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EXPERIMENTAL STUDY ON STRENGTH CHARACTERISTICS OF CONCRETE USING FLYASH AGGREGATE AND QUARRY DUST

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Abstract: **In this experiment the study on strength characteristics of M20 grade concrete using manufactured fly ash coarse aggregate as a partial replacement of natural granite coarse aggregate is conducted along with the use of quarry dust as a replacement of conventional natural river sand. The aggregates were manufactured using cement in lesser quantities and fly ash in excess quantity various trail mixes were conducted and finally a suitable mix is selected for large quantity production. Mix design for fly ash aggregate concrete is done by calculating the specific gravity and water absorption of the manufactured fly ash aggregate and quarry dust since both have lower specific gravity nominal mix M20 mix design cannot be used hence design mix is done. Since the specific gravity of the fine aggregate and coarse aggregate is less the obtained concrete is lighter in weight. Cubes, beams and cylinders were casted by partial replacing natural coarse aggregate by 25%, 30%, 35%, 40%, 45% and 50% of manufactured fly ash aggregate and using quarry as fine aggregate. The strength parameters such as compressive strength, flexural strength and split tensile strength of the casted cubes, beams and cylinders were tested respectively.**

Keywords: **Flash aggregate, Quarry dust, compressive strength, flexural strength, tensile strength.**

I. INTRODUCTION

Concrete is an constitute made essentially of Portland cement, fine aggregates, coarse aggregates and water. The mixture of the materials will undergo in a chemical reaction called hydration and this process will result in a change of mixture from plastic state to a solid occurs over a period of time. By reducing the weight and cost of constituent's materials in concrete, the cost and weight of concrete can be reduced. The cost reduction can be achieved by the usage of locally available alternative materials, instead of conventional materials and the weight of the concrete can be reduced by using manufactured flyash aggregates instead of conventional coarse aggregates. The consumption of fine aggregate in concrete production is very high throughout the world , and several developing countries have facing difficulties in meeting the supply of natural fine aggregate in order to satisfy the increasing needs of infrastructural development in recent years. To the solution for the stress and demand for river fine aggregate, researches have being conducted and an alternative materials such as fly ash, slag, limestone powder and siliceous stone powder is been made used. The attempts for the replacement of river sand by quarry dust have been made in India. Quarry dust, the waste material that causes disposal problem is made as a valuable resource by the successful utilization of this quarry dust as a fine aggregate and this will also overcome the strain on supply of river sand as fine aggregate and also the cost will be reduced. To evaluate the possibilities of replacement of fine sand aggregate with the quarry dust along with manufactured flyash aggregate as a replacement for course aggregate.

During the present study, 100% replacement of fine sand aggregate by quarry dust was made and partial replacement of course aggregate with flyash aggregate. The compression, flexural and split strengths were found after 7, 28 and 56 days of curing.

II. LITERATURE REVIEW

- Shanmugasundaram, Jayanthi, Sundararajan, Umarani, Jagadeesan (2010), have done the research on manufacturing fly ash aggregates using cement as a binder by adapting 0.3 water-cement ratio and then to use them as a partial coarse aggregate replacement.
- **Lokesh, ranjith kumar and loganathan**(2013), have done the experiment on using fly ash as a coarse aggregates by manufacturing the fly ash aggregates using clay as binding material. They manufactured the fly ash aggregates by 80-20 proportion of fly ash and bentonite clay. The aggregates are produced in a semi plastic stage then the mix is made into spherical shape and then oven dried at temperature of 1200°c in a muffle furnace. They selected m25 concrete grade adopting a water-cement ratio of 0.3, mix proportion 1:1:2 was selected.
- **Elavenil, vijaya(2013)**, they conducted an experiment for to fulfill a need for more easily available and cheaper alternative for river sand. It is done by using quarry dust to replace natural river sand by 100%. They decided to cast m25, m30, m35, m40, m45, m50, m55 and m60 concrete grade cubes with one set using natural river sand and other set using quarry dust.
- **Chandana sukesh, katakam bala krishna, sri lakshmi sai teja, kanakambara rao(2013)**,in this research they have replaced 60%,70% and 100% natural river sand by quarry dust and also fly ash is used to replace cement by 10% and 20%. Tests were done on quarry dust to find the properties and conclude it is suitable to replace conventional fine aggregate in concrete. M30 grade concrete cubes were casted using both river sand and manufactured sand for two different sets and also fly ash is used when 100% quarry dust is used.
- **Vinodh(2012)**,in this experimentation he replaced natural fine aggregate river sand by quarry dust and natural granite coarse aggregates by manufactured fly ash aggregate. 100% replacement of fine aggregate and 10%, 20% and 30% replacement of quarry dust is done. Fly ash aggregates with fly ash-cement proportions of 90:10, 85:15 and 80:20 was manufactured using a 0.3 water-cement ratio in a pelletiser. And test for impact value and crushing value. By this values the best proportion for fly ash aggregate was decided.

III. MATERIALS

Cement:

Ordinary Portland Cement (53 Grade) with specific gravity of 3.16 was used for this experimental investigation.

