INTERNATIONAL RESEARCH JOURNAL IN ADVANCED ENGINEERING AND TECHNOLOGY (IRJAET) E - ISSN: 2454-4752 P - ISSN : 2454-4744
VOL 4 ISSUE 3 (2018) PAGES 3815 – 3825
RECEIVED : 05.05.2018 PUBLISHED : 09.06.2018

June 09, 2018

Mechanical And Durability Properties Of Recycled Aggregate Concrete With Fly Ash

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Abstract:

Recycled aggregate is one of the most common materials for the construction and development of infrastructures in all the countries in the world. As for India is concerned it was started recently. In the years to come there will be increase in the production of concrete which needs huge amount of natural aggregates, such huge requirement of natural aggregate may lead to the depletion of natural resources in turn the resources will not be available for future generation. Recycle aggregate can be obtained from various sources like demolished concrete waste of building, roads ,bridges and catastrophes such as wars and earthquakes. Recycling of demolished concrete waste provides an opportunity for saving natural resources, energy, time, money and limited landfill space.The use of recycled aggregated weakens the quality of concrete due to shortcomings such as weaker interfacial bond between aggregate and cement paste .For improving the quality of recycled coarse aggregate, various surface treatment methods such as washing the recycled aggregates with water, diluted acid, enveloping with silica fume were investigated by various researchers.Fly ash is a mineral residue obtained as a by-product from burning of pulverized coals in thermal power plant. Fly ash looks very similar to cement in appearance. In India about 40% of coal is consumed for generating fly ash as a by-product. Fly ash molecules are spheroid in shape and less than 250 micrometers in size. Fly ash has been used in this work for improving of recycled aggregate concrete.

Keywords: Recycled Coarse Aggregate, Concrete Strength, Compressive Strength, Modulus of Elasticity.

I. INTRODUCTION

The use of recycled aggregate in concrete is gaining momentum these days. In the years to come the recycled aggregate concrete may become the need of the day. The waste concrete can be produced from a number of different sources. The most common are demolition projects.Many concrete structures like building, bridges, side walls and roads are razed after a period of time into their service life for purpose of replacement or landscape changes. Other sources of waste include natural disasters like earthquakes, avalanches, and tornadoes. All these contribute to vast quantities of waste concrete that must be managed in some way.Recycled aggregate utilizes demolition material from concrete and burnt clay brick masonry construction as aggregate. Reuse of demolition waste disposal is also helpful in reducing the gap between the demand and supply of crushed granite fresh aggregate. While the amount of demolition waste materials generated in India has not yet been quantified properly, it is thought that presently the yearly rate of demolition of buildings and other structures in the major cities has reached 1 to 2 percent.

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This is mainly due to the following reasons:

- Demolition of structures, which have become obsolete either in serving the basic functions or due to structural deterioration.
- Demolition of structures for better economic gains (through new construction)
- Waste construction material formed due to natural disasters like earthquakes, cyclone and flood and War – inflicted damages.

Most of the waste materials produced by demolishing structures are disposed by dumping them as landfill or for reclaiming land. But with the demand for land increasing day by day, the locations, capacity and width of the land that can receive waste materials are becoming limited. In addition to that, the cost of transportation for disposal makes a major problem. Hence, reuse of demolition waste appears to be an effective solution, it is the most appropriate and large-scale use to produce concrete for new construction. After the Second World War, a number of European countries like Germany, England, Netherlands and Japan made their attempts to study and reuse demolition materials in the construction of civil engineering works.

An existing plant for the production of crushed – rock aggregate, comprising primary and secondary crusher and screens were used to produce recycled concrete aggregate in various size fractions, 20-10, 10-5 and <5 mm. The fragment of the crushed concrete which is less than 5mm is separately collected from the crusher and sieved by using I.S. sieves. The fragment passing through 4.75 mm. I.S. sieves is taken as recycled concrete aggregate, which is used for partial replacement of natural sand.

