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STUDY OF PARTIAL REPLACEMENT OF SAND WITH CERAMIC WASTE IN CONCRETE

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Abstract— The industrial waste contains many inorganic and toxic substances beyond the acceptable limit which cause an impact on the environment. In ceramic industries about 15%-30% production goes as waste while manufacturing the products. These wastes are dumped at open places which results in environment pollution. Taking this into consideration the reuse of this waste has become the need of hour. Hence the utilization of ceramic waste as a partial replacement of fine aggregate in concrete production has been investigated. The ceramic waste which was obtained from manufacturing industry, and construction and demolition sites was collected and crushed into small pieces passing through IS 4.75 mm sieve. The partial replacement of the fine aggregate with ceramic tiles waste powder is done in an incremental order at 0%, 10%, 20%, 30%, 40%, and 50% in producing M20 grade of concrete. This paper deals with the experimental study of the compressive strength property of M20 grade concrete after the partial replacement of sand by ceramic waste. Various tests were carried out as per IS standards to analyse the performance of M20 grade concrete made by partial replacement of sand by ceramic waste. A cost comparison between concrete produced from natural sand and sand replaced with ceramic waste has been carried out.

Keywords— ceramic waste, environment friendly, greener elements, compressive strength

I. INTRODUCTION

Today concrete is the most commonly used material in the world that utilizes the natural resources such as sand, crushed stone and water. Depletion of natural resources is a common phenomenon in developing countries like India due to rapid urbanization & industrialization, involving construction of infrastructures and other amenities. Due to the depletion of these natural resources for concreting, research has been carried out nowadays to reduce the consumption of these resources. There is a need to spare natural resources, for such as aggregate and sand, by using elective materials that are either reused or discarded as a waste. Indian ceramic production is 100 Million tons per year. In the ceramic industry, about 15%-30% waste material is generated from the total production. As per the report of Central Pollution Control Board (CPCB) Delhi, in India, 48 million tons' solid waste is generated out of which 40% is of concrete, 30% ceramic's, 5% plastics, 10% wood, 5% metal, & 10% other mixtures. The Ceramic industries are dumping the powder in any nearby pit or vacant spaces, near their unit. This leads to serious environmental and dust pollution of a vast area of land, especially after the powder dries up, so it is necessary to dispose the Ceramic waste quickly and use in the construction industry. Also with the increase in demand of river sand and decrease in its availability the cost of sand is increasing at present leading to an increase in the total cost hence there is an immediate need for finding alternatives which can replace sand partially or at high proportion. The use of the replacement materials offers cost reduction, energy savings and fewer hazards to the environment. Thus fine aggregates are replaced by waste ceramic tiles for various percentages 10%, 20%, 30%, 40% and 50% to increase the quality, strength and to minimize the cost.

II. OBJECTIVE

1. To effectively utilize the waste material from ceramic industries in concrete production which otherwise affect the environment severely.
2. To replace the fine aggregates partially by ceramic waste in M20 grade concrete in an incremental order of 0%, 10%, 20%, 30%, 40%, 50%.
3. To find out ideal percentage for replacement of fine aggregates with ceramic waste so as to make a structurally strong and economically feasible concrete
4. To conduct compressive strength test on the concrete manufactured with partial replacement of fine aggregates with ceramic waste.

III. METHODOLOGY

1. Obtaining ceramic waste materials:

Ceramic waste was obtained from a reputed tile manufacturing unit.

2. Tests on materials:

Various tests like specific gravity, water absorption, sieve analysis etc. were carried out as per IS standards.

3. Concrete mix design:
Mix design was done for M20 grade concrete.

4. Casting of cubes:
The natural fine aggregates were partially replaced with the ceramic waste powder and concrete cubes were cast as per the mix design.

5. Test on Hardened cubes:
After the curing of cubes for 28 days, the cubes were tested for compressive strength with Universal Testing Machine.

6. Comparison of results:
Study and comparison of the results obtained with the conventional concrete and the concrete cubes cast with the replacement of sand by ceramic waste has been presented in the report.

IV. MATERIAL TESTING

Various tests were conducted on material used in mix design. The results obtained from these results are tabulated as below.

1. **Particle size distribution**
   Sieve analysis test on ceramic waste was carried out and its fineness modulus was found to be 3.18
2. **Specific Gravity**
   The specific gravity of sand was found to be 2.6 and that of ceramic waste to be 2.1
3. **Water absorption**
   The water absorption of natural sand was found to be 17.73% and that of ceramic waste to be 33.57%

V. MIX DESIGN AND SLUMP CONE TEST

By taking into consideration the results obtained from various tests the mix design of 1:1.6:3 was obtained. Adjustments in water requirements due to use of ceramic waste are tabulated below.