Fine Aggregate (Natural River Fine Aggregate):

Locally available river sand having density of 1550 kg/m 3 and fineness Modulus (FM) of 2.66 was used. The specific gravity was found to be 2.62. The fine aggregate was found to be confirming to Zone III as per IS 383:1970.

Coarse Aggregate:

Natural granite aggregate having density of 1500 kg/m^3 and fineness modules (FM) of 7.05 was used. The specific gravity was found to be 2.84 and maximum size of aggregate was 20mm.

Quarry Rock Dust:

Quarry dust is fine rock particles. When boulders are broken into small pieces quarry dust is formed. It is grey in colour and it is like fine aggregate. The physical and chemical properties of quarry rock dust and the fine aggregate are listed in Table 1 and Table 2 respectively.

Tab.1 Property of quarry dust and river sand

Property	Quarry dust	River sand	Test method
Specific gravity	2.62	2.71	IS 2386 (Part III) 1963
Absorption (%)	1.30-1.50	Nil	IS 2386 (Part III) 1963
Fine particles less than 0.075mm (%)	12%-15%	06%	IS 2386 (Part III) 1963
Sieve analysis	Zone II	Zone II	IS 383 – 1970

Manufactured Flyash Aggregates:

The constituents for the proportion of fly ash aggregate are fly ash and cement as a binder, water is used to provide the workability for the manufacturing. Different proportions of fly ash and cement were prepared such as 80:20, 70:30 and 60:40 respectively. After the aggregate impact value and aggregate crushing value 70:30 proportion of flyash and cement mix ratio is selected.

The mixture of fly ash and cement is mixed thoroughly once in a concrete mixer and then angle of the concrete mixer is maintained between 30^0-45^0 angle to form aggregates and water should be added 3-4 times it should not be poured at once. While concrete mixer is still rotating the formed fly ash coarse aggregates are emptied out of the concrete mixer and poured on a tray for sun drying, the fly ash aggregates are emptied out of the concrete mixer whenever they are formed till there is no more fly ash cement mixture in the mixer.

Curing of the aggregates:

Then the fly ash aggregates were left for sun drying on the tray for a day before transferring it to the curing drum for 28days, the fly ash aggregates were taken out of the curing drum after 28 days and then dried for 2days in sun before using it for the experiment.

Tab.2 Impact value and Crushing value of flyash aggregate

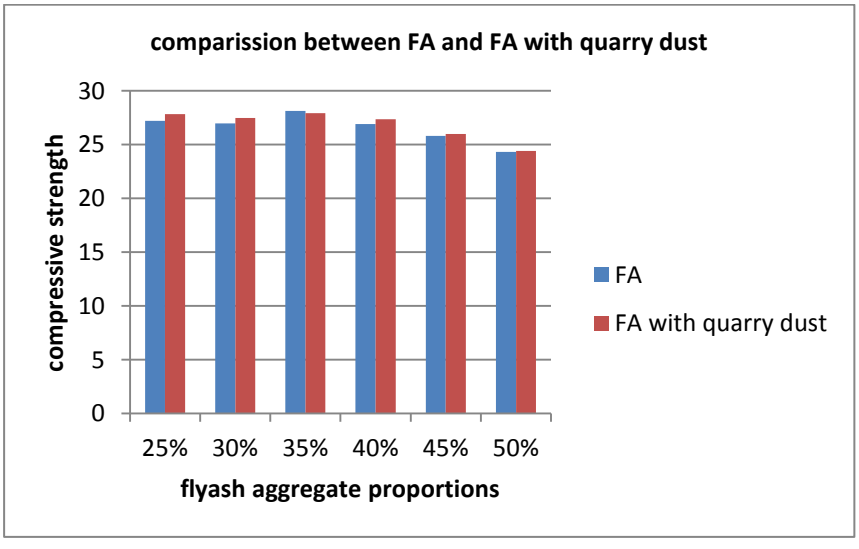
Flyash-cement ratio	Imapct value %	Crushing value
60:40	26.23	37.83
70:30	23.54	30.65
80:20	20.13	28.70

IV. TEST PROCEDURE

Compressive Strength Test:

For 7, 14 and 27 days of curing, the cubes were taken out of the curing tank, dried and tested using a compression machine. These cubes were loaded on their sides during compression testing such that the load was exerted perpendicularly to the direction of casting. The cubes were placed in the compression testing machine and the loads are applied gradually at a rate of $4N/mm^2$ /min. The average value of the compression strength of three cubes was taken as the compression strength. Three conventional concrete cubes and other 6 mixes of 25%,30%,35%,40%,45% and 50% flyash aggregate were tested. The compressive strength of concrete with quarry dust and 25%, 30%, 35%, 40%, 45% and 50% flyash aggregate were tested is shown in the below graph.

