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Utilizing Ceramic Waste To Enhance Compressive Strength Of Self-Compacting Concrete

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Abstract- **Industrial waste is the major contributor in air, water and land pollution through the world especially in the developing and developed nations where the industrialization is the need of hour. Ceramic waste is one such industrial waste which is discharge from a numbers of industries viz. electronic, construction, defense, medicine industries etc. In addition to this due to increase demand of machine and safety measures especially for hilly areas a new form of concrete is introduced in the field of construction is known as Self-compacting concrete (SCC). This new form of concrete has many benefits with respect to conventional concrete. One of the major advantages is that it settles down under its own weight and it does not need any vibrator for its compaction. This type of concrete provides good quality of surface finishing. Considering this scenario, an experimental work has been carried out so as to evaluate use of ceramic powder as partial replacement in concrete and observe its effect on the compressive strength of self-compacting concrete. To confirm the impact of ceramic waste on compressive strength of SCC a progression of tests were directed and the compressive strength at 07 days and 28 days is evaluated by replacing the level of concrete with ceramic residue.**

Keywords — Self-compacting concrete, ceramic powder, fly ash, superplasticizer

I. INTRODUCTION

Self-compacting concrete is a new generation of concrete with high workability and resistance to segregation. It environmental friendly and reduces the noise pollution on the working site. This type of concrete is far better than that of conventional concrete. This type of concrete is widely used in other countries. Using self-compacting concrete on the field make the work easy and along with this it controls noise pollution. It will also save the construction time as well as reduces the risk of professional diseases viz. asthma, skin cancer, contact dermatitis etc. The primary objective of this review paper is to set guidelines to carry out further research work.

In this study we made use of industrial ceramic powder by replacing the percentage of cement and observed its effect on the compressive strength of concrete at different percentage of replacement of cement by ceramic waste powder. Using industrial waste in self-compacting concrete, an attempt was made to reduce the environmental pollution and lower the construction cost.

II. LITERATURE SURVEY

A large number of research work have been done keeping self-compacting concrete as key component to upgrade its workability, compressive strength , durability etc. and they were effective too in attaining their goals. Okamura and Ozawa were the first to find this of concrete in Japan 1980. They explained advantages of using this type of concrete especially in inaccessible areas where machine can't be reached for compaction work.

Many experimental study were carried out using different components in variable ratios like micro silica, fly ash, red mud, wood etc. and they provided satisfactory results.

III. MATERIAL USED

A. CEMENT:

Cement act as a binder, a material that sets and hardens and can bind other materials together during construction. Cement is a product including lime as the primary curing component, but it is far from the first material used for cementation. Cement of grade 53 ordinary Portland cement was used for this experimental work.

Table-1 Properties of Cement

S.No.	Property	Description
1	Specific gravity	3.12
2	Specific surface	228 m^2 /g
3	Initial and final setting time	40 min, 600 min

B. COARSE AGGREGATE:

The fractions varying from 20 mm to 4.75 mm are utilized as coarse aggregate. The Coarse Aggregates

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attained from crushing the Basalt rocks, conforming to IS: 383 are being used.

Table 2 Properties of coarse aggregate

S.No.	Property	Coarse aggregate
1	Specific gravity	2.75
2	Bulk density	1.6 g/cm^3
3	Water absorption	2.30%

C. FINE AGGREGATE

Those fractions from 4.75 mm to 150 micron are called the fine aggregate. The river sand and crushed sand is being used in combination as fine aggregate conforming to the requirements of IS: 383.

Table 3 Properties of fine aggregate

S.No.	Property	Fine aggregate
1	Specific gravity	2.64
2	Bulk density	1.45 g/cm^3
3	Water absorption	1.50%

D. FLY ASH:

It is a common industrial by-product which is obtained from combustion of coal in thermal power plants. It has good binding properties so it can easily be used in place of cement powder.

