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Experimental investigation on partial replacement of coarse aggregate by ceramic waste in concrete

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***Abstract*- Use of hazardous industrial wastes in concrete-making will lead to greener environment. In ceramic industry about 30% production goes as waste, which is not recycled at present. In this study an attempt has been made to find the suitability of the ceramic industrial wastes as a possible substitute for conventional crushed stone coarse aggregates. The behavior of ceramic waste aggregate is studied in two states, fresh state and hardened state. In fresh state, workability studies are studied with slump cone test and compaction factor test and in hardened state, strength of the CWA is studied with compression test, tensile strength and flexural strength are found for ceramic waste when adding in different percentage. The obtained results are compared with M25 grade conventional concrete.**

***Key Words*: Cement, Aggregate, Ceramic Waste, compressive strength, Split tensile strength and Flexural strength**

1. INTRODUCTION

Generally in design of 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. Today's world is a concrete jungle. With the ever increasing population of the world, in general and the developing countries there is the tremendous pressure on the Civil Engineer to develop a cost effective as well as ecofriendly structure to fulfill the need of the human being.In these components only cement is manufactured and both fine and coarse aggregate has been obtained naturally. This has brought up with a great destruction to the environment. And further the disposal of the huge amount of demolition waste was another problem. To solve both these problems use of waste materials such as ceramic waste. These materials have also benefits that these materials are easily available andeconomical. In this research these wastes are used in 20mm Coarse aggregates simultaneously. The study has been conducted on these wastes used in concrete. This used as partial replacement of coarse aggregate. The ceramic industry has about 30% to 50% failed products due to improper mixing or heating conditions so ceramic can be used as a coarse aggregate. Present study has been done to evaluate the suitability of such waste materials in concrete production.

2. OBJECTIVES

This study was conducted to achieve the following objectives:
i) To study the strength developments hardened concrete with waste ceramic coarse aggregate.
ii) To determine the effect of various percentage of ceramic waste as partial coarse aggregates replacement towards compressive strength of concrete.
iii) To determine the water absorption of ceramic aggregate concrete containing various content of ceramic tile as partial coarse aggregates replacement material.

3. MATERIAL DESCRIPTION

The materials used in the projects are cement, Fine aggregate, coarse aggregate, copper slag, Ceramic waste tiles are detailed below:

A,Cement:

Cement is the essential ingredient to bind all other materials to form workable concrete. The Ordinary Portland Cement of 53 grades was used in this experimentation conforming to IS: 12269:1987 is used in this experimental project.

PROPERTY	SPECIFICATIONS
Specific gravity	3.15
Fineness	6 %
Normal consistency	33
Initial setting time	36 Minutes

Table No 1: Physical property on cement

B. Fine aggregate:

Locally available zone II river sand used as fine aggregate. The specific gravity was determined and was found as 2.64 conforming to I.S. – 383-1970.

C.Coarse aggregate:

Crushed angular shape aggregate from a local source was used as coarse aggregate. The specific gravity was
not recycled in any form at present. This cause impacts to environment, so it can be reused as construction materials.Ceramic waste is generated as a waste during the process of cutting, and marking. In this project study an

attempt has been made to find the suitability of the ceramic industrial wastes as a possible replacement for conventional coarse aggregate. Mainly this type of recycled aggregate is used for the developments of concrete with non-conventional aggregates to improve the properties of concrete and reduce the cost.Specific gravity – 2.81.

Advantages:
- Stronger bonds
- Low thermal expansion

D. Ceramic waste:
- CTA are crushed uniformly to about 20mm size manually using hammer and sieved through 20mm IS sieve.In ceramic industry about 15%-30% of daily production goes as waste.
- 2.76.The coarse aggregate used in this project work are 20mm grade of size.

Fig No 1: Ceramic waste

E. Water: Portable water was used for the experimentation.

F. Reinforcement:Beam casting while using10 mm HYSD bar main reinforcement and 6 mm HYSD lateral ties.

4. DESIGN MIX

As per IS 10292-2000 designed by M25 grade of concrete and water cement ratio 0.45.

Materials	Quantity	Mix ratio
Cement(kg/m^3)	430	1
FA(kg/m^3)	600	1.3
CA(kg/m^3)	1030	2.3
Water(lits)	197	0.45

Table No: 2 Mix proportion

Mixing of Concrete, Casting and Curing of test Specimens

Hand mixing was done during the entire process of casting of specimens. Initially the dry mix constituents of the mixnamely cement, fine aggregate and coarse aggregate was mixed for two minutes in the mixer and then the water wereadded and mixing continued for another 2 minutes. The totalmixing time was kept at 4 minutes until a homogeneous mixture was obtained. Compaction was achieved by means of Tamping rod.

