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Experimental Studies on the Effect of Ceramic Fine Aggregate on the Partial Replacement of Sand Is an One of Ingredients in Concrete

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Abstract**:** *Scarcity of the construction materials using the natural resources like sand aggregate and stone aggregate. The partial replacement of aggregates is required for the future generation of concrete structures for the environment sustainability. The depletion of the natural resource get exhausted. We have thick over the alternate replacement of the materials. The replacement of materials calculating concrete strength in the various parameter like compressive strength of cube, split tensile strength of cylinder and flexure strength of prism. The result is interpolated in the replacement of the ceramic fine aggregate with the convention concrete. The comparisons of the parameter are compression strength of cube, split tensile strength of cylinder and flexure strength of prism.*
Keywords: *Cement, Coarsse aggeregte,Compression Stength,FlexureStrenght,Fine aggregate**,** Split tensile strength,Ceramic fine aggregate, Water.*

I. Introduction

The ceramic waste from ceramic and construction industries is a major contribute to construction and demolition waste, representing a serious environmental, technical and economical problem of society nowadays. The major sources of ceramic waste are ceramic industry, building construction and building demolition. It has been estimated that about 30% of the daily production in the ceramic industry goes to waste. This waste is not recycled in any form at present. However, the ceramic waste is durable, hard and highly resistant to biological, chemical and physical degradation forces. As the ceramic waste is piling up every day, there is pressure on the ceramic industries to find a solution for its disposal (RM Sentharamai, 2005). Properties of fresh and hardened concrete using ceramic waste as coarse aggregate and bottom ash as fine aggregate is compared with the properties of conventional concrete (S Karthikkrishnan, 2006). Rock flour can be effectively used as fine aggregate in place of conventional river sand, in concrete. Ceramic scrap can be partially used to replace conventional coarse aggregates (10% and 20%), without affecting its structural significance (MV Reddy, 2007).

Homogeneous ceramic tiles waste can be used as a replacement to natural crushed stones, as their properties are similar as natural coarse aggregates (Mashitah MD, 2008). Recycled concrete obtained through partial substitution of natural coarse aggregate is suitable for structural purposes (C Medina Martinez, Nov.2009). Investigation has been made on physical and mechanical properties of concrete mixed under laboratory conditions. Different proportions of coarse aggregate materials were substituted by porcelain from ceramic installations. Concrete made with porcelain debris as a substitute for part of the coarse aggregates is technically viable (I Guerra, 2009). Concrete with ceramic waste powder has a minor strength loss but possess increased durability performance because of its pozzolanic properties. As for the replacement of traditional coarse aggregates by ceramic coarse aggregates, the results are promising but they underperform slightly in water absorption meaning that the replacement of traditional sand by ceramic sand is a better option (F Pacheco-Torgal, 2010).

In the present study, the tests have been carried out for different trial mixes by gradual substitution of ceramic fine aggregate.

Figure 1 shows crushing of ceramic sinks.

II. Experimental Programme

2.1 Materials

2.1.1 Cement

PPC grade less cement is used for the laboratory investigations. The cement for the whole work was procured in a single consignment and properly stored. The properties of cement used in the investigation are presented in Table 2.1.

Table 2.1: Properties of Cement

Property		**Value**
Specific Gravity		3.15
Standard Consistency (%)		30.5
Initial setting time	(min)	50 min
Final setting time	(min)	580 min
Compressive strength		
@ 3days in MPa		16.5
@7days in MPa		23.5

2.1.2 Fine aggregate

2.1.2 A. Sand

River sand was used as fine aggregate. The properties of sand used in the investigation are presented in Table 2.2.

Table 2.2: Properties of fine aggregate

Property	**Value**
Specific Gravity	2.62
Water Absorption	1.35%
Fineness Modulus	3.2
Bulk Density (g/cm^3)	1.52
Sieve Analysis	Well Graded

2.1.2 B. Ceramic waste

Ceramic wastes of different shapes and sizes can be procured from the ceramic industry and the shapes should be modified using manual operations. In this study, ceramic wastes were collected from sink, wash basin and urinals. These ceramic wastes were broken into small pieces and then crushed in a jaw crusher to get 4.75 mm down size fine aggregate. The properties of fine aggregate used in the study are presented in Table 2.3.