Table 4 Fly ash properties

S.No.	Parameters	Fly ash
1	Specific gravity	2.45
2	Plasticity index	Non-plastic
3	Compaction factor	
	MMD (gm/cc)	0.90-1.60
	OMC (%)	38.00-18.00
4	An angle of internal friction	35^{0}-40^{0}
5	Cohesion (KN/m$^{2)}$	Negligible
6	Compression index	0.05-0.4
7	Permeability (cm/Sec)	10-3-10-5
8	Particle size distribution	
	Clay size fraction (%)	11-Jan
	Silt-size fraction (%)	Jul-85
	Sand size fraction (%)	Jun-90
	Gravel size fraction (%)	0-10
9	Coefficient if uniformity	3.2-10.4

E. CERAMIC POWDER:

Ceramic wastes are largely produced as an outcome of the ceramic processing. This waste is root cause of soil, air, and groundwater pollution. Ceramic waste powder is produced during polishing process of ceramic tiles in large amount in every day.

F. CHEMICAL ADMIXTURE:

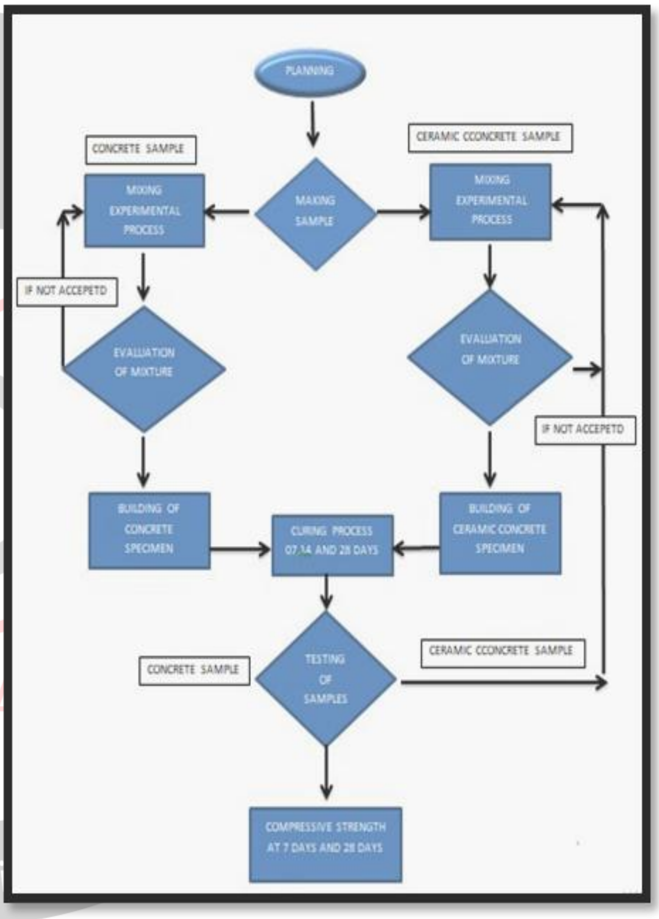
Polycarboxylate ether (PCE)-based a well-known superplasticizer (SP) Master Glenium SKY 8630 was used in the self-compacting concrete mixtures. The other trait which made it suitable for this experiment was its F-type high-range water reducer quality which is in conformity with ASTM: C 494, IS 9103:1999 & IS 2645:2003.

G. WATER-CEMENT RATIO:

It can be well defined as the ratio of water and cement by which they are mixed**.** Water cement ratio ideally is taken as 0.40. Water cement ratio inversely related with the compressive strength. Potable water was used for both mixing and curing process of concrete

IV. METHODOLOGY

The methodology of the experiment to prove our theory is systematically defined in flow chart given below



In this experimental study, first mixing or material was done using indian standard technique of mixing of concrete and follows IS 456:2000. After mixing of all the constituents in their respective proportion (M 25), 18 cubes of size 150 mm were casted at percentage replacement of 20%,30%and,40% cement by ceramic powder , with three cubes for each percentage replacement. Thereafter, these cubes were left for 24 hrs at room temperature and later demoulded. The demoulded cubes were put in water tank for curing purpose at a temperature of 27^{o}C.

