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A Study on Compressive Strength Characteristics of High Strength Concrete Using Demolished Aggregate and Silica Fume

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Abstract: *The major challenge of our present society is the protection of environment. Some of the important elements in this respect are the reduction of the consumption of energy and natural raw materials and consumption of waste materials. These topics are getting considerable attention under sustainable development now-a-days. The use of Demolished Aggregate (DA) from construction and demolition wastes is showing prospective application in construction as alternative to primary (natural) aggregates. It conserves natural resources and decrease the space required for the landfill disposal. The High Strength concrete has become more popular in recent years owing to the extraordinary advantages it offers over the conventional concrete but at the same time strong enough to be used for the structural purpose. The aim of the present work is to study the attitude of coarse aggregate replaced with demolished aggregates in volume percentages of 10 %, 15 %, 20 %, 25 %and 30 % cement replaced with the silica fume in weight percentages of 5 %, 10 %, 15 %, 20 %, and 25 %. The conventional mix has been designed for M40 grade concrete. In this research, cubes, cylinders and beams of standard size have been cast and tested after 3 days, 7 days 28 days, 56 days of curing period. The properties of concrete mix proportions were evaluated by measuring workability (using slump test), compressive strength. The mixing of silica fume enhanced workability, compressive strength of the concrete for the types of cement.*

Keywords: *Demolished Aggregate (DA), Portland cement, Mechanical properties of concrete, Silica fume of concrete*

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I. Introduction

In India, the manufacturing of Portland cement was commenced around the year 1912. The beginning was not very promising and growth of cement industry was very slow. At the time of independence in 1947, the installed capacity of cement plants in India was approximately 4.5 million tons and actual production around 3.2 million tons per year. The large construction activity undertaken during the various 5 years plans necessitated the growth of cement industry. However, until the year 1982, the growth remained stinted due to the complete control exercised by the Government over the cement industry. The partial deep control in 1982 prompted various industrial houses to setup new cement plants in the country. Concrete is the largely used material in different types of construction, from the flooring of a cot to a multi storied high boost structure from pathway to an airport runway, from an underground tunnel and deep sea platform to high-rise chimneys and TV Towers. The last millennium concrete has challenging requirements both in terms of technical performance and economy while greatly varying from architectural masterpieces to the simplest of utilities. Concrete is one of the intelligent heterogeneous materials, civil engineering has always known. The arrival of concrete civil engineering has touched highest peak of technology. Concrete is a material with which any shape can be casting and with any strength. The material of preferred where strength, performance, durability, impermeability, fire resistance and abrasion resistance are required.

II. Literature Review

It has been shown that the crushed concrete rubble, after separated from other construction and demolition wastes are sieved, can be used as substitute for Natural Coarse Aggregates and can be used as Natural Fine Aggregate in concrete. Successful application of Demolished Coarse Aggregate in construction projects has been reported in some European and American countries, as reviewed by Demister et al. (2000). In comparison with natural regular weight aggregates and Demolished Coarse Aggregates are weaker, more porous and have higher values of water absorption. The results of research studies by Hendricks et al. 1998, when DCA obtained from crushed concrete are used to replace up to 20% by weight of the Natural Coarse Aggregate in concrete, little effect on the properties of concrete is noticed.The concrete strength decreases when recycled concrete was used (Barry et al., 1996) , However, no decrease in strength was reported for concrete containing up to 20% fine or 30% coarse Demolished Coarse aggregate , but beyond these levels , there was a systematic decrease in strength as the content of Demolished Coarse Aggregates increased (Dire et al.,1999).The strength characteristics of concrete was not affected by the quality of Demolished Coarse Aggregates at high water/cement ratio, it was only affected when the water/cement ratio is low (Rye, 2002 and Padding et al ., 2002). Higher water/cement ratio , lesser is the devaluation in compressive strength (Chen et al ., 2003, Dire et al ., 1999 and Rye, 2002).Beyond 28 days of curing, the ratio of strength development in containing crushed concrete is higher than that of the control indicating further cementing action in the presence of fine Demolished Coarse Aggregate (Katie, 2005).

The investment of cement content, workability, compressive strength and cost of concrete made with demolished fine aggregate were studied by researchers Babu K.K. et al., 1997, Nag raj T.S et al. 1996 and Narasimahan et al. 1999. The mix design proposed by Naga raj et al. 2000 shows the possibilities of ensuring the workability by combination of DFA and FA, use of optimum water content using generalized lyses Rule.Sahu A.K. et al. 2003, reported significant increase in compressive strength, when 20 percent of Fine aggregates regained by DFA in concrete. Nagamani A.K.et al. 2006 reported that Natural Aggregate with full replacement in concrete as possible with proper treatment of DFA before utilization

III. Materials Used

3.1 CEMENT: - 53 grade (OPC – Ultratech Cement) was used in the experimental investigation. It was tested for its physical properties in accordance with Indian Standard specifications. The fine aggregate used in this investigation was clean river sand, passing through 4.75 mm sieve with specific gravity of 2.6. The grading zone of fine aggregate was zone II as per Indian Standard specifications. Machine crushed granite broken stone angular in shape was used as coarse aggregate. The maximum size of coarse aggregate was 20 mm with specific gravity of 2.60. Ordinary clean portable water free from suspended particles and chemical substances was used for both mixing and curing of concrete.

