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Performance Study of Pelletized Aggregate Formed using Fly Ash

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ABSTRACT

The installation of Helical Confinement in the Compression Zone of reinforced High Strength Concrete beams is also investigated in this study. Helical Confinement is more effective than the rectangular ties, Compression Longitudinal reinforcement and steel fibers in increasing the strength and ductility of Confined Concrete. A total number of 3 Specimens were casted. The Pitch distance for helical confinement of two specimens is 50mm, 60mm and the Pitch distance for normal confinement is 50mm. The Specimen is of a size of 600mm X 300mm X 300mm. It contains of 8 mm dia bar as longitudinal reinforcement and 6mm dia bar as transverse reinforcement. M 40 and Fe 500 Grade steels were used. After 28 Days of Curing. The Specimens were taken out and allowed to dry and tested under universal testing machine of capacity 1000 KN. The Effect of Yield strength ductility, were studied from Stress – Strain and Load – Displacement Curves. This Study Concluded the Helical Reinforcement is an effective method for increasing the Strength and Ductility of Reinforcement High Strength Concrete Beam.

1. Introduction

Fly ash is not a polluting industrial waste, but a resource material useful for various construction applications, in cement and concrete [1-4]. Both coarse and fine aggregates for making concrete are become scarce, and many cities and towns worldwide.

Recycled concrete aggregate (RCA) is obtained mainly by crushing and processing concrete elements that have been previously used in construction [5-7], where the masonry content material, including approximately a 30-35 percent of material less than 4mm, is fed to a plant in which the fines are separated.

The process has produced satisfactory aggregate and the research has proved that there is no decrease in the properties of medium grade concrete, with the use of 20 percent recycled aggregate and 80 percent natural stone [8-11]. The above materials are used in construction works, but mainly sand and aggregates are widely used in concrete.

Objective of the Research

- Prepare the artificial aggregate from waste material.
- To study the properties of flyash.
- Analyze the relative performance of artificial coarse aggregate in concrete.
- To Study the practicability of using artificial aggregate in concrete.
- Compare the properties of conventional concrete and concrete made of artificial Aggregate.
- Develop analysis model to study the properties of concrete made of artificial aggregate.

2. Methodology

The methodology clearly shows the process which have been carried out in this work. The step by step process of this project is explained in the flow chart figure 1.

2.1. Methodology Description

- In this project an experimental study is carried on investigation the behavior of concrete using artificial aggregates.
- Artificial aggregate made of 20mm size using cement and waste materials such as fly ash are manufactured.
- Artificial aggregates were prepared for the ratio of 1:2 (C:FA), 1:3 (C:FA).
- Then the strength properties like specific gravity, water absorption test, sieve analysis, impact test, attrition test, bulk density, abrasion test, aggregate crushing test are studied.
- IS method of mix design adopted for the concrete as per IS 10262-2009.
- Experimental and analytical investigation has been done for RC member which are made of artificial aggregate.

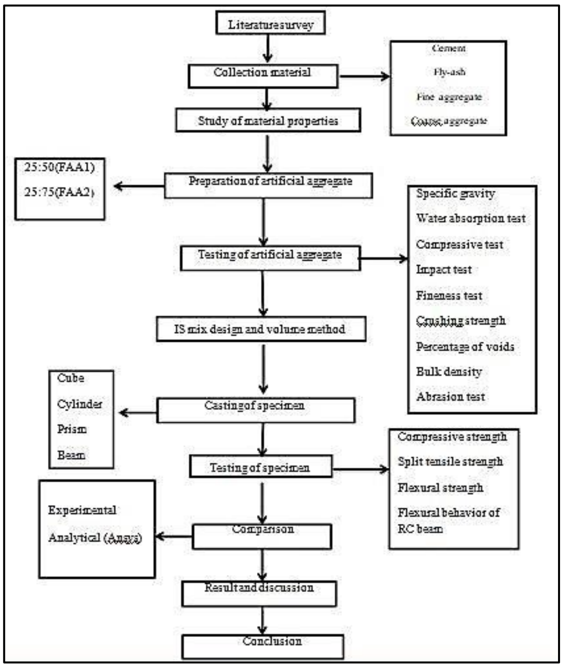

Fig.1. Methodology flow chart

3. Mix Design

The object of mix design is to decide the proportions of materials, which will produce concrete having the required desirable properties. The mix proportions should be selected in such a way that the resulting concrete is of desired workability while fresh and it could be placed and compacted easily for the intended purpose.

3.1. Types of Mix Design

- ACI mix design method.
- British mix design method.
- Mix design based on Indian standard recommended guidelines for concrete mix design.

