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WORKABILITY TEST ON REPLACEMENT OF FINE AGGREGATE BY WASTE MATERIAL CERAMIC WASTE IN HIGH PERFORMANCE CONCRETE USING STEEL FIBRE

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Abstract: - High strength Steel-fiber reinforced concrete is being used increasing day by day as a structural material. From many years High Performance Concrete has been used in column of high rise building [1]. High Performance Concrete (HPC) is a concrete meeting special combinations of performance and uniformity requirements that cannot be always achieved routinely by using conventional constituent sand normal mixing. Use of steel fiber in HPC is mainly for superior resistance to cracking and formation of cracks [2].In High performance concrete we are using ceramic waste as a waste material with 10%, 20%, 30%, and 40% replacement of fine aggregate. The aim of the present work will to use waste material as a replacement of fine aggregate in HPC using steel fiber . A series of workability tests will be conducted to study the effect of optimum replacement of fine aggregate by waste material (ceramic waste) and optimum use of steel fiber.

Keywords: High performance concrete, steel fibre, replacement, waste material, ceramic waste

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INTRODUCTION

ACI (American Concrete Institute) defines HPC as a specially engineered concrete, one or more specific characteristics of which have been enhanced through the selection of component materials and mix proportions.[5] Note that this definition does not cover a single product but a family of high-tech concrete products whose properties have been tailored to meet specific engineering needs, such as high workability, very-high early strength (e.g. 30-40 MPa compressive strength in 24 hours), high toughness, and high durability to exposure conditions.[6].There is some special Characteristics of HPC like Ease of placement, Compaction without segregation, Early age strength, Long-term strength and mechanical properties Permeability, Density, Heat of hydration, Toughness, Volume stability. There are major application of HPC is Pavements, Long-span bridges, High-rise buildings and other miscellaneous application are Floor slabs, Pavements, Refractories, Hydraulic structures, Thin shells, Rock slope stabilization, Mine tunnel linings, Many precast products etc.

MATERIALS USED

A. *Cement:*

The Ordinary Portland Cement of 53 grades conforming to IS: 8112 is being used.

Table – 1 Properties of Cement

PROPERTY	IS CODE IS : 8112 - 1989
Specific Gravity	3.12
Consistency	33
Initial setting time	30 minimum
Final setting time	600 maximum

B. *Fine aggregates:*

Those fractions from 4.75 mm to 150 microns are termed as fine aggregate. Fine aggregate are basically sands won from the land or the marine environment. Fine aggregates generally consist of natural sand or crushed stone with most particles passing through a 9.5mm sieve. Sieve analysis of fine aggregates given in below table

Table – 2 Sieve analysis of Fine aggregate

IS Sieve Size (mm)	% of Passing
10	100.00
4.75	100.00
2.36	90.40
1.18	62.20
0.600	47.90
0.300	16.50
0.150	1.10

C. *Coarse aggregates:*

Coarse aggregates are particles greater than 4.75mm, but generally range between 10 mm to 40.5mm in diameter. They can either be from Primary or Secondary source.

D. *Steel fibres:*

Steel fibers of 50 mm length and 1 mm thickness with double hook end shape which gave an aspect ratio of 63.5 were used. The steel fiber was added by 3% of weight fraction.

E. *Superplasticizer:*

Glenium SKY 8784 helps to produce high performance concrete with longer workability retention, and high early strength. Mostly compatible with all OPC, PPC, PSC and can be used with high pozzolonic material.

F. *Ceramic waste:*

Ceramic tiles were obtained from building construction sites. For this Experiment a Varmora Verified tiles was used. Its bulk density and water absorption were 2.35 gm/cc and 0.08% respectively.

PROCEDURE

The mix design was carried out for M55 grade concrete as per ACI: 363 which yielded a proportion of **1: 2.28: 1.55** with a w/c ratio of 0.33. The dosage of super plasticizer used was 0.79% (by weight of cement). The steel fibres were added at the rate of 2.0% by weight fraction. The cement, sand and coarse aggregates were weighed according to the proportion of 1: 2.28: 1.55 and dry mixed. The required amount of water was added to this dry mix and intimately mixed. The calculated quantity of super plasticizer was now added and mixed thoroughly. After this, steel 2% by weight of concrete material was added to the mix and the entire concrete was agitated thoroughly to get a homogeneous mix and workability test were carried.