Following seven long periods of curing 09 blocks were taken out and left for thirty minutes so additional water may get expelled. And then these cubes were tested for compressive strength and readings were shown in tables

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later in the section. In the similar manner rest of cubes were tested after 28 days of curing and observation table was prepared.

Using formula and data compressive strength was computed.

V. COMPRESSIVE STRENGTH

Compressive strength is load carrying capacity of cube mould when the load is applied at the rate of 140 N/mm^2 before its failure. It is calculated as:

Compressive Strength= maximum compressive load / cross sectional area of mould

Where, cross sectional area of mould = 150 mm*150 mm*150 mm

Compressive strength for each mix proportioning is calculated by taking average of three cubes after the observation of 07 days and 28 days respectively.

VI. RESULT AND DISCUSSION

This experimental approach was carried out in order to improve and enhance the quality of construction work and remove the use of vibrator on site during construction work for compacting concrete, especially inaccessible, areas. In this experimental work, 18 cubes were prepared with different proportion of ceramic powder, three mould for each mix was prepared and then compressive load was observed using universal testing machine (UTM) after curing period. Compressive load at 07 days and 28 days was shown in table-5 and table-7 and corresponding figure-1 and figure-2 respectively. The compressive strength was then found out using data from the experiment. The compressive strength of these moulds was tabulated in table-6 and table-8. A combine graph was plotted showing compressive strength and its behavior of percentage replacement of cement with ceramic residue at 07 days and 28 days respectively after curing period

A. OBSERVATION TABLE:

The experimental strength analysis of the 18 moulds in the interval of 07 days and 28 days respectively revealed the following results which are indicated in the given tables:

Table 5 Compressive load at 07 days

SCC	TRIAL 1	TRIAL 2	TRIAL 3
At 20% replacement of cement	400	410	412
At 30% replacement of cement	420	425	415
At 40% replacement of cement	390	395	398

The average values of the samples were taken to increase the accuracy of the findings and reduce the outliers.

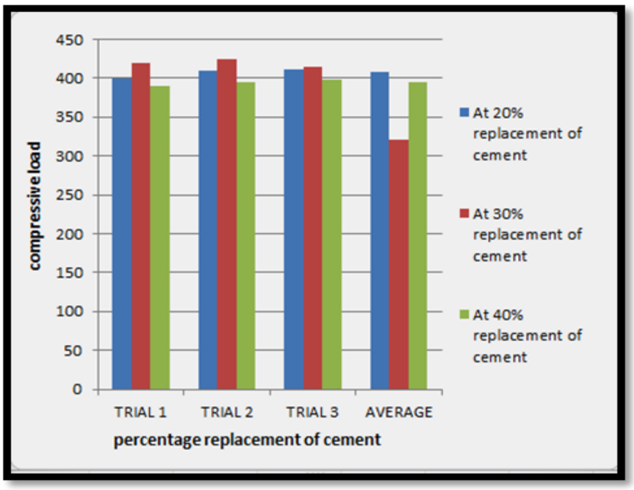

Figure 1 Compressive load at 07 days

Table 6 Compressive strength at 07 days

SCC	COMPRESSIVE STRENGTH (N/MM2)
At 20% replacement of cement	17.52
At 30% replacement of cement	18.67
At 40% replacement of cement	17.52

Table 7 Compressive load at 28 days

SCC	TRIAL 1	TRIAL 2	TRIAL 3	AVERAGE
At 20% replacement of cement	550	553	557	553.33
At 30% replacement of cement	560	562	564	562
At 40% replacement of cement	440	442	420	434