Table 2.3: Properties of ceramic fine aggregate

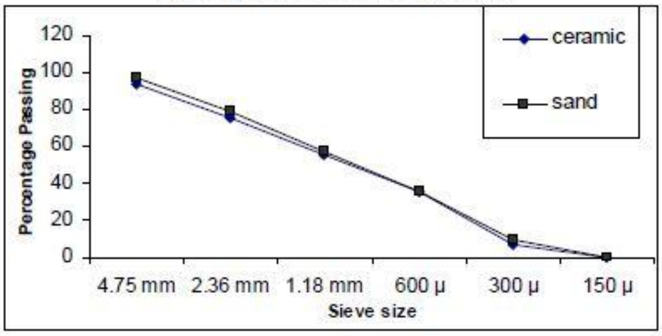
The particle size distribution of Ceramic fine aggregates and sand is shown in Figure 2.1. It is observed that, both ceramic fine aggregates and sand are confirming to Zone II.

Figure 2.1: Particle Size distribution

Property		**Value**
Specific Gravity		1.89
Water Absorption		6.56 %
Bulk Density (g/cm^3)		1.26
Impact Test		23.69 %

The particle size distribution of Ceramic fine aggregates and sand is shown in Figure 2.1. It is observed that, both ceramic fine aggregates and sand are confirming to Zone II.

Figure 2.1: Particle Size distribution



2.2 Preparation of Specimens

The quantities of the constituents of the concrete were obtained from the Indian Standard Mix Design Method (IS 10262:2007). The concrete was prepared in the laboratory using mixer. The cement, fine aggregate and coarse aggregate were fixed in dry state to obtain uniform colour and calculated amount of water, obtained from workability test, was added and the whole concrete was mixed for five minutes in wet state. Meanwhile the moulds were screwed tightly to avoid leakage. Oil was applied on inner surface of moulds in three layers by Poking with a tamping rod. The cast specimens were removed from moulds after 24 hours and the specimens were immersed in a clean water tank. After curing of specimens for a period of 28 days, the specimens were removed from the water tank and allowed to dry under shade.

Figure 2.2 Shows Mixing of materials, weigthing of materials and curing of concrete.

2.3 Tests

Three cubes of 150 mm x 150 mm x 150 mm size were tested to determine compressive strength for 28 days. Three cylinders of 150 mm diameter x 300 mm height size were tested for split tensile strength. Three prisms of 100 mm x 100 mm x 450 mm size were tested in flexure to determine the flexural strength.

Figure 2.2 Shows testing of concrete

2.4 Mix proportions

The grade of concrete adopted for investigation was M_{35}. In the present work, fine aggregate is replaced with ceramic fine aggregate. The mix proportion of conventional concrete (with 0% ceramic fine aggregate), 10% and 20% replacement of natural fine aggregate by ceramic fine aggregate is done along with varying cement content and coarse aggregates combination is indicated in Table 2.4 to Table 2.6.

Figure 2.3 Shows the mixing of concrete

Table 2.4: Mix proportion for conventional concrete

Mix designation	w/c (by weight)	Cement kg/m³	Proportions (by volume)
			C:FA:CA10:CA20*
M1	0.389	420	1:1.76:1.01:1.63
M2	0.392	400	1:1.88:1.08:1.74
M3	0.375	380	1:2.04:1.17:1.89

Table 2.5: Mix proportion with 10% replacement of natural fine aggregate by ceramic fine aggregate

Mix designation	w/c (by weight)	Cement kg/m³	Proportions (by volume)
			C:FA:CA10:CA20:CFA**
M4	0.410	420	1:1.28:0.98:1.58:0.428
M5	0.414	400	1:1.37:1.05:1.695:0.458
M6	0.396	380	1:1.49:1.14:1.838:0.496

Table 2.6: Mix proportion with 20% replacement of natural fine aggregate by ceramic fine aggregate