Test results of concrete cube specimens for M20 grade:

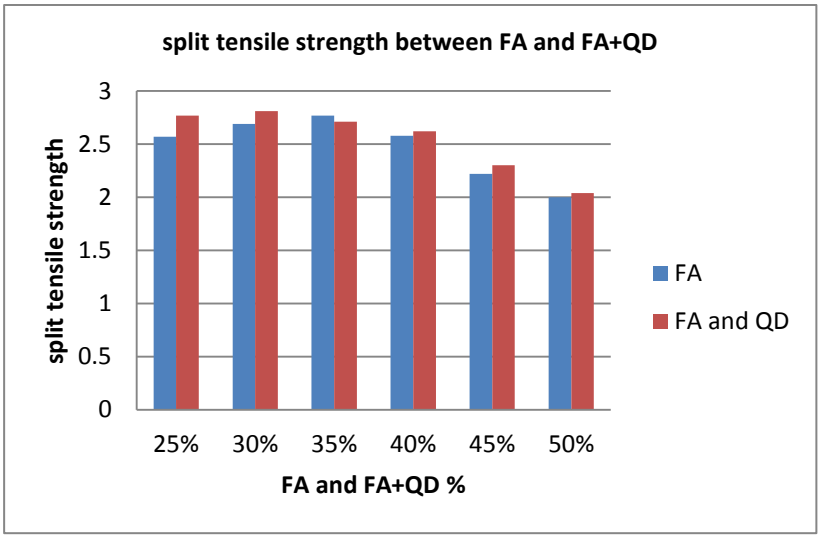


Graph.1 Compressive strength comparison between FA and FA with QD

Split Tensile Strength Test:

The cylinder specimens of diameter 150mm and height 300mm were used to determine the split tensile strength. The specimens were tested in universal testing machine of capacity 1000kN. Three cylindrical specimens were tested for each percentage of replacement. The cylinders were placed in the machine horizontally. Load was applied gradually at a uniform rate until the specimens failed. Split tensile strength was taken as the average strength of three specimens.

Three conventional concrete cylinders and other 6 mixes of 25%,30%,35%,40%,45% and 50% flyash aggregate were tested. The tensile strength of concrete with quarry dust and 25%, 30%, 35%, 40%, 45% and 50% flyash aggregate were tested is shown in the below graph.

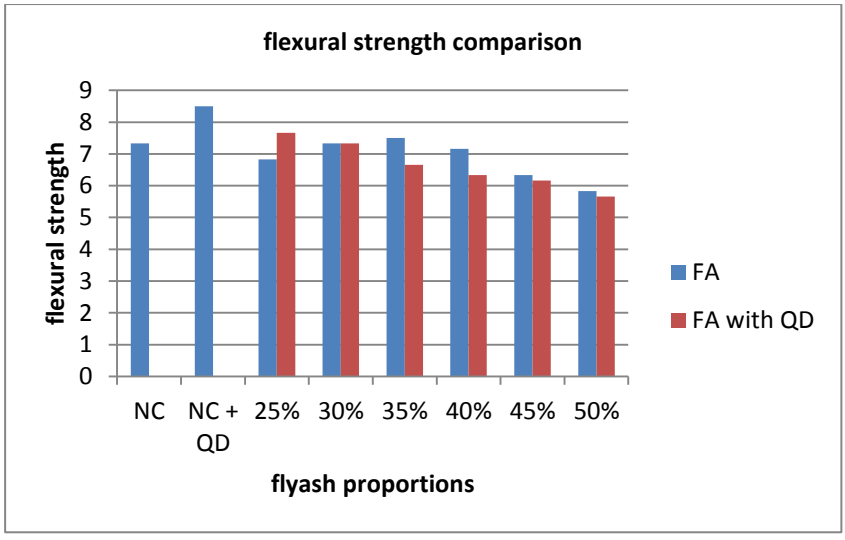


Graph.2 split tensile strength comparison between FA and FA with QD.

Flexural Strength Test:

The prism specimens of size 500 x 100 x 100 mm were used for the determination of the flexural strength. The bearing surface of the supporting and loading rollers were wiped clean and any other loose fine aggregate or other materials removed from the surface of the specimen where they are to make contact with the rollers. The specimen was then placed in the machine and two point loads was applied. Load was increased until the specimen failed and the load at failure was recorded and the flexural strength was determined. Flexural strength was taken as the average strength of three specimens.

Three conventional concrete beams and other 6 mixes of 25%,30%,35%,40%,45% and 50% flyash aggregate were tested. The flexural strength of concrete with quarry dust and 25%, 30%, 35%, 40%, 45% and 50% flyash aggregate were tested is shown in the below graph.



Graph.3 Flexural strength comparison between FA and FA with QD

V. CONCLUSION

- The flyash aggregate were manufactured using flyash-cement proportions of 60:40, 70:30, and 80:20 and then tested for impact value and crushing value. 70:30 flyash-cement proportion is selected as suitable mix proportion based on the test results.
- M20 grade concrete cubes, beams and cylinders were casted using flyash aggregate and quarry dust, then tested for compressive strength, flexural strength and split tensile strength respectively and compared with the normal concrete. as the results in the above chapter shows use of flyash aggregate as a partial replacement up to 40% of natural coarse aggregate is possible without compromising the strength characteristics.
- Using quarry dust as a replacement of natural river sand along with manufactured fly ash aggregate actually improves the compressive strength of the concrete, but it slightly decreases the flexural strength of the concrete because of the void spaces in concrete created by the quarry dust since the finer particles were sieved off.

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