JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

EVALUATING THE EFFECT OF USING CERAMIC TILE WASTE AND SAND DUNE BY SUBSTITUTING CEMENT AND FINE AGGREGATES IN CONCRETE

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Abstract: The utilization of waste materials in concrete production is very common. In current study, a control mix design of M35 grade of concrete using natural materials was prepared. Then, modified concrete of M35 grade using ceramic tile waste (5%, 10%, 15% and 20%) and sand dune (10%, 20%, 30% and 40%) from raiser, Bikaner (Rajasthan) by substituting cement and fine aggregates respectively was prepared. Different properties of control and replacement concrete were determined in the laboratory. From the results, it is concluded that the utilization of 10% of ceramic waste and 20% of sand dunes is the optimum dosage to achieve maximum strength parameters of concrete.

Key words - Replacement Concrete, Sand Dunes, Ceramic Tile Waste.

I. INTRODUCTION

Concrete is the footing of the modernized world. Concrete material is utilized to erect buildings, highways, bridges, roads, etc. while considering the pace of modernization, the demand for this construction material increased rapidly. Due to its diverse nature and capacity to withstand huge loads, it is the most prolific and shapeable construction material in the world. Concrete is being used on a very gigantic scale in the construction industry all over the world for constructing different kinds of structures (residential, commercial, hospitals-high rise and low rise buildings, bridges, etc.). Over the past few years, inventions related to raw ingredients of concrete and applications are made for different construction sectors. Some researchers have used replacement materials to make the concrete more effective and eco-friendly and some have come up with new design and construction methods with which construction becomes a little easy.

The concept of replacement of raw materials in the production of any product is not new in the world. Different manufacturing industries, in the past, have replaced the conventional materials with new sustainable materials which ultimately reduce either cost of material or have some other kind of benefits. Bringing the same concept to the concrete industry because there is a dire need to replace the raw cement and aggregates because of the threats pose to the environment. For every 1 ton of cement saved can reduce approximately 1 ton of CO_2 which is being released into the environment. Using aluminum and silica-based waste material to replace the cement will not only solve the environmental problem but also saves money and raw material for future generation. The reduction of carbon footprint is the main goal of replacing cement however; it comes with other benefits too.

Ceramic wastes have been uncovered to be found satisfactory while using it as a replacement for fine and coarse aggregate in the manufacturing process of concrete. As per the previous research studies, it has been found that almost 30% of the material in the making of ceramic products ends up as a waste that is dumped into the environment. Due to the replacement of raw materials in the concrete industry, the sustainable utilization of demolished construction wastes such as ceramic tiles has appeared as a feasible choice for lowering the generation of solid garbage which also solves the problem of limited supplies of raw cement (OPC) which were required for concrete production. Ceramic Waste is generated from the manufacturing industry, demolished structures, waste produced while construction etc. This waste material exhibits similar composition to that of Cement which can be used to replace them in concrete.

India is a country with diverse territories. The varieties of mountains, plains, and desserts are present in India from where different kinds of fine and coarse aggregates can be obtained. But utilization of natural aggregates is becoming detrimental to the atmosphere due to over usage of these raw aggregates. In numerous desert provinces, naturally occurring very fine sand is readily available which is called Dune Sand. Although this dune sand is abundantly available, the utilization of this sand in one way or the other is not considered in the past. and when the construction activity occurs in these remote areas, the ability of the raw and natural aggregates becomes difficult. In the past years, few researchers have used this Dune sand in the past in concrete manufacturing while replacing the natural fine sand. This will solve the problem of obtaining raw aggregates from the far places and the cost of the manufacturing will also reduce drastically. Generally, this dune sand comes under the category of Zone III or Zone IV sand.

II. MATERIAL USED:

Cement: Ordinary Portland cement of grade 43 was utilized which confirms to the IS: 8112.

Table: 1. Physical Properties of OPC 43 grade.

Property	Cement
Fineness % passing (sieve size)	96.45 (45 µm)
Unit weight, Kg/m3	3150
Specific gravity	3.15

Fine Aggregates: fine and crushed sand was utilized in current study and the particle size lies within 4.75mm to 75 microns. Sieve analysis of the fine aggregates was done as per the codal provisions of IS: 383.

Table: 2. Physical Properties of Fine Aggregates

Test	Value Obtained
Specific Gravity	2.54
Fineness Modulus	2.24
Silt Content	4.35 %

Coarse Aggregates: Crushed and angular coarse aggregates were chosen for the study. Gradation of coarse aggregate was carried out as per IS: 383-1970. Aggregate of nominal size 20 mm and 10 mm were combined in the ratio 2:1 to get graded aggregates.

