International Journal of Inventive Engineering and Sciences (IJIES)
ISSN: 2319–9598, Volume-2, Issue-4, March 2014

Effect of Waste Materials in Partial Replacement of Cement Fine Aggregate and Course Aggregate in Concrete

Dayalan. J, Beulah. M

***Abstract:** A brief study on the suitability of silica fumes, powdered ceramic tiles and crushed animal bones as partial replacement for cement, fine aggregate and coarse aggregate respectively in concrete work has been carried out. Experimental study has been conducted for approximately 10 % of the silica fumes in replacement for cement, 20 % of the powdered ceramic waste powder in replacement for fine aggregate and 50 % of the crushed animal bones in replacement for coarse aggregate separately and in a single sample. Compressive strength, flexural strength and split tensile strength has been conducted for each sample. Results were quite satisfactory with no compromise in strength requirements for M20 grade concrete. Hence comparative study has been done between normal concrete and new concrete mix.*

***Keywords:** Silica Fumes - Powdered Ceramic Tiles - Crushed Bones – Compressive Strength – Flexural Strength - Split Tensile.*

I. INTRODUCTION

Concrete is widely used in construction of buildings, bridges and other structures. Great demand for building materials like sand and blue metal due to cost, scarcity has made the civil brains to find alternatives with the use of waste materials, by-products and recyclables. In this paper, silica fumes which is a by-product of silicon alloy manufacture, disposed ceramic tiles and unused animal bones are chosen to partially replace the basic materials of concrete. This study is concentrated mainly on low cost, easily available and high strength materials that possess the properties of concrete.Dilip Kumar Singha Roy and Amitava Sil, has studied that 10 % replacement of cement by silica fume has given excellent strength. The experimental study carried out by K.Perumal and R. Sundarajan has revealed that the replacement of 10% of silica fumes in cement has increased durability property. According to Zeena Adel Mohammed, 20 % of sand is replaced by powdered ceramics / porcelain. Javed Ahmad Bhat, Reyaz Ahmad Qasab and A. R. Dar has carried out the study at 25%, 35%, 50 %, 75% and 100% replacement levels of normal aggregates by crushed animal bones by weight and comparative study has been done. In this study, an attempt has been made to replace cement, sand and coarse aggregates in the same sample. Concrete mix for M20 grade is prepared with a water cement ratio of 0.55 and placed in moulds for cubes of size 150 mm, cylinders of diameter 150 mm & height 285 mm and beams of size 50 cm x 10 cm x 10 cm. In fresh state, slump cone test and compaction factor test have been conducted. Test for compression, flexural and split tensile have been done in hardened state on 7 days and 28 days.

Manuscript received March, 2014.

Dayalan. J, Department of Civil Engineering, Christ University Faculty of Engineering, Bangalore, India.

Beulah.M, Department of Civil Engineering, Christ University Faculty of Engineering, Bangalore, India.

II. EXPERIMENTAL WORK

In the present study various tests on materials such as cement, fine aggregate, coarse aggregate and the waste materials were performed as per the Indian Standards.

A. Material Used

Sand: River sand was used as fine aggregate. The size of the sand used is 4.75 mm and down size. The properties of sand are conformed as per Indian Standards. The specific gravity of sand was found to be 2.67.

Ceramic powder: Ceramic tiles waste powder obtained from local ceramic tile manufacturing unit was used in replacement of fine aggregates in 10% in all mix composition. Ceramic material is hard, rigid. It is estimated that 15 to 30% waste are produced of total raw material used. The specific gravity of ceramic powder is found to be 3.12.

B. Coarse aggregate

The fractions from 20 mm to 4.75 mm are used as coarse aggregate conforming to IS: 383 is used. The Flakiness and Elongation Index were maintained well below 15%. The specific gravity and water absorption of coarse aggregates are found to be 2.9 and 0.6 % respectively.

C. Crushed animal bones

The animal bones are crushed in machine to size of 15-20mm and below. The physical of crushed animal bones are presented in table 1.