METHODOLOGY

Fig – 1 (a) Compaction Factor Test (b) J-Ring Test

1) ***Slump Test:***

As per IS:1199 (1959) Slump test is the most commonly used method of measuring consistency of concrete. It is not a suitable method for very wet or very dry concrete. The apparatus for conducting the slump test essentially consist of a metallic mould in the form of a frustum of a cone having the internal dimensions as under:

Slump Apparatus

Bottom diameter: - 20 cm

Top diameter: - 10 cm

Height: - 30 cm

The internal surface of the mould shall be thoroughly cleaned and freed from superfluous moisture and any set concrete before commencing the test. The mould shall be placed on a smooth, horizontal, rigid and non-absorbent surface, such as a carefully levelled metal plate, the mould being firmly held in place while it is being filled. The mould shall be filled in four layers, each approximately one-q6arter of the height of the mould. Each layer shall be tamped with twenty-five strokes of the rounded end of the tamping rod. The strokes shall be distributed in a uniform manner over the cross-section of the mould and for the second and subsequent layers shall penetrate in@ the underlying layer. The bottom layer shall be tamped throughout its depth. After the top layer has been rodded, the concrete shall be struck off level with a trowel or the tamping rod, so that the mould is exact 19 filled. Any mortar which may have leaked out between the mould and the base plate shall be cleaned away. The mould shall be removed from the concrete immediately by raising it slowly and carefully in a vertical direction. This allows the concrete to subside and the slump shall be measured immediately by determining the difference between the height of the mould and that of the highest point of the specimen being tested. The above operations shall be carried out at a place free from vibration or shock, and within a period of two minutes after sampling**.**

2) ***Compacting* Factor *Test:***

As per IS: 1199 (1959), the sample of concrete to be tested shall be placed gently in the upper hopper, using the hand scoop. The hopper shall be' filled level with its brim and the trap-door shall be opened so that the concrete falls into the lower hopper. Certain mixes have a tendency to stick in one or both of the hoppers. If this occurs, the concrete may be helped through by pushing the rod gently into the concrete from the top & ring this process, the cylinder shall be covered by the trowels. Immediately after the concrete has come to rest, the cylinder shall be uncovered, the trap-door of the lower hopper opened, and the concrete allowed to fall into the cylinder. The excess of concrete remaining above the level of the top of the cylinder shall then be cut off by holding a trowel in each hand, with the plane of the blades horizontal, and receiving them simultaneously one from each side across the top of the cylinder, at the same time keeping them pressed on the top edge of the cylinder. The outside of the cylinder shall then be wiped clean. The above operation shall be carried out at a place free from vibration *or* shock. The 'weight of the concrete in the cylinder shall then be determined to the nearest 10 g. This weight shall be known as c the weight of partially compacted concrete '. The cylinder shall be refilled with concrete .from the same sample in layers approximately 5 cm deep, the layers being heavily rammed or preferably vibrated so as to obtain full compaction. The top surface of the fully compacted concrete shall be carefully struck off level with the top of the cylinder. The outside of the cylinder shall then be wiped clean.

The compacting factor $= \frac{\textbf{Weight of partially compacted concrete}}{\textbf{Weight of fully compacted concrete}}$

3) J Ring Test:

As per ASTM Perform the test on a flat, level, and nonabsorbent base plate. Position and shim the base plate so that it is fully supported and level. Pre-moisten base-plate with a damp towel, rag, or sponge. Rest the J-Ring at the center of the base plate. Filling Procedure B (Inverted Mold) – Dampen the mold, and place it on the base plate with the smaller opening facing down and concentric with the J-Ring. Support the mold and fill the mold in one lift (Note 2). Heap the concrete above the top of the mold. Strike off the surface of the concrete level with the top of the mold by a sawing motion of the strike off bar. Remove concrete from the area surrounding the mold to preclude interference with the movement of the flowing concrete. Raise the mold a distance of 9 ± 3 in (230 ± 75 mm) in 3 ± 1 s by a steady vertical lift with no lateral or torsional motion. Complete the entire procedure from start of the filling through removal of the mold without interruption within an elapsed time of 2½ min. Wait for the concrete to stop flowing and then measure the largest diameter (d1) of the resulting circular flow of concrete. When a halo is observed in the resulting circular flow of concrete, it shall be included as part of the diameter of the concrete. Measure a second diameter (d2) of the circular flow at approximately perpendicular to the first measured diameter (d1). Measure the diameters to the nearest ¼ in (5 mm). Determine the J-Ring flow in accordance with Section 9 of this test method. Conduct a slump flow test without the J-Ring in accordance with Test Method C 1611/ C 1611M. Use the same filling procedure as used with the J-Ring. Complete the tests with and without the J-Ring within 6 min.

TEST RESULTS

Different test results such as workability are tabulated as shown: Following Table 2 gives the workability test results as measured from slump, compaction factor.

Table 4: Workability test results

Percentage of Ceramic waste added	Slump (mm)	Compaction factor	J Ring		
			Slump (mm)	Spread	T 500 (Sec)
M0	collapsed	0.96	645		6
M1	collapsed	0.96	648		6
M2	collapsed	0.96	656		5
M3	collapsed	0.97	662		5
M4	collapsed	0.97	663		5
M5	collapsed	0.97	665		4

CONCLUSION

In this study ceramic waste were used as a replacement of Conventional fine aggregates. Replacement of Fine aggregates with Ceramic Waste will increase the workability of Concrete. Increase in the percentage of replacement of fine aggregate by fine ceramic waste will increase the workability of high performance concrete with steel fiber

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