Fig No 2: Mixing of concrete

5. EXPERIMENTAL RESULTS

Fresh concrete:

The fresh concrete properties slump test is conducted. The slump value of concrete was 74mm.

Hardened concrete:

The hardened concrete specimen properties are checked by compressive strength, split tensile strength and flexural strength.

Compressive strength:

For every percentage of replacement 6 cubes have been casted. Among them, 3 cubes were tested on the 7th and the other 3 cubes were tested on the 28th day. Totally 24 cubes were casted and 7th day and 28th day testing has been completed. Compressive test of concrete is carried out on specimens like cube by compression testing machine.

f_c = (P/A) N/mm^2

Where,

P = Load at which the specimen fails in Newton (N)

A = Area over which the load is applied in mm

f_c = Compressive Stress in N/mm^2

Grade of concrete	% of Ceramic waste	7days (N/mm^2)	28 days (N/mm^2)
M25	0	15.52	31.24
	30	17.7	32.46
	40	19.56	34.08
	50	20.6	33.86

Table No 3: Compressive Strength Results

Grade of concrete	% of glass fibre	7days (N/mm^2)	28 days (N/mm^2)
M25	0	4.02	4.315
	30	3.25	4.692
	40	3.76	4.950
	50	4.85	5.01

Analysis of compressive Strength

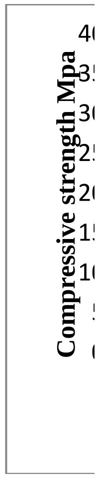

Chart-1

Fig No 3:Testing of cube

Split tensile Strength

For every percentage of replacement 6 cylinders have been casted. Among them, 3 cylinders were tested on the 7th and the other 3 cylinders were tested on the 28th day. Totally 24 cylinders were casted and 7^{th} day and 28^{th} day testing has been completed.Split tensile Strength test of concrete is carried out on specimens like cylinders by compression testing machine. The Split tensile strength of the specimen was calculated by using the formula

$f_t = (2P/\prod dl)\ N/mm^2$

Where,

P = Maximum load in N applied to the specimen

d = Measured length in cm of the specimen

l = Measured diameter in cm of the specimen

f_t= Tensile strength N/mm^2

Table No 4: Split Tensile Test Results

Grade of concrete	% of Ceramic waste	7days (N/mm^2)	28 days (N/mm^2)
M25	0	1.88	2.153
	30	2.12	4.126
	40	1.9	3.95
	50	1.76	3.1

Flexural Strength Test

For every percentage of replacement 3 beams have been casted.The 3 beams were tested on the 28th day**.**Totally 24 prisms were casted and 7^{th} day and 28^{th} day testing has been completed.Flexural strength is the one of the measure of the tensile strength of concrete. The flexural strength of the specimen was calculated by using the formula

$f_b = (Pl/bd^2)\ N/mm^2\ N/mm^2$

Where,

P = Load at which specimen fails in N

l = Effective span in mm

b = Breadth of the specimen in mm

d = Depth of the specimen in mm

Table No 5: Flexural Strength Test Results

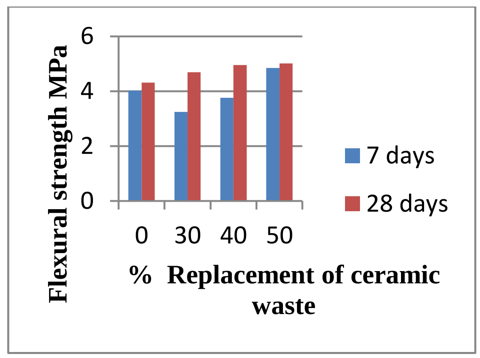

Chart-3 Analysis of Flexural Strength

Fig No 5: Testing of prism

6. CONCLUSION

Sustainable development is a key towards improving living conditions of the future generations. Thus recycling wastes is only rational and logical step towards conservation of natural resources. The economic aspect of recycling is motivation to proceed in this direction. From the researches discussed, it is clear that ceramic wastes are suitable to be used in the construction industry, and more significantly on the making of concrete. Ceramic wastes are found to be suitable for usage as substitution for fine and coarse aggregates and partial substitution in cement production. Researchers have indicated their potential for usage in both structural and non-structural concrete and even for mortars. They were found to be performing better than normal concrete, in properties such as density, durability, permeability and compressive strength.

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