Table: 3. Physical Properties of Graded Coarse Aggregates

Test	Results
Specific Gravity	2.71
Water Absorption	0.56 %

Sand Dunes: In numerous desert provinces, naturally occurring very fine sand is readily available which is called Dune Sand. This dune sand is abundantly available in the areas of Rajasthan. It is collected from raiser, Bikaner (Rajasthan).

Ceramic Tile Waste: Ceramic wastes have been uncovered to be found satisfactory while using it as a replacement for fine and coarse aggregate in the manufacturing process of concrete. This waste is cementitious in nature and has the capability to replace the cement in the production of concrete.

Table: 4. Different Concrete Mix Designations

Mix Design	% of Ceramic Waste	% of Sand Dune
CM	0	0
C5S10	5	10
C10S20	10	20
C15S30	15	30
C20S40	20	40

III. RESULTS AND DISCUSSION

Slump test results:

To determine the workability of each concrete mix, slump test was carried out in the laboratory.

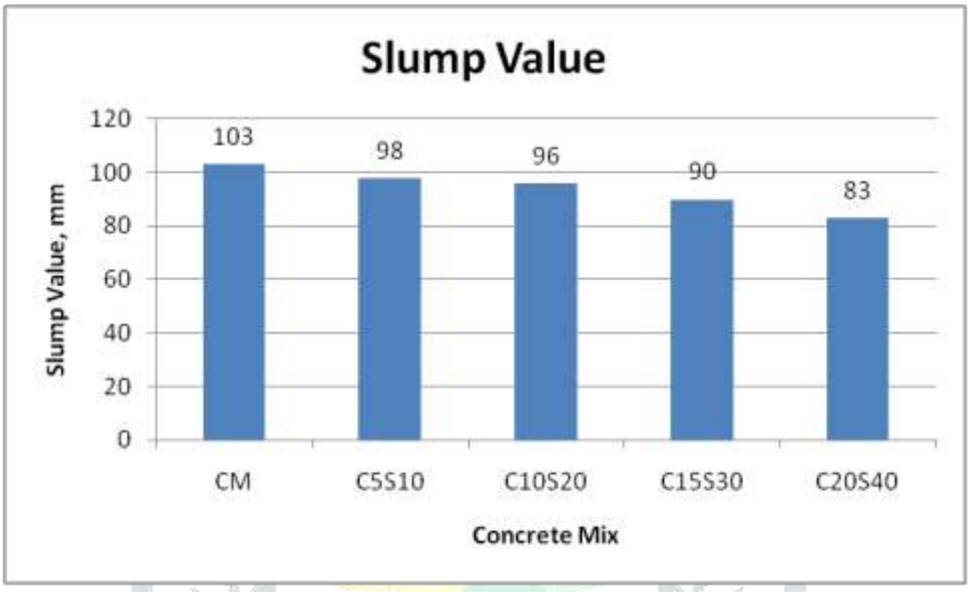

Figure 1. Slump Values for various Concrete Mixes

From the above results of slump test, it can be clearly seen that with the addition of replacement material the workability decreases with each concrete mix. The percentage increase/decrease in the workability is -4.85%, -6.80%, -12.62% and -19.42% for the mix C5S10, C10S20, C15S30 and C20S40 respectively.

Compressive Strength:

To assess the compressive strength of various concrete mixes, cube samples were tested at 7 days and 28 days in the laboratory in CTM machine.