Recycled Coarse Aggregate

Fly ash closely resembles volcanic ashes used in production of the earliest known hydraulic cements. About 2,300 years ago. Those cements were made near the small Italian town of Pozzuoli - which later gave its name to the term "pozzolan." A pozzolana is a siliceous or siliceous / aluminous material that, when mixed with lime and water, forms a cementations compound. Fly ash is the best known, and one of the most commonly used, pozzolana in the world. Instead of volcanoes, today's fly ash comes primarily from coal-fired electricity generating power plants. These power plants grind coal to powder fineness before it is burned. Fly ash is the mineral residue produced by burning coal is captured from the power plant's exhaust gases and collected for use.

Fly ash is one of the residues generated in combustion, and comprises the fine particles that rise with the fuel gases. Ash which does not rise is termed bottom ash. In an industrial context, fly ash usually refers to ash produced during combustion of coal. Fly ash is generally captured by electrostatic precipitators or other particle filtration equipments before the flue gases reach the chimneys of coal-fired power plants, and together with bottom ash removed from the bottom of the furnace is in this case jointly known as coal ash. Depending upon the source and makeup of the coal being burned, the components of fly ash vary considerably, but all fly ash includes substantial amounts of silicon dioxide (SiO_2) (both amorphous and crystalline and calcium oxide (CaO), both being endemic ingredients in many coal-bearing rock strata.

Fly ash is comprised of the non-combustible mineral portion of coal. When coal is consumed in a power plant, it is first ground to the fineness of powder. Blown into the power plant‘s boiler, the carbon is consumed leaving molten particles rich in silica, alumina and calcium. These particles solidify as microscopic, glassy spheres that are collected from the power plant‘s exhaust before they can fly away hence the product‘s name: Fly Ash.

Mechanically, fly ash also pays dividends for concrete production. Because fly ash particle are small, they effectively fill voids. Because fly ash particle are hard and round, they have a ball bearing effect that allows to concrete to be produced using less water. Both characteristics contribute to enhanced concrete workability and durability.

Finally, fly ash use creates significant benefits for our environment. Fly ash use conserves natural resources and avoid land fill disposal of ash products. By making concrete more durable, life cycle costs of road and structure are reduced. Furthermore, fly ash use partially displaces production of other concrete ingredients, resulting in significant energy savings and reductions in greenhouse gas emissions.

II. EXPERIMENTAL INVESTIGATION

A. Cement

Cement used for the specimen was ordinary Portland cement. The cement used was in standard gunny bags and transferred to latter to air tight steel drums to avoid deterioration of the quality confirming IS 8112:1989

B. Fly Ash

The fly ash is collected from METTUR THERMAL POWER STATION and it is confirming to IS 3812

C. Fine Aggregate

The fine aggregate used in this experimental investigation was natural river sand confirming to zone II of IS: 383 – 1970.

D. Coarse Aggregate

The coarse aggregate used in the mixes are hard blue granite stones from quarries around 20 mm size aggregate was used and It is confirmed to IS383

E. Recycle Coarse Aggregate

Crushed concrete waste passing through 20mm and retained on 4.75mm I.S sieve were used as recycled coarse aggregate and they met the grading requirements IS 2386 - 1983.The recycled coarse aggregate was collected from demolished structures. 20 mm size aggregate was used.

F. Water

The water used for experiments was potable water.

G. Experimental Programme

The mix design of recycled coarse aggregate concrete is not different from that of conventional concrete and same mix design procedure given in IS 10262:2000 was adopted.

The concrete specimens are prepared with natural aggregate and fully recycled aggregate for the grades of concrete M30.

The cement content in this mix has been replaced by fly ash in 0%, 25%, 35%, and 55%. Natural Aggregate (NA) was replaced by Recycled Aggregate (RA) of 0%, 50% and 100%.

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H. Slump Test

Slump test is used to determine the workability of fresh concrete. The test simple and cheap. It is suitable to use in the laboratory and also at site. Although the test is simple, but the testing has to be done carefully due to huge slump may obtain if there is any disturbance in the process.