Published By:
Blue Eyes Intelligence Engineering
& Sciences Publication Pvt. Ltd.

Table 2. Details of Mix designation

Mix Designation	Cement		Fine Aggregates		Coarse aggregates	
	Cement	Silica fume	Sand	Ceramic tiles	Coarse aggregate	Crushed bones
M0	100%	-	100%	-	100%	-
M1	90%		80%	20%	50%	50%
M2	90%	10%	80%	20%	100%	-
M3	100%	-	80%	20%	-	50%
M4	90%	10%	100%	-	100%	50%
M5	90%	10%	100%	-	100 %	-
M6	100%	-	80%	20%	100%	-
M7	100%	-	100%	-	50%	50%

Table 1. Properties of Crushed Animal Bones (CAB)

Sl. No.	Property	Value
1	Specific Gravity	1.7
3	Water Absorption	3 %
4	Bulk density (Kg/m^3)	21
5	Crushing value	30%

D. Cement

The Ordinary Portland Cement of 53 grade conforming to IS: 8112 is used. The standard tests were conducted and all the results were found satisfactory as per IS code.

E. Silica Fume

Silica fume has been obtained from Ishran nanotech foundation Chennai. It is a byproduct resulting from reduction of high purity quartz with coal or coke and wood chips in an electric arc furnace during the production of silicon metal or Ferro silicon alloys. The specific gravity of silica fume is 2.2.It consist of 0.1 to 1 micron sized fine ,smooth spherical glassy particles with fineness of 20m² /gm.

III. MIX SELECTION

The grade of concrete adopted for investigation is M 20. The mix proportion used is 1:1.5:3 with water cement ratio 0.45 .the details of mix designations and specimens used in experimental program are given in Table No.2

IV. RESULTS AND DISCUSSIONS

A. Workability test

In fresh state, concrete is first tested for slump. Slump for various samples has been displayed in Table.2. It was observed that samples with replacement materials have different slump. Due to rough texture and angular shape of crushed bone aggregates the concrete becomes low workable, but on the other hand there is good bonding among the ingredients as compare to conventional concrete ingredients. This can be attributed to the fact that since the normal aggregates are denser than CAB aggregates and the replacement is by weight, the specific surface area increases as the CAB aggregate content is increased. Thus, increase in the specific surface area due to lightness of CAB aggregates and greater amount of water needed for the mix ingredients to get closer packing, results in decrease in workability of mix.

Table3. Slump value for different mix

Sl. No.	Mix Designation	Slump(mm)
1	M0	130
2	M1	85
3	M2	78
4	M3	114
5	M4	0
6	M5	55
7	M6	98
8	M7	1

B. Compressive strength

Compressive strength tests were performed on compression testing machine using cube samples. Three samples per batch were tested with the average strength values reported in this paper. The comparative studies were made on their characteristics for concrete mix ratio of 1:1.80:3.38 with partial replacement of cement, sand and coarse aggregates as given in mix designation. The average compressive strength results are shown in Table 4. From the result it is observed that the compressive strength of mix M5 is maximum and minimum for mix M1 i.e. when cement, coarse aggregates and fine are aggregates are replaced by silica fume, CAB and silica fume respectively.

Table 4. Average Compressive strength (N/mm^2)

Sl. No.	Mix Designation	Average Compressive Strength (N/mm^2)	
		7 Days	28 Days
1	M0	13.33	20.74
2	M1	12.2	18.3
3	M2	16.54	27.06
4	M3	13.72	21.93
5	M4	14.56	24.52
6	M5	17.38	29.65
7	M6	15.7	24.47
8	M7	11.74	19.39

C .Split-tensile strength:

The results obtained from split tensile strength are tabulated in Table 5. The maximum value of spilt tensile strength is found to be 7.22 for design mix M6 (16% more than that of conventional mix).