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3.2. Mix Design by IS Method

IS method of mix design is based on IS 10262 – 1982.The mix proportion for normal concrete made with natural gravel and fly ash aggregate concrete. Fly-ash aggregate were taken and immersed in water, after it taken into fly ash aggregate dry condition or saturated condition used made in concrete.

3.3. Mix Design by Volume Method

American Concrete Association (ACI) Absolute Volume Method of Concrete Mix Design

The American concrete institute mix design method is but one of many basic concrete mix design methods available today. The ACI absolute volume method because it is widely used.

Table 1. Mix ratio

Material	Mix proportions	Water cement ratio
Conventional	1:1.58:2.70	0.5
FAA1	1:0.63:1.14	0.5
FAA2	1:0.5:1.10	0.5

Table 2. Mix proportion

Mix design	Water cement ratio	Water (kg/m^3)	Cement (Kg/m^3)	Fine aggregate (Kg/m^3)	Natural aggregate (Kg/m^3)	Fly-ash aggregate (Kg/m^3)
M1:2$_{20}$	0.5	186	372	680	944.54	157.23
M1:2$_{40}$	0.5	186	372	680	704.40	314.47
M1:2$_{60}$	0.5	186	372	680	472.27	471.71
M1:3$_{20}$	0.5	186	372	680	944.54	148.99
M1:3$_{40}$	0.5	186	372	680	704.40	297.98
M1:3$_{60}$	0.5	186	372	680	472.27	446.97
CC/M$_{20}$	0.5	186	372	680	1180.68	_

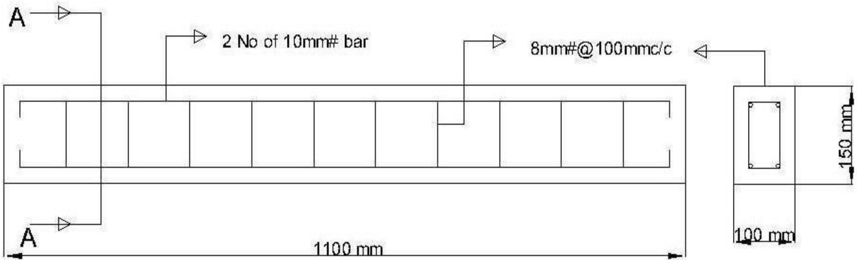
4. Experimental Investigation

4.1. Flexural Behaviour of Artificial Aggregates

Totally 30 specimens were casted for FAA1 & FAA2 replacement of Fly ash artificial aggregates. Those specimens were tested for compressive strength and split tensile strength. From the result the optimum percentage replacement of artificial aggregate is identified. Then RC beams were casted for the optimum percentage obtained from the above test. All the beams were tested for flexure under UTM of capacity 1000kN. These beams were tested on an effective span of 1000mm with simply supported conditions under two point loading. Deflection was measured under the mid span using dial gauge.

Reinforcement Detailing

The reinforcement detailing for the beam to be tested for flexural behavior show in Figure 2.



Longitudinal section of flexure member Cross section- AA

Fig.2. Cross section and longitudinal section

of flexure member

4.2. Load Deflection Behaviour of Flexure Member

Conventional beam load deflection curve

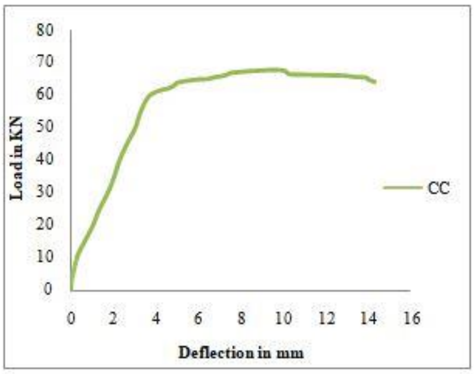
Conventional beam of load deflection curve is compare with flexure strength of another two different categories of the load deflection curve to be determined as shown in Fig 3.

Fly ash aggregate of beam load deflection curve for FAA1

This is 40 % replacement of artificial aggregate to be using RC beam the load deflection curve which is compare to conventional beam. This is 40 % replacement of artificial aggregate to be using RC beam the load deflection curve which is compare to conventional beam is load is decreasing and deflection is increasing. Decreasing and deflection isincreasing as shown in Fig 4.

Fly ash aggregate of beam load deflection curve FAA2

This is 40% replacement of artificial aggregate to be using RC beam the load deflection curve which is compare to conventional beam is load is decreasing and deflection is increasing.



