EXPERIMENTAL INVESTIGATION ON STRENGTH PROPERTIES OF CONCRETE BY PARTIAL REPLACEMENT OF COARSE AGGREGATE BY CERAMIC WASTE IN CONCRETE PAVEMENT

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Abstract: This paper is due to the day to day innovations and development in construction field, the use of natural aggregates is increased tremendously and at the same time, the production of solid wastes from the demolitions of constructions is also quite high. Because of these reasons the reuse of demolished constructional wastes like ceramic tile and granite powder came into the picture to reduce the solid waste and to reduce the scarcity of natural aggregates for making concrete. The ceramic tile waste is not only occurring from the demolition of structures but also from the manufacturing unit. Studies show that about 20-30% of material prepared in the tile manufacturing plants are transforming into waste. This waste material should have to be reused in order to deal with the limited resource of natural aggregate and to reduce the construction wastes.This paper generalizes results of study of use of ceramic waste as coarse aggregates partially replacement of 0%,10%,20%,30%. The attempt has been made to compare the 3 days , 7 days and 28 days, compressive strength and flexural strength of rigid pavement concrete is found 30% of mix got high strength as compared to 0%,10%,20%,

***Index Terms* – coarse aggregates, Ceramic waste.**

I. INTRODUCTION

Natural sources required for various constructions are getting depleted at a rapid rate, due to which there is always a rise in their price. This led the engineers and researchers in finding other substitutes for the production of construction materials keeping in mind of maintaining the quality, strength and durability. One of the most important constituents of concrete being coarse aggregate the fact being that it occupies 70-80% of the volume of concrete; thus making a big impact on the characteristics and properties of concrete. However, with the urbanization and rapid rise in the population especially in a country like India the demands for this particular construction material cannot be met easily.

Generally in design of rigid pavement concrete mix, cement, fine aggregates and coarse aggregates are using from long back, which plays a crucial role in designing of a particular grade of concrete. But now a day there is a scarcity in aggregates. So, some new materials which are locally available for low cost have to introduce for replacing the coarse aggregates. So we have to search for different materials to reduce the quantity of basic natural materials in the rigid pavement concrete mix without changing any mix design procedure and considerations. Use of cheaper material without loss of performance is very crucial to the growth of developing countries. We cannot replace the whole basic material in the concrete, but we can replace with other materials to some extent.

In the present world, huge amount of solid wastes are obtaining from manufacturing units and demolitions of construction from human daily habitats. Some researchers are working on solid waste as partial replacing substances based on the locally available waste materials like crushed plastic, Stone dust, over burnt bricks, M – sand, glass powder, coconut shells, waste tires, slag, fly ash produced from industries, broken glass pieces, rice husk ash, coconut shell ash, etc., to use them in concrete to partially replace the basic materials. And studies have been going on to preserve the natural basic aggregates and to promote use of the

recycled aggregates to the next level in the concrete mix and to reuse the solid waste from construction again as a material in the concrete to decrease the land fill of solid waste and decrease the scarcity of natural aggregates like gravel and sand. Huge usage of ceramic tiles and other ceramic for architectural appearance, the productions of which are drastically increased.

11 **NEED FOR CERAMIC MATERIALS IN CONCRETE**

Indian ceramic production is 100 Million ton per year. In the ceramic industry, about 15%- 30% waste material generated from the total production. This waste is not recycled in any form at present. However, the ceramic waste is durable, hard and highly resistant to biological, chemical, and physical degradation forces. The Ceramic industries are dumping the powder in any nearby pit or vacant spaces, near their unit although notified areas have been marked for dumping. Utilization of Ceramic waste and its application are used for the development of the construction industry, Material sciences. It is the possible alternative solution of safe disposal of Ceramic waste. Use of ceramic materials brings positive effect to the environment. Waste tiles can be used to replace some of the aggregates in a concrete mixture.