TABLE NO.1
MIX DESIGN

Replacement	Requirement of Natural Sand (kg/m^3)	Requirement of Ceramic Waste (kg/m^3)	Requirement of Water (lit/m^3)
10%	573.181	53.860	296.48
20%	509.496	107.778	294.93
30%	445.809	161.667	293.38
40%	382.122	215.556	291.83
50%	318.435	269.445	290.28

Slump test were conducted on prepared mix and results obtained are tabulated as below:

TABLE NO.2
SLUMP CONE TEST RESULTS

Trial	**10%**	**20%**	**30%**	**40%**	**50%**
Slump	83	78	64	60	38

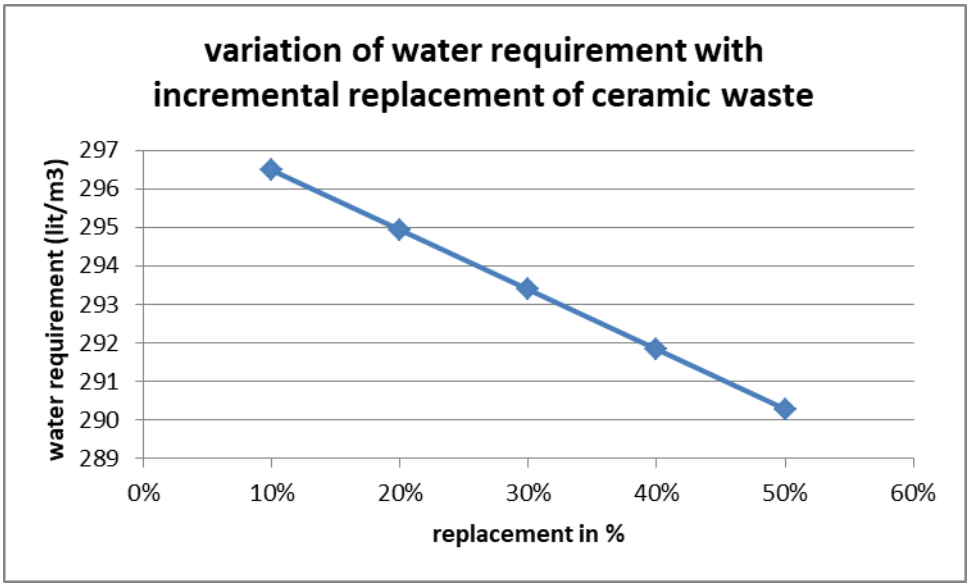

Fig. 1 Relationship between water requirement and incremental use ceramic waste

VI. COMPRESSIVE STRENGTH

The compressive strength of concrete was tested with the help of UTM. The results obtained are noted below.

TABLE NO. 3
COMPRESSIVE STRENGTH RESULTS

Sr.no	% replacement	Wt. of cube(kg)	Load (KN)	Strength(KN/m^2)
1	10%	8.102	465	20.66
2	20%	8.328	460	20.44
3	30%	8.212	540	24.00
4	40%	8.258	560	24.88
5	50%	8.223	530	23.55

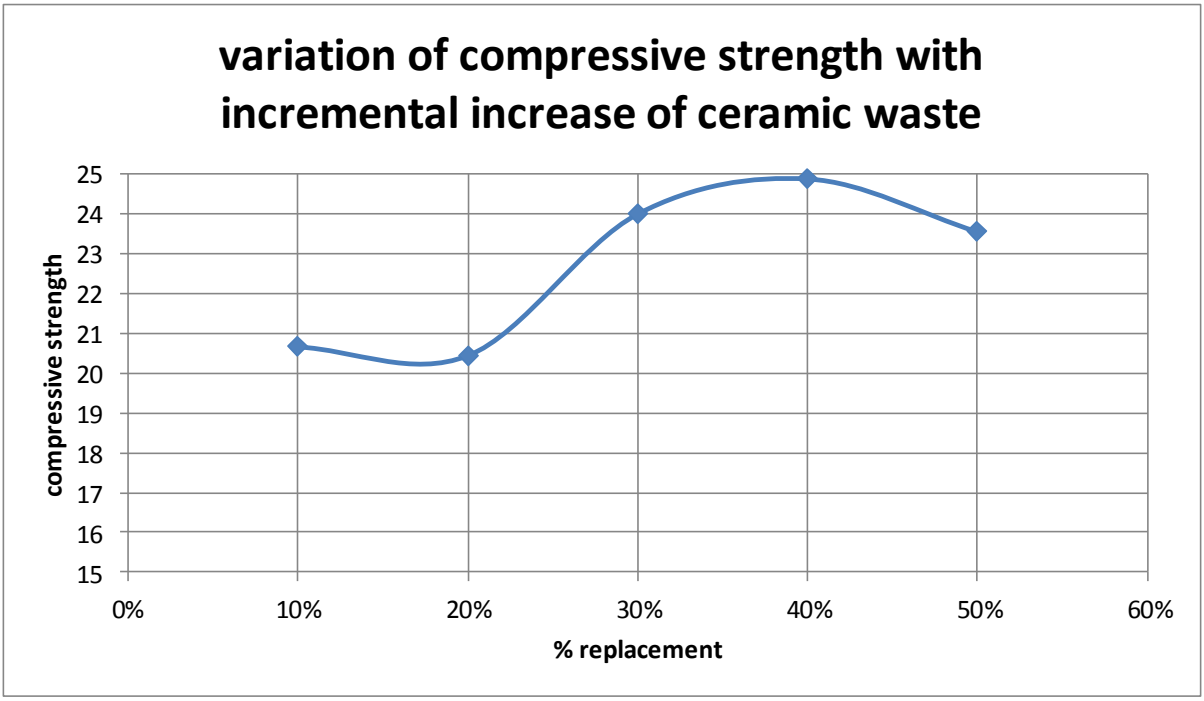

Fig 2. Variations of compressive strength results

VII. CONCLUSIONS

1. With increment in use of ceramic waste, water requirement decreases.
2. Slump values are satisfactory at 30 and 40 % replacement. At 50% replacement the mix behaves in a stiff manner.
3. The compressive strength shows an increasing trend upto 40% replacement, beyond it shows a downward trend.

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