TABLE I

Specimen	Replacement of Fly Ash %	Replacement of RCA %	Slump Value (mm)
Trial 1	0	0	72
		50	71
		100	70
Trial 2	15	0	71
		50	72
		100	70
Trial 3	25	0	72
		50	73
		100	71
Trial 4	35	0	72
		50	71
		100	70

Slump

Specimen

I. Compaction Factor

Compaction factor test was also used to determine the workability of fresh concrete as it gives a more accurate than slump test. The compacting factor test is also known as the “drop test”, which measures the weight of fully compacted concrete and compare it with the weight of partially compacted concrete.

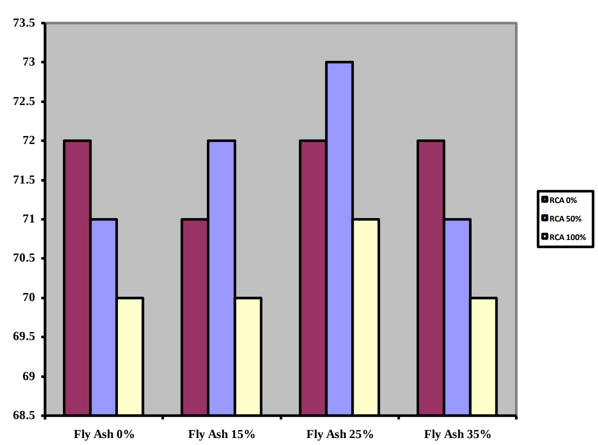

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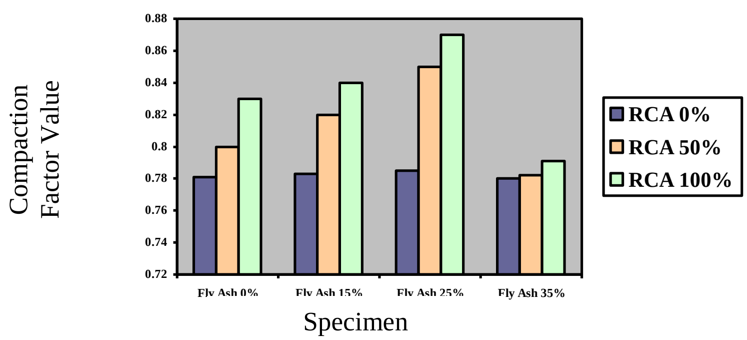
TABLE III

Specimen	Replacement of Fly Ash %	Replacement of RCA %	Compaction Factor Value
Trial 1	0%	0	0.781
		50	0.800
		100	0.830
Trial 2	15	0	0.783
		50	0.820
		100	0.840
Trial 3	25	0	0.785
		50	0.822
		100	0.870
Trial 4	35	0	0.780
		50	0.782
		100	0.791



J. Compression Strength Test

The average compressive strength and decrease in compressive strength values due to replacement of cement with fly ash and NCA with RCA at varies ages of concrete.

Specimens	Replacement Of Fly Ash%	Replacement Of RCA %	Avg Comp Strength 7 Days N/mm^2	Average Comp Strength 14 Days N/mm^2	Average Comp Strength 28Days N/mm^2
Con	-	-	**19.5**	**26.95**	**29.98**
TRIAL 1	0	0	19.5	26.95	29.98
		50	19.45	26.9	29.85
		100	19.43	26.88	29.78

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TRIAL 2	15	0	19.48	26.92	29.91
		50	19.47	26.93	29.89
		100	19.4	26.91	29.84
TRIAL 3	25	0	19.5	26.9	29.9
		50	19.52	26.97	29.97
		100	19.42	26.89	29.87
TRIAL 4	35	0	19.45	26.89	29.87
		50	19.47	26.87	29.8
		100	19.41	26.85	29.92

K. Split Tensile Test

The splitting test is well known as indirect test used for determining the tensile strength of concrete. They are sometimes referred as split tensile strength of concrete.