Table 5. Split tensile strength

S.No	Mix designation	Split-tensile Strength (N/mm^2)	
		7th day	28th day
1	M0	4.08	6.12
2	M1	3.01	5.7
3	M2	2.60	5.34
4	M3	2.14	4.57
5	M4	0.81	2.69
6	M5	1.23	4.15
7	M6	3.98	7.22
8	M7	0.38	1.92

D. Flexural Strength

The various flexural values for the samples are tabulated for different mix designation in Table. The maximum 28 days strength of concrete mix was found to be 3.52 N/mm^2 for mix M5. This value is far more than the value calculated from the expression 0.7√ fck (where fck is the characteristic strength of concrete) as specified by IS: 456 (Indian Standard Specifications).

Table 6. Flexural Strength

S.No	Mix designation	Flexural Strength (N/mm^2)	
		7th day	28th day
1	M0	3.13	2
2	M1	2.09	3.25
3	M2	2.55	3.26
4	M3	2.36	2.79
5	M4	2.17	3.05
6	M5	2.35	3.52
7	M6	2.74	2.99
8	M7	1.98	2.58

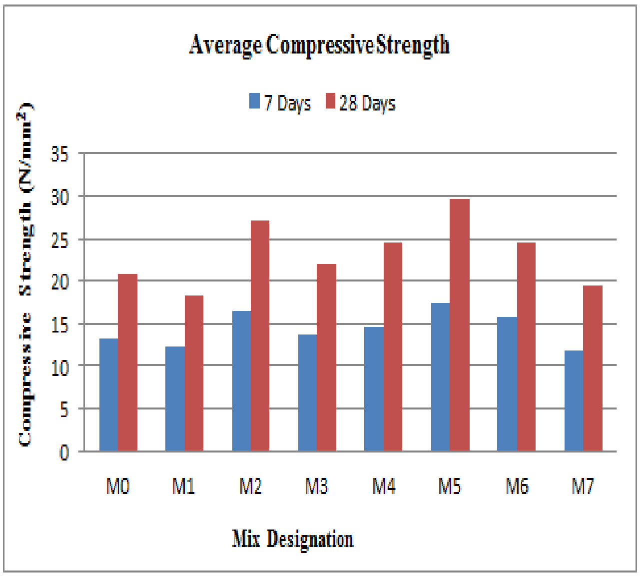

Fig.1. Average Compressive Strength

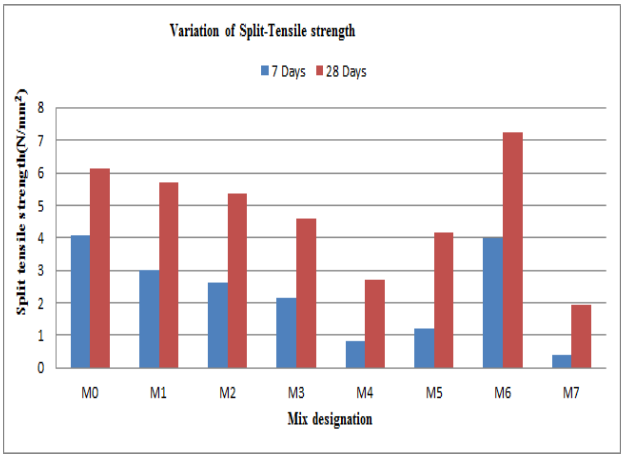

Fig.2.Split tensile Strength

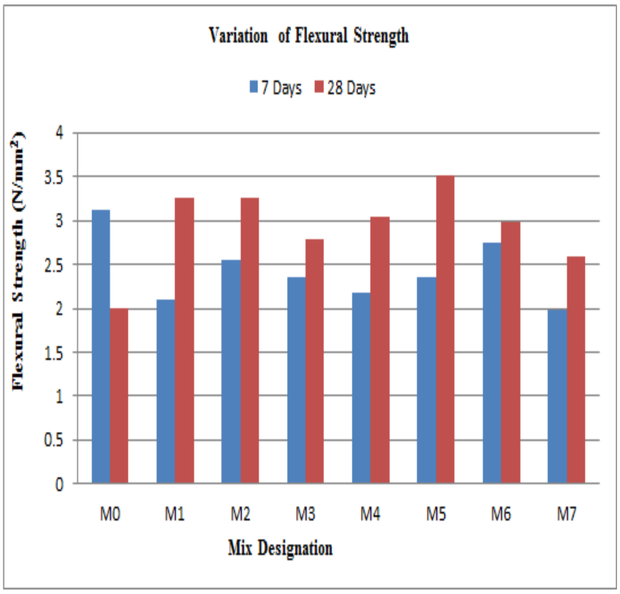

Fig.3.Flexural Strength

IV.CONCLUSION

It is concluded that the replacement of cement, sand and coarse aggregate with waste materials did not affect the properties of normal concrete mix drastically. At the same time, it gives less positive results when compared to the samples which have a single material being replaced. Further studies are needed for implementation of samples like this. Hence a concrete can have benefits of light weight, economical, reduction in environmental pollution, good quality, high strength, durable and highly compact structure simultaneously.

REFERENCE

[1]. Mukesh B.Patel, Charkha.D.. "Effect of silica fume and partial replacement of ingredients on flexural and split tensile strength of concrete", International journal of emerging trends in engineering and development, Issue 2, Vol.4 (May2012)

[2]. Ramkumar.V.R,, Murali. G, Jayaganesh.V, "Flexural behaviour of concrete by using silica fumes as partial replacement of cement", International journal of emerging trends in engineering and development, Issue 2, Vol.4 (May2012), p.p 590-593