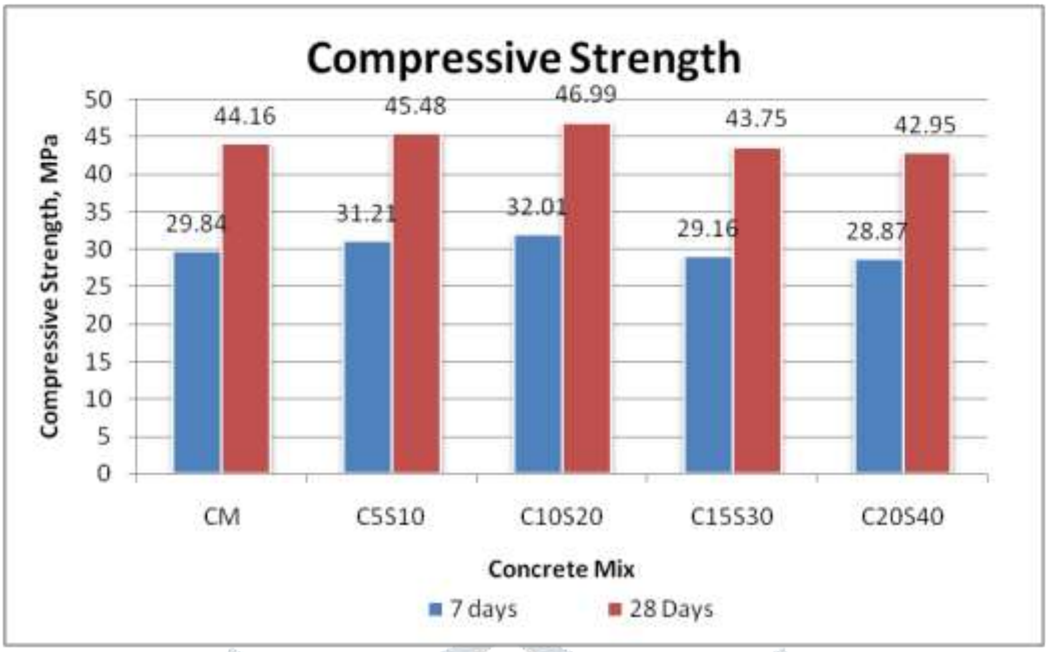

Figure 2. Compressive strength of various Concrete Mixes.

From the above results of compressive strength test, the compressive strength increases till C10S20 but after C10S20 it decreases with C15S30 and C20S40 concrete mixes. The percentage increase/decrease is slightly small. The percentage increase/decrease in the compressive strength at 7 days is +4.59%, +7.27%, -2.28% and -3.35% whereas, at 28 days, the percentage increase/decrease is +2.99%, +6.41%, -0.93% and -2.74% for the mix C5S10, C10S20, C15S30 and C20S40 respectively. Therefore, it is concluded that the maximum compressive strength is attained by the mix C10S20 at both the curing period i.e. at 7 days and 28 days.

Split Tensile Strength:

To assess the split tensile strength of various concrete mixes, cylindrical samples were tested at 7 days and 28 days in the laboratory.

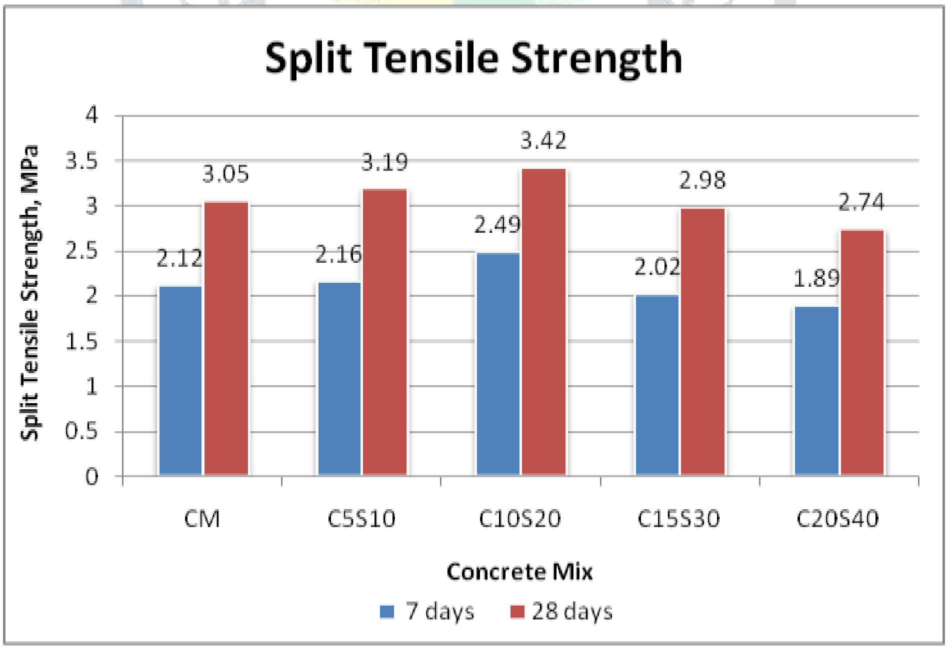

Figure 3. Split Tensile strength of various Concrete Mixes.

From the above results of split tensile strength test, the split tensile strength increases till C10S20 but after C10S20 it decreases with C15S30 and C20S40 concrete mixes. The percentage increase/decrease in the split tensile strength at 7 days is +1.89%, +17.45%, -4.72% and -10.85% whereas, at 28 days, the percentage increase/decrease is +4.59%, +12.13%, -2.30% and -10.16% for the mix C5S10, C10S20, C15S30 and C20S40 respectively. Therefore, it is concluded that the maximum split tensile strength is attained by the mix C10S20 at both the curing period i.e. at 7 days and 28 days.

Flexural Strength:

To assess the Flexural strength of various concrete mixes, beams samples were tested at 7 days and 28 days in the laboratory.