Specimens	**Replacement Of Fly Ash %**	**Replacement Of RCA %**	**Average Split Tensile Strength 28days N/mm^2**
Conventional	-	-	2.76
TRIAL 1	0	0	2.76
		50	2.52
		100	2.41
TRIAL 2	15	0	2.54
		50	2.49
		100	2.40
TRIAL 3	25	0	2.71
		50	2.51
		100	2.45
TRIAL 4	35	0	2.51
		50	2.42
		100	2.21

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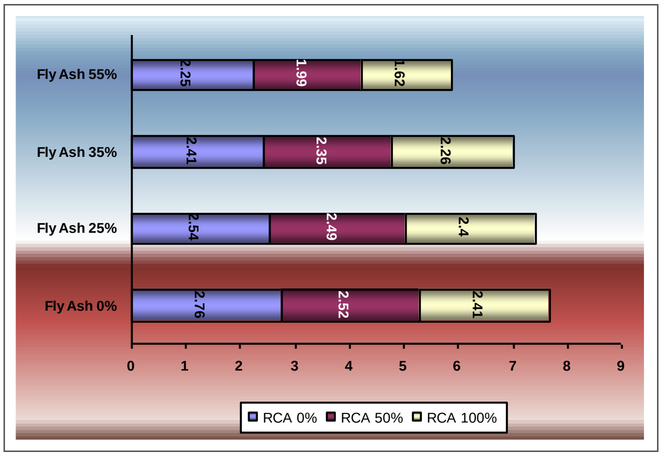
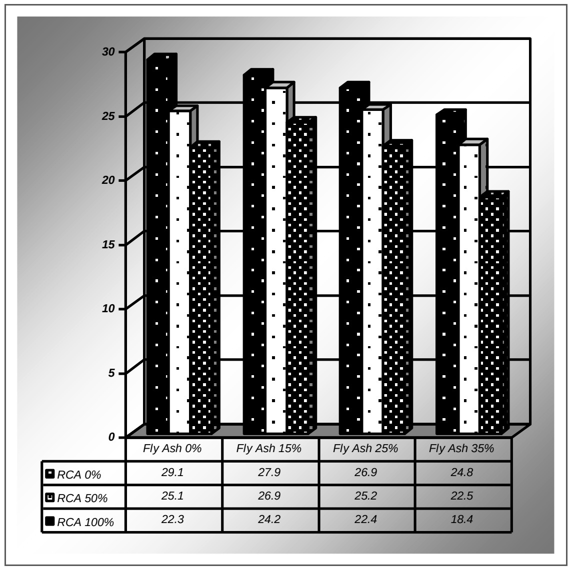


L. Static Modulus Of Elasticity

The static modulus of elasticity test was found by using the following relationship the maximum load at failure reading was taken and average stress and strain calculated and tabulated as follows.

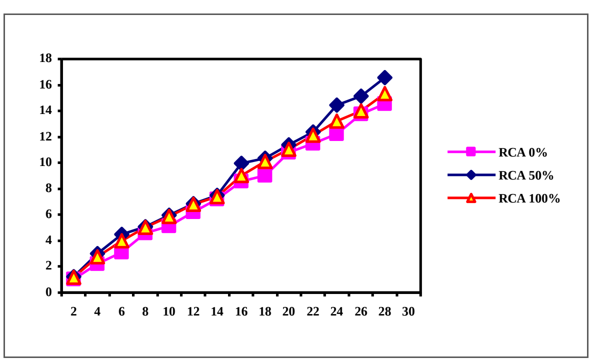
Mix Type	Young's Modulus Value in Gpa
Control	29.1
0 % FA + 0 % RCA	29.1
0 % FA + 50 % RCA	25.1
0 % FA + 100 % RCA	22.3
15 % FA + 0 % RCA	27.9
15 % FA + 50 % RCA	26.9
15 % FA + 100 % RCA	24.2
25 % FA + 0 % RCA	26.9
25 % FA + 50 % RCA	25.2
25 % FA + 100 % RCA	22.4
35 % FA + 0 % RCA	24.8
35 % FA + 50 % RCA	22.5
35 % FA + 100 % RCA	18.4