[3] Dilip Kumar Singha Roy, Amitava Sil,,"Effect of Partial Replacement of Cement by Silica Fume on Hardened Concrete" International Journal of Emerging Technolgy and Advanced Technology,Issue 8, Vol.2 (Aug 2012) p.p.472-475

Published By:
Blue Eyes Intelligence Engineering
& Sciences Publication Pvt. Ltd.

[4]. Zeena Adel Mohammed, "Effect of partial replacement of fine aggregate on some engineering properties of concrete" by
[5]. Javed Ahmad Bhat, Reyaz Ahmad Qasab and A. R. Dar in "Machine crushed animal bones as partial replacement of coarse aggregates in lightweight concrete", ARPN Journal of Engineering and Applied Sciences,(sep 2012), Vol.7.p.p.1202-1207
[6]. Indian Standards. 1970. IS: 383, Specification for Coarse and fine aggregates from Natural sources for concrete.Bureau of Indian standards, New Delhi, India.
[7]. Thomas, M D. A. Using Silica Fume to Combat ASR in Concrete, Indian Concrete Journal, (Oct. 2001), pp 656-664 [6] Lewis, R. C. , Hasbi, S. A. : Use of Silica Fume concrete :Selective case studies, Indian Concrete Journal, (Oct. 2001), pp. 645-652.
[8] Roncero, J., Gettu, R., Agullo, L. Vazquez, E. : Flow behaviour of superplasticised cement pastes : Influence of Silica Fume, Indian Concrete Journal, (Jan. 2002), pp. 31-35.
[9]. Polat R., Demirbo_A.R., Karakoç M.B. and Türkmen I.(2010) The influence of lightweight aggregate on the physico-mechanical properties of concrete exposed to freeze–thaw cycles. Cold Reg. Sci. Tech. 60: 51-56.
[10]. Robert L., Lindon S., Peter W. and Ray R. 2003.Cementitious additions. In: John N, Ban SC (Eds.).Advanced Concrete Technology. Elsevier publications,Amsterdam.
[11]. Rossignolo J.A., Agnesini M.V.C. and Morais J.A. 2003. Properties of high performance LWAC for precast structures with Brazilian lightweight aggregates. Cement Con. Compo. 25: 77-82.
[13]. Teo D.C.L., Mannan M.A. and Kurian V.J. 2006.Structural Concrete Using Oil Palm Shell (OPS) as Lightweight Aggregate. Turk. J. Eng. Env. Sci. 30: 251

Published By:
Blue Eyes Intelligence Engineering
& Sciences Publication Pvt. Ltd.