted into ceramic powder and used as cement replacement. The usage of ceramic in the form of powder is better than using it as fine or coarse aggregate. 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%.



Fig.1 Ceramic tile powder

III. EXPERIMENTAL PROGRAM

The aim of the experimental program is to compare the properties of concrete made with and without ceramic powder, used as partial cement replacement. The basic tests carried out on materials used for casting concrete samples are discussed in this chapter, followed by a brief description about mix design and curing procedure adopted.

In this research work the Ordinary Portland Cement 53 grade, coarse aggregate with nominal size of 20mm are adopted. Various tests were conducted to check the properties of the coarse aggregate and some of the tests include the specific gravity, water absorption, fineness modulus, crushing strength tests etc. The natural sand is used as the fine aggregate in this study. Various tests were conducted for fine aggregate also to find out the fineness of sand, specific gravity of sand etc. Colorless, odorless portable fresh water was used for mixing the concrete.

Here ceramic powder is used as partial cement replacement for making the concrete specimens. The test for cement was carried out to find the specific gravity, fineness, water absorption, Setting time and consistency. Initial and final setting time is found with and without the replacement of ceramic tile powder in cement by Vicat apparatus. The percentage replacement for cement by tile powder was done in the proportion of 0, 10, 15 and 20.

After the various tests done on the materials the concrete is prepared through batching. The selected materials are properly weighed and mixed as per the design mix proportion of 1:1.57:2.57 for M30 grade concrete, the water cement ratio used in the work is 0.45, which is obtained from the IS 10262. The concrete was cast in the form of cubes and cylinders with 0%, 10%, 15% and 20% replacement of cement by Ceramic tile powder. To find out the workability of concrete the slump test was carried out in the fresh

concrete mix.

After 24 hours, the specimen is removed from the cube and cylinder mould and cured. The compression and split tensile test was carried out in 7, 14 and 28 days using compression testing machine.

Compressive strength = Load in (N) / Area in (sqm)

Split Tensile strength = $2P / \pi LD$

IV. RESULTS AND FINDINGS

The specific gravity test conducted for cement, coarse aggregates, fine aggregates and tile powder are carried out as per IS2386 using a parameter. Fineness test for fine and coarse aggregate is found out by I.S.SIEVES. The results obtained are mentioned below.

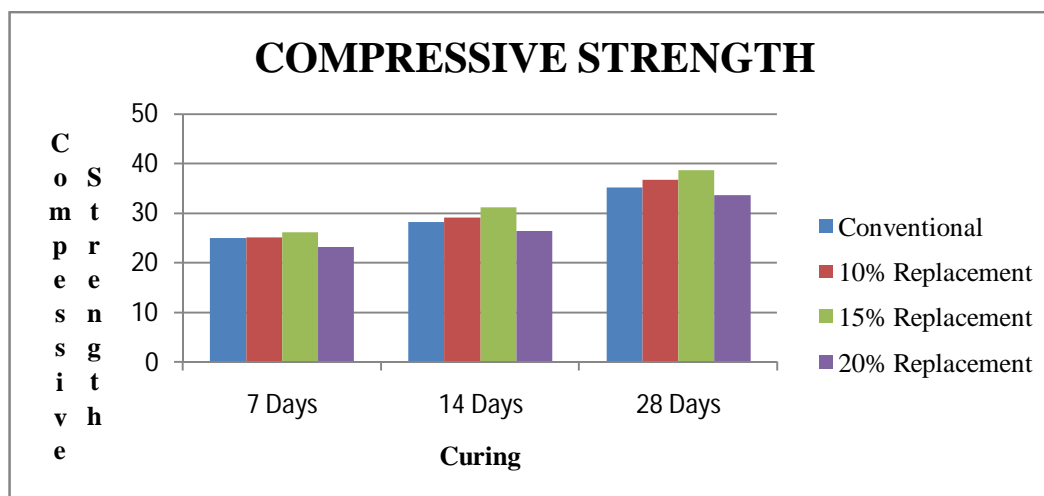
TABLE I
TEST REPORT OF MATERIALS

	Cement	Fine Aggregate	Coarse Aggregate	Ceramic Tile Powder
Specific gravity	3.15	2.52	2.56	2.62
Fineness	4.33%	4.3%	3.18%	3.42%
Water absorption	-	6.2%	8%	8.49%

