EXPERIMENTAL STUDY ON BEHAVIOUR OF SELF COMPACTING CONCRETE USING HIGH STRENGTH GLASS FIBRE AND CERAMIC TILES WASTE

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Abstract : A self-compacting concrete (SCC) is the one that can be placed in the form and can go through obstructions by its own weight and without the need of vibration. Since its first development in Japan in 1988, SCC has gained wider acceptance in Japan, Europe and USA due to its inherent distinct advantages. Although there are visible signs of its gradual acceptance in the Middle East through its limited use in construction, Saudi Arabia has yet to explore the feasibility and applicability of SCC in new construction. The contributing factors to this reluctance appear to be lack of any supportive evidence of its suitability with local marginal aggregates and the harsh environmental conditions. The utilization of solid waste in cement manufacturing company will help in conservation of natural resources. The study is aimed at utilizing Ceramic tile waste as coarse aggregate in concrete. The replacement is done partially in proportion of 0%, 10%, 20%, 30%, and 40 % with coarse aggregates and its effect on properties of concrete were investigated.

Index Terms - Self Compacting Concrete(SCC), Admixtures, Ceramic Tile Waste, Super-plasticizers, Viscosity modifying Agent(VMA), Compressive Strength, Split Tensile Strength

1. INTRODUCTION

Development of self-compacting concrete (SCC) is a desirable achievement in the construction industry in order to overcome problems associated with cast-in-place concrete. Self-compacting concrete is not affected by the skills of workers, the shape and amount of reinforcing bars or the arrangement of a structure and, due to its high-fluidity and resistance to segregation it can be pumped longer distances (Bartos, 2000). The concept of self-compacting concrete was proposed in 1986 by professor Hajime Okamura (1997), but the prototype was first developed in 1988 in Japan, by professor Ozawa (1989) at the University of Tokyo. Self-compacting concrete was developed at that time to improve the durability of concrete structures. Since then, various investigations have been carried out and SCC has been used in practical structures in Japan, mainly by large construction companies. Investigations for establishing a rational mix-design method and self-compactability testing methods have been carried out from the viewpoint of making it a standard concrete. Self-compacting concrete is cast so that no additional inner or outer vibration is necessary for the compaction. It flows like “honey” and has a very smooth surface level after placing. With regard to its composition, self-compacting concrete consists of the same components as conventionally vibrated concrete, which are cement, aggregates, and water, with the addition of chemical and mineral admixtures in different proportions. Usually, the chemical admixtures used are high-range water reducers (super plasticizers) and viscosity-modifying agents, which change the rheological properties of concrete. Mineral admixtures are used as an extra fine material, besides cement, and in some cases, they replace cement. In this study, the cement content was partially replaced with mineral admixtures, e.g. fly ash, slag cement, and silica fume, admixtures that improve the flowing and strengthening characteristics of the concrete.

In contrast to ordinary concrete, SCC for the full frame, or a large part of the structure, can be cast in one pour through an appropriate timber or steel mould sealed and bolted, instead of the beams and column being shuttered independently where joints are usually developed which weak the structure.

Because of these advantages and maybe others, literature showed that SCC is gradually replacing much conventional concrete. However, the higher the initial cost of SCC concrete over conventional concrete has hindered its wider application to the general construction. So that the cost needs to be reduced to an acceptable limit; the key factor is to produce SCC concrete, having similar properties, with alternative low-cost materials.

2. EXPERIMENTAL INVESTIGATIONS

Materials

a) Cement

In concrete mix, Ordinary Portland Cement of 53 grade was used in this project. For the mix design the following properties of OPC 53 were checked.