1.2 **CERAMIC TILES**

In India the Ceramic Tile Industry approximate worth is Rs.21,000 Crore and was reported, the Indian Ceramic Tiles industry grew by around 11% in 2013-14 and expected to reach a size of Rs.301 billion by 2016. As in a present report of Global Ceramic Tiles Market of February 2016, the global ceramic tiles market will grow at a CAGR (Compound Annual Growth Rate) of 9.59% during the period of 2016-2020. Globally India is ranked 3rd and accounted for over 6% of total global production.The constituent chemical elements present in the ceramic wastes are as given in the table below.

Table 1 –Chemical composition of ceramic waste

MATERIALS	(%) of the Materials Present
SiO2	63.29
Al2O3	18.29
Fe2O3	4.32
CaO	4.46
MgO	0.72
P2O5	0.16
K2O	2.18
Na2O2	0.75
SO3	0.10

2.1 MATERIAL AND METHODOLOGY

2.1.1 Cement:

Cement is one of the ingredients in concrete the physical properties of cement test in laboratory the results are shown in Table: 2

Table 2- physical properties of cement

Physical Properties	**Physical Properties of OPC 53 grade Cement**	**As per IS :(IS:8112-1989)**
Consistency of Cement	28%	30-35
Initial setting time	35 Min	30 Minimum
Final setting time	178 Min	600 Maximum
Specific gravity	3.15	3.10-3.15

2.1.2 Coarse Aggregate:

Crushed stone of nominal size of aggregate are used as coarse aggregate. It's collected near nearby quarry. Physical properties of aggregates are shown in table no: 3

Table 3- physical properties of coarse aggregate

SL.NO	Properties	Observed values
1	Specific gravity	2.84
2	Impact test	9.94%
3	Crushing test	24.87%
4	Flakiness index	13.61%
5	Elongation index	13.83%
6	Water absorption	0.7%

2.1.3: Ceramic Tiles

Broken tiles were collected from an apartment being constructed near vidyanagar opposite to the new dental college Bellary. Tiles were broken down and were sieved according to the gradation as per IS code. Physical properties Ceramic aggregate are shown in table no: 4

Table 4- physical properties of Ceramic aggregate

SL.NO	Properties	Observed values
1	Specific gravity	2.63
2	Impact test	20.49
3	Crushing test	23.32%
4	Flakiness index	12.9%
5	Elongation index	13.76%
6	Water absorption	0.5%

2.2 METHODOLOGY:

2.2.1 Aim of Present Study

Experimental investigation on strength properties of concrete by partial replacement of coarse aggregate by ceramic waste in concrete pavement. The ceramic waste crushed tiles were partially replaced in place of coarse aggregates by 10%, 20% and 30% in the concrete. In order to determine the compressive strength and flexural strength of the ceramic concrete various cubes and beams are casted. Cubes of size 150mm * 150mm *150 mm are casted to determine compressive strength. Beams of size 100mm*100mm*500mm are casted to determine the flexural strength. M20 grade concrete is to be casted of slump 25mm.

2.2.2 OBJECTIVES:

1. To understand properties of ceramic waste in order to use it as partial replacement for the coarse aggregate.

2. To establish the economical and environmental benefits of ceramic waste over conventionally used natural coarse aggregates.

3. To verify the improvement of properties like compressive strength, flexural strength by partial replacement of coarse aggregate by ceramic waste in concrete pavement.

4. To draw conclusion on whether ceramic waste can provide an appropriate alternative for the conventionally used natural coarse aggregates.