3.2.FINE AGGREGATE: The fine aggregate obtained from river bed, clear from all sorts of organic impurities was used in this experimental program. The fine aggregate was passing through 4.75 mm sieve and had a specific gravity of 2.44. The grading zone of fine aggregate was zone II as per Indian Standard specifications.

3.3.COARSE AGGREGATE: Coarse aggregate are the crushed stone is used for making concrete. The commercial stone is quarried, crushed, and graded. Much of the crushed stone used is granite, limestone, and trap rock. The last is a term used to designate basalt, gabbro, diorite, and other dark-colored, fine-grained igneous rocks. Graded crushed stone usually consists of only one kindof rock and is broken with sharp edges. The sizes are from 0.25 to 2.5 in (0.64 to 6.35 cm), although larger sizes may be used for massive concrete aggregate. Machine crushed granite broken stone angular in shape was used as coarse aggregate. The maximum size of coarse aggregate was 20 mm and specific gravity of 2.60.

3.4.Water

Water fit for drinking is generally considered fit for making concrete. Water should be free from acids, oils, alkalies, vegetables or other organic Impurities. Soft waters also produce weaker concrete. Water has two functions in a concrete mix. Firstly, it reacts chemically with the cement to form a cement paste in which the inert aggregates are held in suspension until the cement paste has hardened. Secondly, it serves as a vehicle or lubricant in the mixture of fine aggregates and cement.

3.5. Demolished Coarse Aggregate (DCA): The construction and demolition wastes are collected from a regional building that has been demolished and constructed. The aggregates passing over IS sieve 20 mm and retained on 12.6 mm are taken. The specific gravity of tile aggregates is 2.6 and fineness modulus of 7.358. The easy and compacted bulk densities are 1358 kg/m3 and 1512 kg/m3 respectively , and water absorption of 0.50%.The aggregate crushing value (%) and aggregate impact value (%) of coarse aggregate is 36.3% and 35.20% respectively. Demolished waste is collected from residential building near Tirupati. L.C. Nagar and Tirupati.

3.6.Silica Fume: The American Concrete Institute (ACI) defines silica fume as “very fine non-crystalline silica produced in electric arc furnaces as a by-product of the production of elemental silicon or alloys containing silicon”. It is usually a gray colored powder, somewhat similar to Portland cement or some fly ashes

IV. Results And Discussions

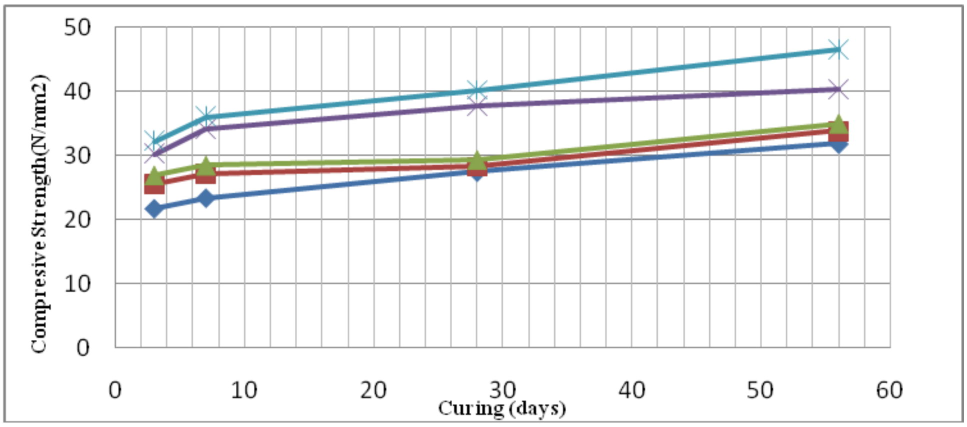
II.1 Compressive Strength Of Demolished Coarse Aggregate *and Silica Fume Concrete*

Compressive Strength Results:

The experimental program was designed to compare the mechanical properties i.e., Compressive Strength of Cubes & Cylinders of high strength concrete with M40 grade of concrete and with different replacement levels of Ordinary Portland cement (Ultra Tech cement 53 grade) with Demolished Coarse Aggregates and Silica Fume Compression testing machine was used to test all the specimens. The series of specimens were cast with M40 grade concrete with different replacement levels of Coarse Aggregates as 10%, 15%, 20% and 25%.30% with Demolished Coarse Aggregates and 0%, 5% & 10% of Silica Fume.