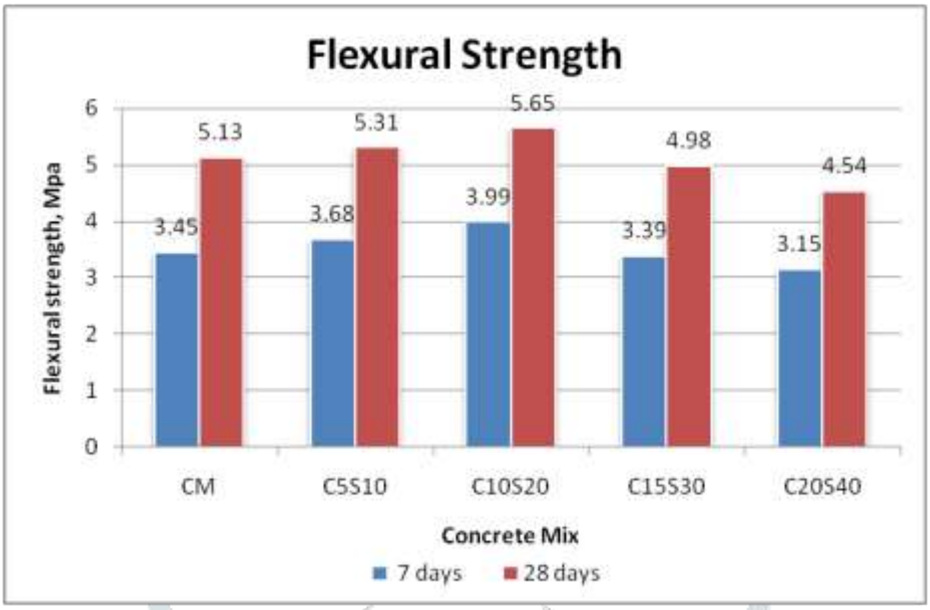

Figure 4. Flexural strength of various Concrete Mixes.

From the above results of flexural tensile strength test, the flexural tensile strength increases up to mix entailing 10% ceramic waste and 20% sand dune and then it decreases slightly. The percentage increase/decrease in the Flexural strength at 7 days is +6.67%, +15.65%, -1.74% and -8.70% whereas, at 28 days, the percentage increase/decrease is +3.51%, +10.14%, -2.92% and -11.50% for the mix C5S10, C10S20, C15S30 and C20S40 respectively. Therefore, it is concluded that the maximum flexural strength is attained by the mix C10S20 at 7 days as well as at 28 days.

IV. CONCLUSION

The current experimental study was undertaken to assess the behavior of ceramic waste and sand dunes in the production of concrete. Various laboratory tests were conducted and the results were obtained. From those results, the conclusions were drawn which are mentioned as under:

1. By adding the replacement materials in concrete, the workability decreases with each concrete mix. The percentage increase/decrease in the workability is -4.85%, -6.80%, -12.62% and -19.42% for the mix C5S10, C10S20, C15S30 and C20S40 respectively.
2. The compressive strength increases till C10S20 but after C10S20 it decreases with C15S30 and C20S40 concrete mixes. The percentage increase/decrease is slightly small. The percentage increase/decrease in the compressive strength at 7 days is +4.59%, +7.27%, -2.28% and -3.25% whereas, at 28 days, the percentage increase/decrease is +2.99%, +6.41%, -0.93% and -2.74% for the mix C5S10, C10S20, C15S30 and C20S40 respectively. Therefore, it is concluded that the maximum compressive strength is attained by the mix C10S20 at both the curing period i.e. at 7 days and 28 days.
3. The split tensile strength increases till C10S20 but after C10S20 it decreases with C15S30 and C20S40 concrete mixes. The percentage increase/decrease in the split tensile strength at 7 days is +1.89%, +17.45%, -4.72% and -10.85% whereas, at 28 days, the percentage increase/decrease is +4.59%, +12.13%, -2.30% and -10.16% for the mix C5S10, C10S20, C15S30 and C20S40 respectively. Therefore, it is concluded that the maximum split tensile strength is attained by the

mix C10S20 at both the curing period i.e. at 7 days and 28 days.

4. The flexural tensile strength increases up to mix entailing 10% ceramic waste and 20% sand dune and then it decreases slightly. The percentage increase/decrease in the Flexural strength at 7 days is +6.67%, +15.65%, -1.74% and -8.70% whereas, at 28 days, the percentage increase/decrease is +3.51%, +10.14%, -2.92% and -11.50% for the mix C5S10, C10S20, C15S30 and C20S40 respectively. Therefore, it is concluded that the maximum flexural strength is attained by the mix C10S20 at 7 days as well as at 28 days.

Therefore, in order to produce concrete with replacement material (ceramic waste and sand dunes), it is suggested to use 10% of ceramic waste and 20% of sand dunes to achieve maximum strength parameters of concrete.

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