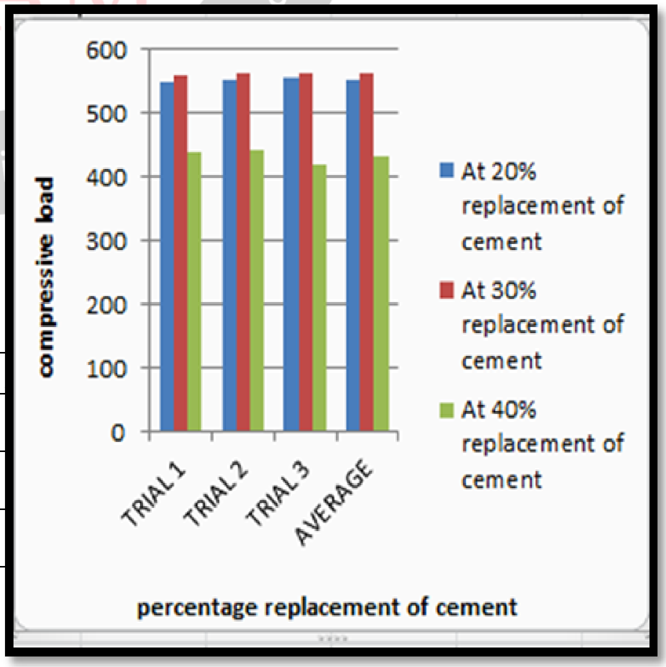

Figure 2 Compressive loads at 28 days

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Table 8 Compressive strength at 28 days

SCC	COMPRESSIVE STRENGTH (N/mm^2)
At 20% replacement of cement	24.59
At 30% replacement of cement	24.97
At 40% replacement of cement	19.28

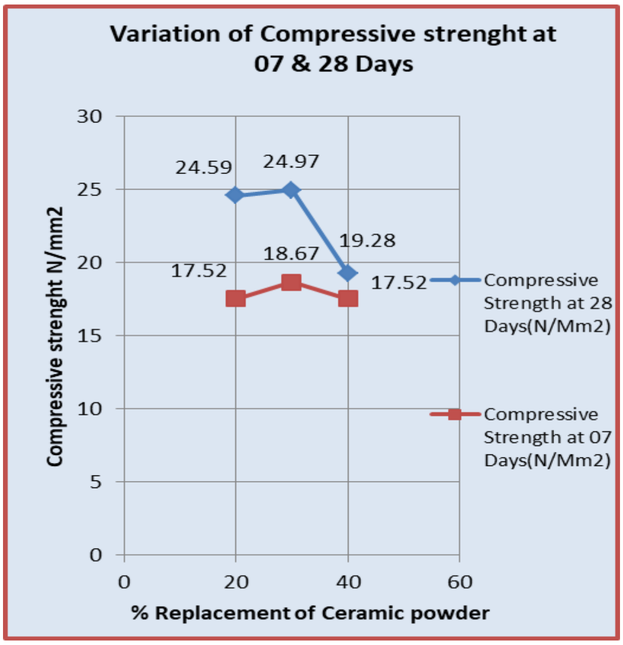

Figure 3: Compressive strength at 7 days and 28 days

The main objective of carrying out this research was being achieved as the results showed that the strength of concrete was increased using ceramic waste. From these results two main inferences can be drawn:

a) This alternative of cement is more cost effective.

b) Problem of disposal of industrial waste can be mitigated by using it in SCC as partial replacement of cement.

VII. CONCLUSION

This study established that as we increased the replacement of ceramic residue the compressive strength of SSC started to increase. This phenomenon is seen until the replacement reached to around 30 %. At this point the compressive strength was at its maxima. However, after this mark the compressive strength showed a constant decreasing pattern.

The study revealed that use of ceramic powder in self-compacting concrete minimizes the void ratio hence lower the water cement ratio which results in reduction of segregation of concrete. Thus the strength of self-compacting concrete also increased considerably.

This study also provided a more economically viable and environmental friendly alternative to conventional method of construction. The used of ceramic waste in this research also/ gave a suitable way of disposing up of hazardous ceramic waste.
This study paves the way for the use of other industrial waste in more economical way by using it in construction.

These encouraging results also build the platform of carry out further research work in this area.

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