Table No. 1. Average Compressive Strength for M40 using % of DCA

Sample	Compressive Strength (MPa)			
	3 Days	7 Days	28 Days	56 Days
10%DCA	21.77	23.43	27.466	31.86
15%DCA	25.57	27.24	28.29	33.86
20%DCA	26.90	28.44	29.32	34.95
25%DCA	30.25	34.11	37.65	40.29
30%DCA	32.25	36.09	40.26	46.62



Graph.1. Comparisons Values of Compressive Strength for M 40 Using DCA

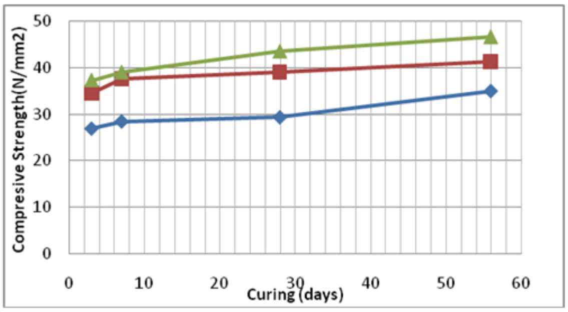
Table No. 2.Average Compressive Strength for M40 (DA+SF)

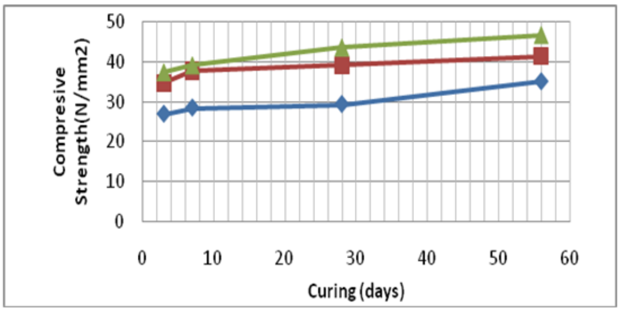
Sample	Compressive Strength (MPa)			
	3 Days	7 Days	28 Days	56 Days
10%DCA+0%SF	21.77	23.43	27.466	31.86
10%DCA+5%SF	28.09	28.97	29.80	34.59
10%DCA+10%SF	29.65	32.00	35.04	37.59

Sample	Compressive Strength (MPa)			
	3 Days	7 Days	28 Days	56 Days
15%DCA+0%SF	25.57	27.24	28.29	33.86
15%DCA+5%SF	31.57	34.64	36.47	39.12
15%DCA+10%SF	32.24	36.03	37.47	41.27

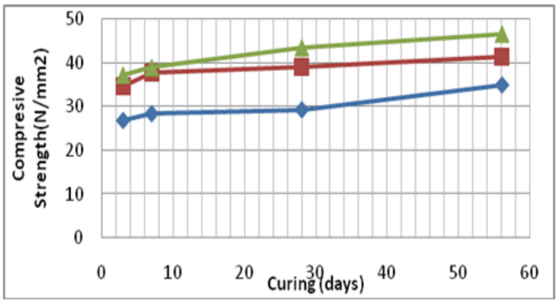
Sample	Compressive Strength (MPa)			
	3 Days	7 Days	28 Days	56 Days
20%DCA+0%SF	26.90	28.44	29.32	34.95
20%DCA+5%SF	34.57	37.64	39.02	41.27
20%DCA+10%SF	37.24	38.97	43.47	46.60

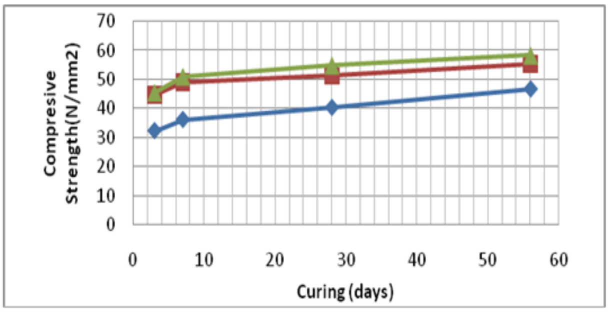
Sample	Compressive Strength (MPa)			
	3 Days	7 Days	28 Days	56 Days
25%DCA+0%SF	30.25	34.11	37.65	40.29
25%DCA+5%SF	38.24	40.14	44.14	47.93
25%DCA+10%SF	41.24	45.14	48.47	52.93





Graph.2. Compressive Strength for M_{40}using10%DCA+5%&10%SF
Graph.3. Compressive Strength for M_{40}using20%DCA+5%&10%SF





Graph.4. Compressive Strength for M_{40}using15%DCA+5%&10%SF
Graph.5. Compressive Strength for M_{40}using25%DCA+5%&10%SF

V. Conclusion

Based on the present experimental investigation, the following conclusions are drawn Cement replacement with 5% and 10% SF & Coarse replacement with 10%DCA leads to increase in Compressive Strength.For M40 Grade with DCA 30% the percentage increase in Compressive Strength is 14.76%, 4% and 6.4% respectively.30 % DAC appears to be the optimum in the Standard concrete mix like M40 without any admixtures.For M40 Grade with DAC 30 % and Silica Fume 5 %,10 % the percentages increase in Compressive Strength is 26.41 %.There is an increase in Young's Modulus of Concrete for M40 with DAC 30 % and Silica Fume 10% is 50.70 % and 58.88 % respectively higher than Conventional Concrete The Compressive Strength of Cylinders for M40 with Silica Fume 10% is 17.14% and 11.07 % respectively higher than Convectional Concrete

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