MIX PROPORTIONS

Table 5- Mix Deign Proportions

Ingredients	Weight per cubic meter	Ratio
Cement	415 kg/m^3	1
Water	186 kg/m^3	0.45

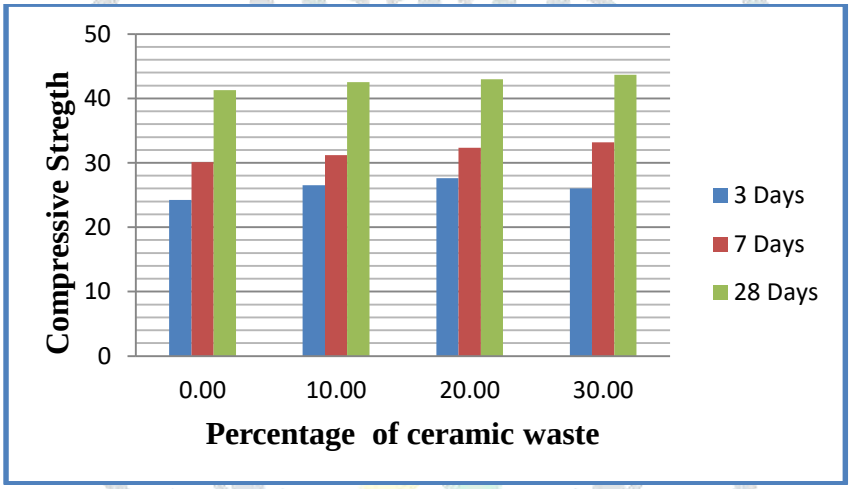
Fine aggregate	668 kg/m^3	1.60
Coarse aggregate	1242 kg/m^3	2.99

3.1RESULTS AND DISCUSSION

3.1.1COMPRESSIVE STRENGTH TEST

Table 6: Results of Compressive strength for replacement of 0%, 10%20%, and 30% of ceramic aggregates

% of Ceramic waste	0%	10%	20%	30%
3 Days	24.25	26.52	27.6	26.02
7 Days	30.08	31.19	32.35	33.16
28 Days	41.29	42.54	42.98	43.68

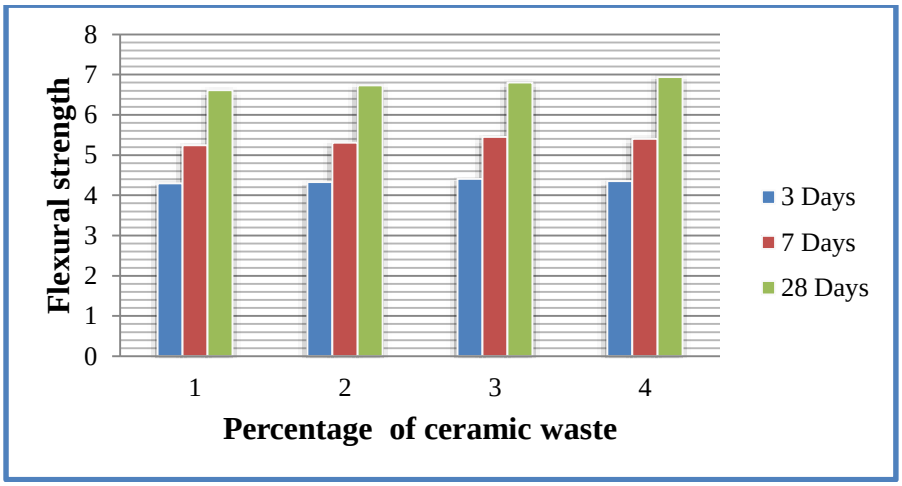


Graph 1- Showing variation of Compressive Strength

3.1.2. Flexural strength test

Table7: Results of Flexural strength for replacement of 0%, 10%20%, and 30% of ceramic aggregates

% of Ceramic waste	0%	10%	20%	30%
3 Days	4.3	4.33	4.41	4.35
7 Days	5.24	5.31	5.45	5.4
28 Days	6.61	6.73	6.8	6.94



Graph 2- Showing variation of flexural strength

4. Conclusion and Further Work

1. Percentage of compressive strength 5.78% was increase when 30% of coarse aggregate is replaced with ceramic waste tiles.

2. Percentage of flexural strength 4.99% was increase when 30% of coarse aggregate is replaced with ceramic waste tiles

3. Percentage of ceramic waste also increases for 40% to100% in further research work.

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