Mix designation	w/c (by weight)	Cement kg/m³	Proportions (by volume)
			C:FA:CA10:CA20:CFA**
M7	0.430	420	1:0.833:0.96:1.54:0.833
M8	0.433	400	1:0.875:1.00:1.62:0.875
M9	0.423	380	1:0.976:1.12:1.79:0.976

Cement : Sand: Coarse aggregate of 20 mm:Coarse aggregate 10 mm :Ceramic fine aggregate

III. Experimental Results

In the present investigation, compressive, split tensile and flexural strength of the concrete specimens were tested. Mix design is done as per IS: 10262-2007 [8]. As per the Mix design, the cement content works out to be 420 kg/m³. In our study, the cement content is also varied along with the ceramic fine aggregates. The natural fine aggregate in concrete is replaced by ceramic fine aggregate up to 20%. The compressive strength of concrete increases slightly with 10% replacement of ceramic coarse aggregate in concrete, which is observed in MV Reddy et.al (2007) is shown in Figure 3.1 to 3.3.

Figure 3.1: Compressive Strength of cubes for 420 kg/m³

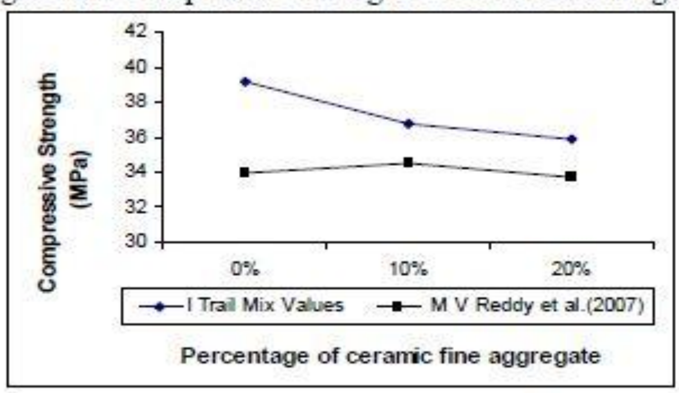


Figure 3.2: Compressive Strength of cubes for 400 kg/m^3

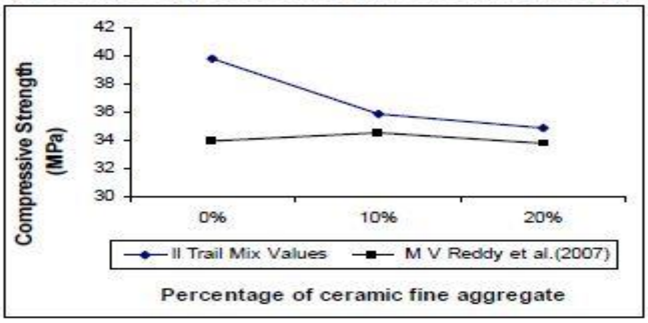
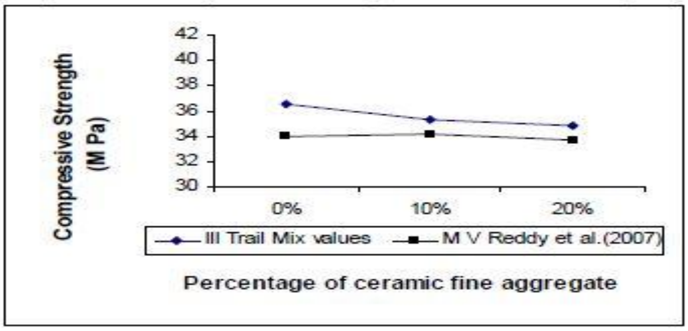


Figure 3.3: Compressive Strength of cubes for 380 kg/m^3



In our investigation, it is found that the compressive strength of concrete decreases slightly with increase in percentage of ceramic fine aggregates and also there is no much variation of strength with variation of cement content.

The split tensile strength of cylinders remains same with 10% and 20% replacement of ceramic coarse aggregate in concrete, which is observed in MV Reddy et.al (2007) is shown in Figure 3.4 to 3.6.