TABLE II

COMPRESSIVE STRENGTH TEST ON CUBE FOR 7,14 AND 28 DAYS

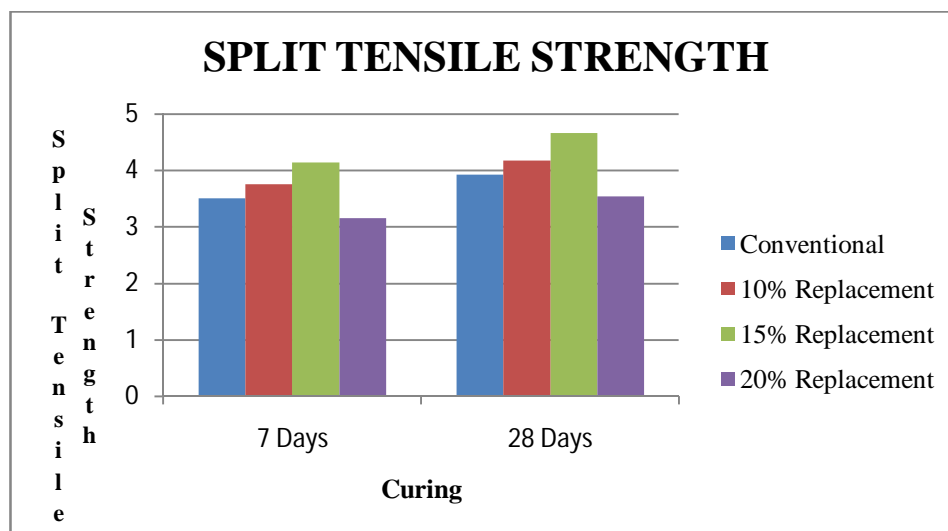
MIX %	COMPRESSIVE STRENGTH		
	7 days (N/mm ²)	14 days (N/mm ²)	28 days (N/mm ²)
0	24.95	28.27	35.22
10	25.12	29.15	36.68
15	26.19	31.21	38.68
20	23.24	26.42	33.58



The above chart represents the strength of the cube in 7 days, 14 days, and 28 days for both conventional concrete and replacement of cement in concrete by different ratios of ceramic tile powder. It is observed that if the curing time increases then the strength of concrete is also increases. From the observation the 15% replacement of the Ceramic Tilepowder gains strength more than the conventional concrete.

TABLE III
SPLIT TENSILESTRENGTH TEST ON CYLINDERS FOR 7,14 AND 28 DAYS

MIX %	SPLIT TENSILE STRENGTH	
	7 days (N/mm ²)	28 days (N/mm ²)
0	3.51	3.92
10	3.76	4.17
15	4.14	4.66
20	3.16	3.54



The above chart shows the variation in split tensile strengths for both conventional concrete and Tile powder replacing concrete cylinders with different proportions. The result shows the ultimate strength occurs in 15% of replacement of cement by Ceramic tile powder.

V. CONCLUSION

This study was carried to obtain the results, test conducted on the tile powder modified cement concrete mix, in order to ascertain the influence of tile powder on the characteristic strength of concrete.

- The most optimal dosage for the partial alternative of cement by ceramic tile powder is 15 %.
- The compressive strength of concrete decreases, when the addition of dosage is more than 15%.The results show if 20% replacement of cement by ceramic tile powder will affect the strength of concrete.
- By doing this project we could gave a contribution to the society by making the environment more eco friendly by utilizing the ceramic waste scientifically.
- Thus by adopting replacement method we can overcome problems such as waste disposal crisis. 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.
- By using the replacement materials offers cost reduction and can overcome few environmental hazards.

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