Tests	Results
Specific Gravity	3.15
IST	35 min
FST	360 min
Standard Consistency	30.00%

b) Fine Aggregate

The fractions for 4.75 mm to 150 micron are term as fine aggregate. Sand and crushed sand is used in combination as fine aggregate conforming to the requirements of IS: 383 of grading zone

Tests	Results
Fineness Modulus	3.48
Specific Gravity	2.61
Water Absorption	0.80 %
Bulk Density	1280 kg/m^3
Grading Zone	I

c) Coarse Aggregate

The fraction from 20 mm to 10 mm is used for coarse aggregate in this project.

Tests	Results
Fineness Modulus	3.49
Specific Gravity	2.64
Water Absorption	0.81 %
Bulk Density	680 kg/m^3
Impact Value	8.21 %

d) Glass Fibre

In concrete mix, Glass fibre of 12 mm size was used.

e) Ceramic Tiles Waste

The fraction for Ceramic tiles waste from 20 mm to 10 mm is used as coarse aggregate in this project.

3. METHODOLOGY

a. Mix Design of Self Compacting Concrete

Ingredients	Contents
Cement	365 kg/m^3
Water	219 kg/m^3
Fine Aggregate	963 kg/m^3
Coarse Aggregate	857 kg/m^3
Water- Cement Ratio	0.60
Admixture	1.825 ltr/m^3
Glass Fibre	620 gm/m^3

Casting

Properly mixed concrete is poured immediately into the moulds. Concrete is placed in to the mould in three layers. Then the top surface is well finished. The sizes of the moulds used are cube (150mmx150mmx150mm), cylinder (150mm dia and 300mm height), and prism (150mmx150mmx700mm). The Coarse aggregate is partially replaced with ceramic tiles waste. Total 10 %, 20 %, 30 %, and 40 % proportions were made.

Curing

After 24 hours moulds were demoulded and were kept in room temperature for curing. The average temperature recorded during the period of curing was 38ºC. The curing is done for 28 days.

Results

a. Compressive Strength

The compression test on cubes were conducted according to Indian standard specification (IS:516 1959).Compressive strength for various mixes are as below

Table 1: Results of Compressive Strength

Various Proportion of Ceramic Tiles	Compressive Strength (N/mm^2)
0% CTW	30.65
10 % CTW	34.61

20 % CTW	35.82
30 % CTW	40.14
40 % CTW	30.47

b. Flexural Strength

This test is conducted in order to determine the flexural strength of concrete and this test is carried out on beams of size 150mmx150mm x700mm. Flexural strength was conducted as per IS 516 -1959.

Table 2: Results of Flexural Strength

Various Proportion of Ceramic Tiles	Flexural Strength (N/mm^2)
0% CTW	5.04
10 % CTW	7.65
20 % CTW	7.69
30 % CTW	6.53
40 % CTW	5.89

c. Split Tensile Strength

A direct measurement of ensuring tensile strength of concrete is difficult. One of the indirect tension test method is split tension test. The split tensile strength test was carried out on the compression testing machine. The casting and testing of the specimens were done as per IS 5816- 1999.

Various Proportion of Ceramic Tiles	Split Tensile Strength (N/mm^2)
0% CTW	1.81
10 % CTW	1.92
20 % CTW	1.95
30 % CTW	2.03
40 % CTW	1.67

1. CONCLUSIONS

Based on the Experimental Study on Glass Fibre Reinforced Self Compacting Concrete using Ceramic Tiles Waste as Partial replacement of Coarse Aggregate, The Following Conclusions can be drawn

a. For M25 Grade of Concrete, Mix Proportion for SCC comes out to 1:2.63:2.34.

b. From Slump Flow Test, It has been observed that minimum slump for M25 SCC is 650 mm and maximum slump is 800 mm.

c. From Compressive Test, It has been observed that along with 1.5 % of glass fibre optimum content of ceramic tiles is 30 %.

d. From Flexural Test, It has been observed that along with 1.5 % of glass fibre is 20 % in replacement of Coarse Aggregate.

e. From Split Tensile Test, It has been observed that along with 1.5 % of glass fibre is 30 % in replacement of Coarse Aggregate.

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