Figure 3.4: Split tensile strength of cylinders for 420 kg/m^3

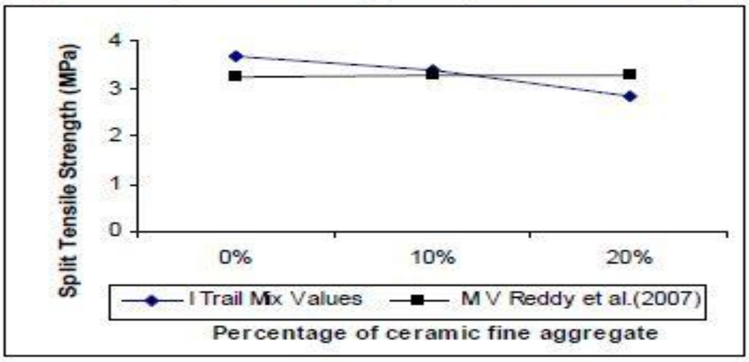


Figure 3.5: Split tensile strength of cylinders for 400 kg/m^3

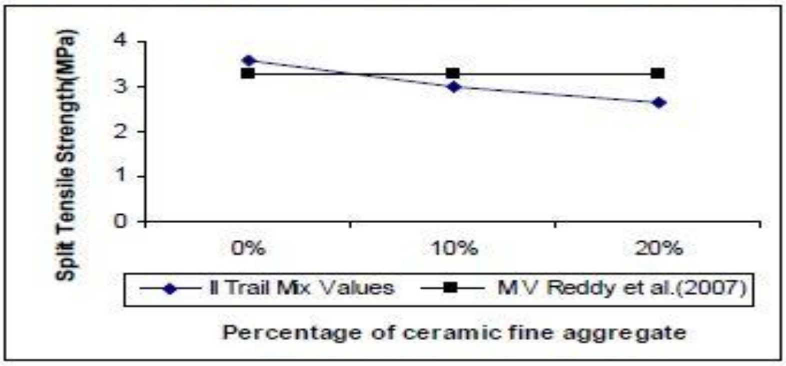
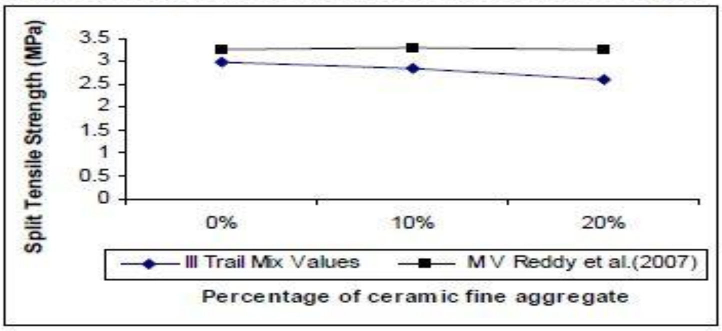


Figure 3.6: Split tensile strength of cylinders for 380 kg/m^3



In our investigation, it is found that the split tensile strength of cylinders decreases slightly with increase in percentage of ceramic fine aggregates and also there is no much variation of strength with variation of cement content from 420 kg/m^3 to 380 kg/m^3.

The flexural strength of prisms remains, the same with increase in percentage of ceramic coarse aggregate is shown in MV Reddy et al (2007). In our investigation, it is found that flexural strength of concrete decreases slightly with increase in ceramic fine aggregate is shown in Figure 3.7 to 3.9.