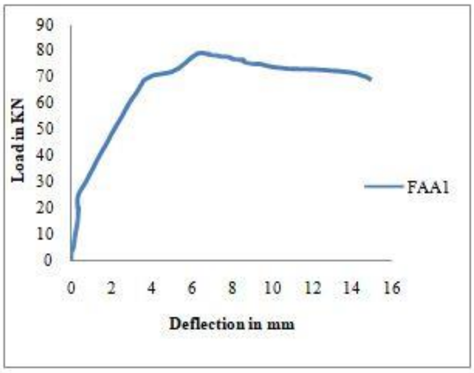


Fig.3. Load Vs Deflection of conventional beam **Fig.4.** Load Vs Deflection of 40% Replacement

First Crack Load

Two point static loads were applied on all beams and each load increment of 5kN deflection was noted. In control beam initiation of crack take place at load of 18.5kN.

For 40% replacement of fly ash aggregate proportion FAA1 takes the first crack load of 37kN. For 40% replacement of fly ash aggregate proportion FAA2 takes the first crack load of 26kN.

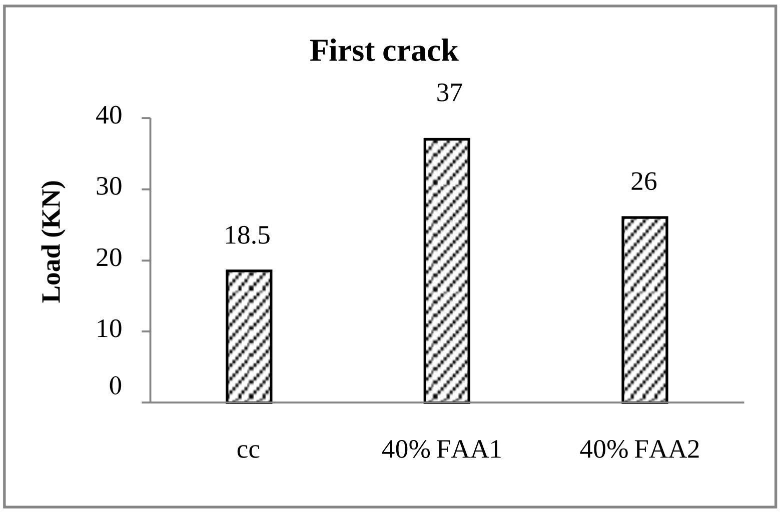


Fig.5. First crack load for artificial aggregate RC beam

Ductility Factor

Ductility is the ratio between deflections at ultimate load to that at the onset of yielding.

Ductility factor 40% of fly ash proportion FAA1 replacement of aggregates were high when compare to conventional beam as shown in Figure 6.

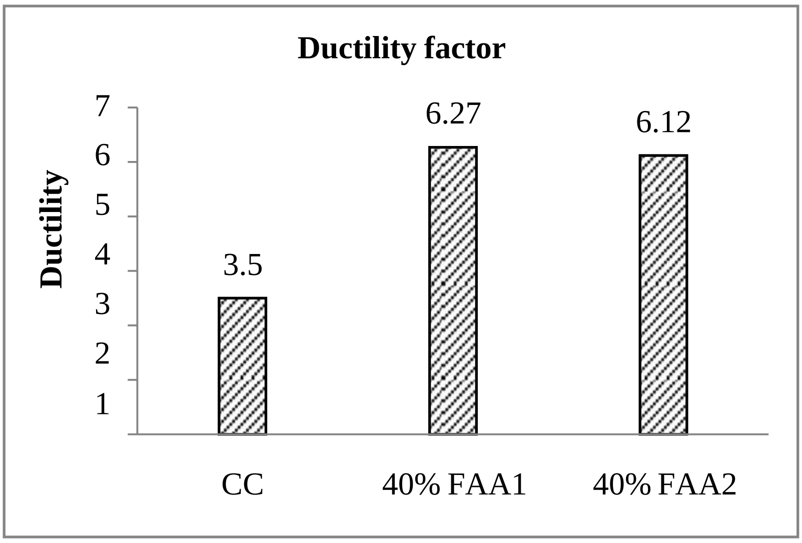


Fig.6. Ductility factor for RC beam

Stiffness

Stiffness is defined as the force applied on the body for a unit displacement. Stiffness forfly ash aggregates less than when compare conventional specimen as shown in Figure 7.