M. Beam

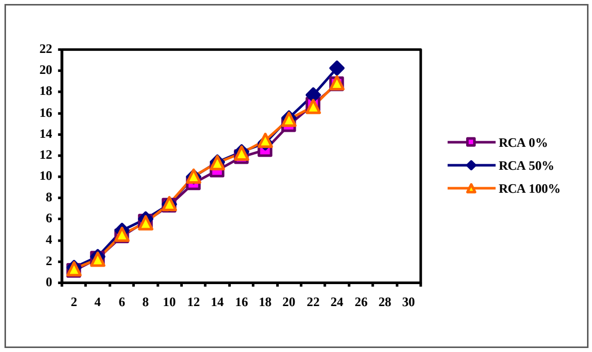
Beams carry load primarily by bending action. In the limit state method, these members are first designed for strength and durability and their performance is then checked with regard to other limit states of serviceability.

TRIAL - 1 FA - 0 % with 0,50,100% of RCA



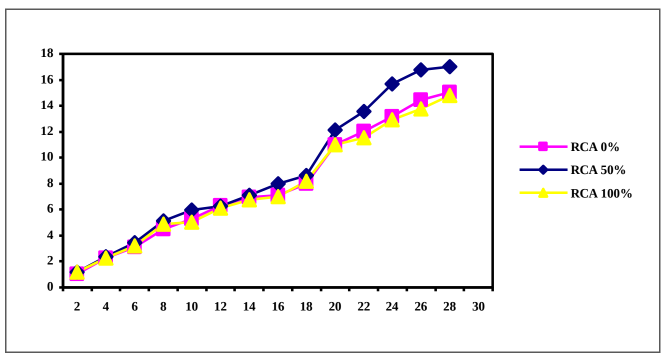
Load VS Deflection

TRIAL - 2 FA - 15 % with 0,50,100% of RCA



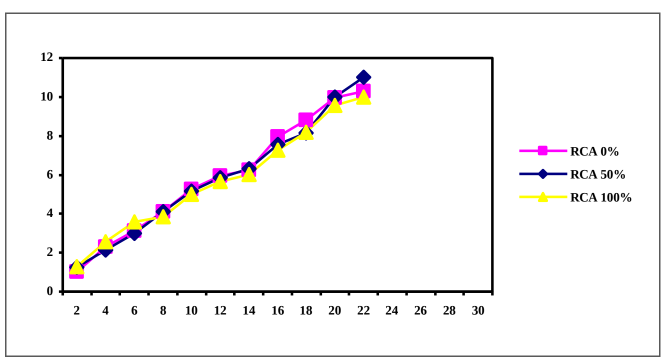
Load VS Deflection

TRIAL - 3 FA - 25 % with 0,50,100% of RCA



Load VS Deflection

TRIAL - 4 FA - 35 % with 0,50,100% of RCA



Load VS Deflection

III. CONCLUSION

The experimental results show that the strength of concrete specimen in the optimal mix proportion of 25% Fly Ash and 50% RCA .Hence recycled aggregate can be used in concrete and achieves the strength higher than the conventional concrete strength.

ACKNOWLEDGMENT

I express my sincere thanks to Mr.A.S.VIJAY VIKRAM, M.E, Head of the Department, Department of Civil Engineering, Global Institute Of Engineering & Technology for his invaluable guidance and also I express my sincere thanks to our P.G-Coordinator, Mr. D. JAYASEELAN, M.E Assistant Professor, Department of Civil Engineering, Global Institute of Engineering & Technology for his support & all his help in the completion of this project. Mr. N.SELVAKUMAR, M.E Assistant Professor, Department of Civil Engineering, Global Institute of Engineering & Technology for his internal supervision and guidance as well.

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