Figure 3.7 Flexural strength of concrete for 420 kg/m^3

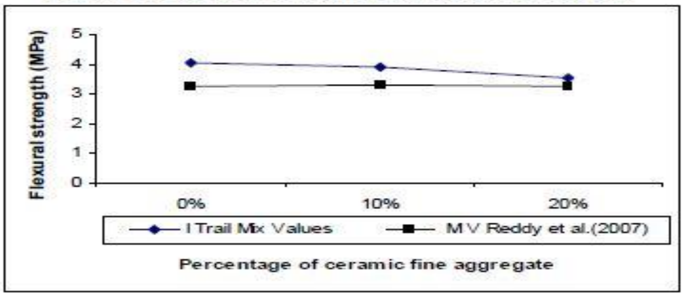


Figure 3.8 Flexural strength of concrete for 400 kg/m^3

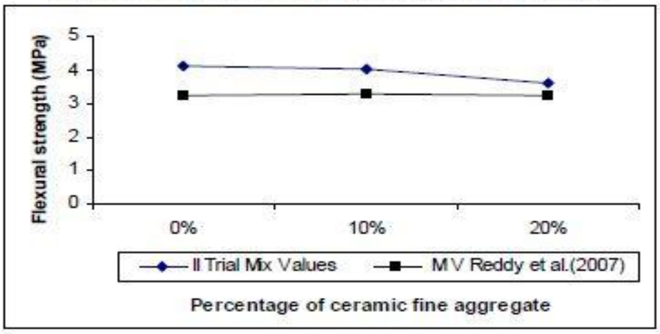
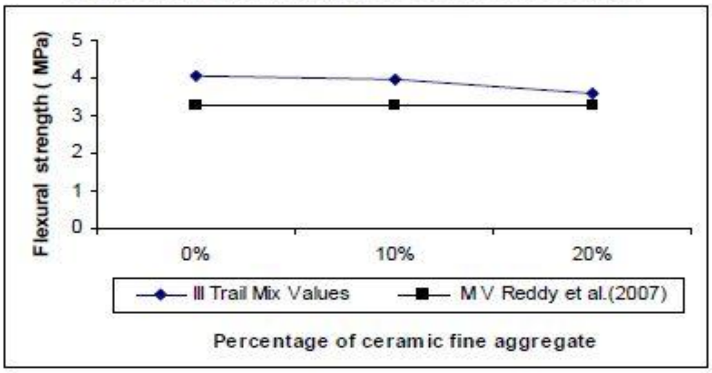


Figure 3.9 Flexural strength of concrete for 380 kg/m^3



IV. Conclusions

- The compressive strength of concrete slightly decreases with increase in percentage of ceramic fine aggregate in concrete but there is no much variation in compressive strength of concrete with the variation of cement content.
- The split tensile strength of concrete slightly decreases with increase in percentage of ceramic fine aggregate in concrete but there is no much variation in split tensile strength of concrete with the variation of cement content.
- The flexural strength of concrete slightly decreases with increase in percentage of ceramic fine aggregate but there is no much variation in split tensile strength of concrete with the variation of cement content.

References

[1]. R.M. Sentharamai, P Devadas Manoharam, "*Concrete with ceramic waste aggregate*," Cement & Concrete Composites, 27, pp.910-913, 2005.

[2]. Mashitah M.D, Kin CC, Badorui AH, "*Recycling of homogenous ceramic tiles for the production of concrete block*", International Symposium on Environmental Management: Hazardous-Environmental Management Toward Sustainability, pp 25-28, 2008.

[3]. C. Medina Martinez, MI Guerra Romero, JM Moran del Pozo and A Juan Valdes, "*Use of ceramic wastes in structurals concretes*,"*1st*

[4]. Spanish national conference on advances in materials recycling and Eco-energy Maoria, 12-13, pp 137-139, Nov.2009.

[5]. F Pacheco-Torgal, S Jalali, "*Reusing ceramic wastes in concrete*," Construction and Building Materials, 24, pp 832-838, 2010.

[6]. I Guerra, I Vivar, B Llamas, A Juan, J Moran, "*Eco-efficient concretes: The effects of using recycled ceramic material from sanitary installations on the mechanical properties of concrete*," Waste Management, 29, pp 643-646, 2009.

[7]. S. Karthikkrishnan, Dr. R.M. Senthamarai, "*Strength characteristics of concrete with ceracrete and bottom ash*," National conference on recent developments in concrete technology, Government college of Technology, Coimbatore- *641013*, 2006.

[8]. M.V. Reddy, C.N.V.S. Reddy, "*An experimental study on use of Rock flour and insulator ceramic scrap in concrete*," Journal of the Institution of Engineers, India, 88, pp 47-50, 2007.

[9]. IS: 10262-2007, "*Recommended guidelines for concrete mix design*," Bureau of Indian Standards, New Delhi.