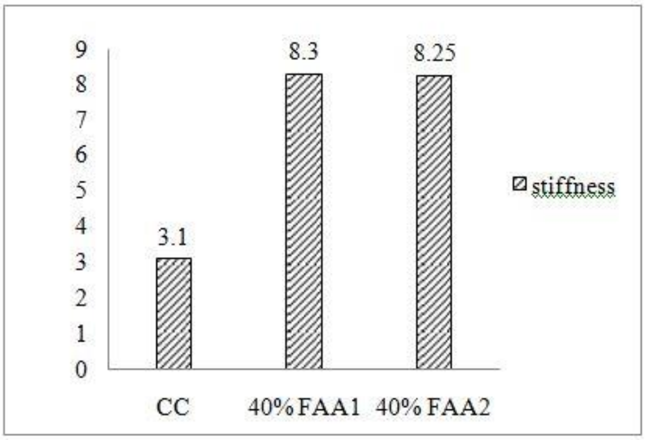


Fig.7. Stiffness of RC beams

Mode of Failure

Flexural failure was observed for all the beam specimen in the reinforced concrete beam the crack were comparatively more but the crack width was small and the elongation of the cracks were also not much higher. The cracks were first formed at the bottom tension face of the specimen which then propagated to the compression face and the crushing of the concrete take place at top of the specimen when load reaches its ultimate level where the failure of specimen takes place the failure patterns of all members as shown in Fig 8.

Fig.8. Tested beams of crack patterns

5. Interpretation of Results

The obtained result of the members with Ansys of conventional beam as shown in Figure 9 and 10 respectively.

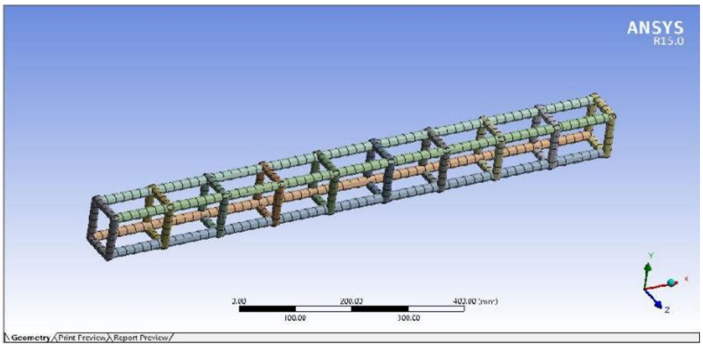


Fig.9. Reinforcement detailing for Ansys

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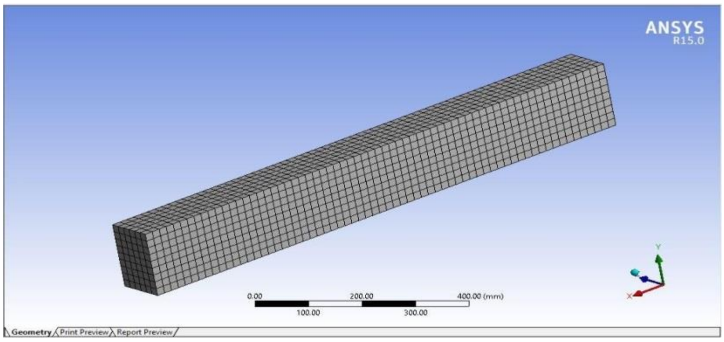

Fig.10. Meshing of beam

6. Conclusion

The artificial aggregate provides an alternate source for natural aggregates. Artificial aggregates are made by pelletization method, for different proportion of cement and waste material. The properties of artificial aggregates mainly depend on its source material. But each of them has their specific application and usage in construction industry. Waste utilization in construction must be extensively taken covering various aspects at different level to minimize the environmental pollution, depletion natural resources, and growing cost of construction and are more economical sources compare to the natural aggregates.

6.1. Based on the study, following conclusions were arrived

- The rounded shape of fly ash pellet aggregate gives good workability when compared to the natural aggregate.
- The compressive and split tensile strength of concrete has obtained foroptimum percentage 25:50 40% replacement of fly ash aggregate.
- Low specific gravity compared to the natural aggregate proves it to be light weight aggregate.
- The fly ash aggregate shows improved performance when compared to naturalaggregate
- The fly ash aggregate concrete is reduces the self-weight of concrete when compareto natural aggregate concrete.
- Fly ash aggregates satisfies all the properties required for a light weight concrete.

6.2. Scope for Future Study

- Investigation can be extended for different methods like sintering and autoclaving.
- Fibers can be utilizedin artificial aggregate concrete to improve the overall performance of beam.
- Manufacture of high strength concrete can be carried out in future worksusing artificial aggregate.

Declarations

Source of Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Competing Interests Statement

The authors declare no competing financial, professional and personal interests.

Ethical Approval

Not Applicable.

Consent for publication

Authors declare that they consented for the publication of this research work.

Availability of data and material

Authors are willing to share data and material according to the relevant needs.

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