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SUSTAINABLE CONCRETE USING GGBS AND FLYASH

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Abstract*—One of the major challenges of our present society is the protection of the environment. Some of the important elements which protects environments is less consumption of energy, retention of natural raw resources and usage of the industrial by products. Keeping in view of usage of waste materials now a day's considerable attention is given to development sustainable concrete. In this study the sustainable concrete is developed with the usage of recycled coarse aggregates. And the suitability of recycled aggregate is verified with cementitious materials ggbs and flyash. A suitable experimentation was carried to check application of recycled coarse aggregate in varied proportion in combination, with 40% of GGBS, 25% Class F flyash and 35% Cement. On observation of test results it is found that the recycled coarse aggregate can be used in production of sustainable concrete.

Keywords*—Recycled Coarse Aggregates (RCA), GGBS, Flyash Class F, OPC, Sustainable concrete, Compressive strength, Flexural strength, Split tensile strength.

I. INTRODUCTION

Cement is a binder, a substance used for construction that sets, hardens, and adheres to other materials to bind them together. Cement production contributes to environmental problems liberating carbon dioxide intothe atmosphere. In view of this, there is a need to develop sustainable alternatives to conventional cement using the cementitious properties of industrial by-products such as fly ash and GGBS. On the other hand, the abundance and availability of fly ash and GGBS around the world create an opportunity to use these byproducts, as a partial replacement and performance enhancer for OPC.

GGBS (Ground Granulated Blast-furnace Slag) is a cementitious material whose main use is in concrete and is a by-product from the blast-furnaces used to make iron. Blast-furnaces operate at temperatures of about 1,500°C and are fed with a carefully controlled mixture of iron ore, coke, and limestone. The iron ore is reduced to iron and the remaining materials form a slag that floats on top of the iron. This slag is periodically tapped off as a molten liquid and if it is to be used for the manufacture of GGBS it has to be rapidly quenched in large volumes of water. The quenching optimizes the cementitious properties and produces granules similar to coarse sand. This 'granulated' slag is then dried and ground to a fine powder. Although normally designated as 'GGBS' it can also be referred to as 'GGBFS' or 'slag cement'.

Fly ash is a byproduct from burning pulverized coal in electric power generating plants. During combustion, mineral impurities in the coal (clay, feldspar, quartz, and shale) fuse in suspension and float out of the combustion chamber with the exhaust gases. As the fused material rises, it cools and solidifies into spherical glassy particles called fly ash. Fly ash is collected from the exhaust gases by electrostatic precipitators or bag filters. The fine powder does resemble Portland cement but it is chemically different. Fly ash chemically reacts with the byproduct calcium hydroxide released by the chemical reaction between cement and water to form additional cementitious products that improve many desirable properties of concrete. All fly ashes exhibit cementitious properties to varying degrees depending on the chemical and physical properties of both the fly ash and cement. Two types of fly ash are commonly used in concrete: Class C and Class F. Class C are often high-calcium fly ashes with carbon content less than 2%; whereas, Class F is generally low-calcium fly ashes with carbon contents less than 5% but sometimes as high as 10%.

Recycled coarse aggregate is generated from construction debris, which can be reused in other building projects. This collection of construction refuse is mainly used for road base, cement concrete or other infrastructure projects. The use of recycled materials for construction is a sustainable move in the construction industry.

II. AIM OF THE PROJECT

The aim of this work is to study the influence of GGBS and Flyash on concrete which is made from recycled coarse aggregate.

III. OBJECTIVES OF THE PROJECT

The following are the objectives of this project work.

To study variation of the compressive strength, split tensile strength andflexural strength for concrete made from recycled aggregates at different ages for a particular grade concrete.

IV. EXPERIMENTAL WORK

Cement: Ordinary Portland cement (OPC) is used of 53 grade. Testing of cement was done as per IS 4031. The properties cement are Standard consistency-32%, Fineness-6%, Specific Gravity-3.15, Initial Setting Time-150 minutes and Final Setting Time-220 minutes.
Flyash: Class F fly ash is procured from KTPS, Bhupalpalle (District), Telangana.The specific gravity of flyash is 2.25.
GGBS: The GGBS is procured from Venkat Sai Enterprises and it is located at Warangal Urban (District), Telangana.The specific gravity of GGBS is 2.75.
Fine Aggregate: The Fine aggregate used in this project is conventional fine aggregatei.e. river sand. The physical properties of fine aggregate are Specific Gravity-2.45, Bulk Density-1.5gm/cm^3,Fineness modulus-2.7, Percentage of Voids-35% and Void Ratio-0.53.

Coarse Aggregate (NCA): Thesize of coarse aggregate used in this project is passing through 20mm.The physical properties of coarse aggregate are Specific Gravity-2.77, Bulk Density-1.402gm/cm^3, Fineness modulus-7.89, Percentage of Voids-49.8% and Void Ratio-0.9.

RecycledCoarse Aggregate (RCA): RCA used in this work is obtained by crushing the test specimens like cubes, cylinders, prisms at the stone crusher. The physical properties of RCA are Specific Gravity-2.53, Bulk Density-1.371gm/cm^3, Percentage of Voids-45.71% and Void Ratio-0.84.

Water: Water available in college is used for casting and curing of test specimens andwhich is portable.

Mix Design: The final mix proportion used for the investigation is 1:1.68:2.30 with water cement ratio 0.45. Which is obtained after number of trials according to IS: 10262-2009.

Preparation of test specimen: The experimental work consists of 108 specimens. Out of which 36 are cubes (18 for 7 days + 18 for 28 days), 36 are cylinders (18 for 7 days + 18 for 28 days) and 36 are prisms (18 for 7 days + 18 for 28 days). The total casting was carried out in 6 stages with different combination of materials in which first stage consists of (35% cement + 40% GGBS + 25%Flyash + 100% FA + 100% NCA). The second stage consists of (35% cement + 40% GGBS + 25%Flyash + 100% FA + 80% NCA + 20% RCA). The third stage consists of (35% cement + 40% GGBS + 25%Flyash + 100% FA + 60% NCA + 40% RCA). The fourth stage consists of (35% cement + 40% GGBS + 25%Flyash + 100% FA + 40% NCA + 60% RCA). The fifth stage consists of (35% cement + 40% GGBS + 25%Flyash + 100% FA + 20% NCA + 80% RCA). The sixth stage consists of (35% cement + 40% GGBS + 25%Flyash + 100% FA + 100% RCA).

V. RESULTS AND DISCUSSIONS

To understand the effect of recycled aggregate on GGBS and Class F flyash various graphs are drawn and presented, from the experimental test results. The graph-1 shows the variation of compressive strength, split tensile strength and flexural strength with the variation of RCA for 7 days curing period. The graph-2 shows the variation of compressive strength, split tensile strength and flexural strength with the variation of RCA for 28 days curing period. The graph-3 shows the variation of compressive strength with the variation of RCA for 7 and 28 days curing period. The graph-4 shows the variation split tensile strength with the variation of RCA for 7 and 28 days curing period. The graph-5 shows the variation of flexural strength with the variation of RCA for 7 and 28 days curing period.

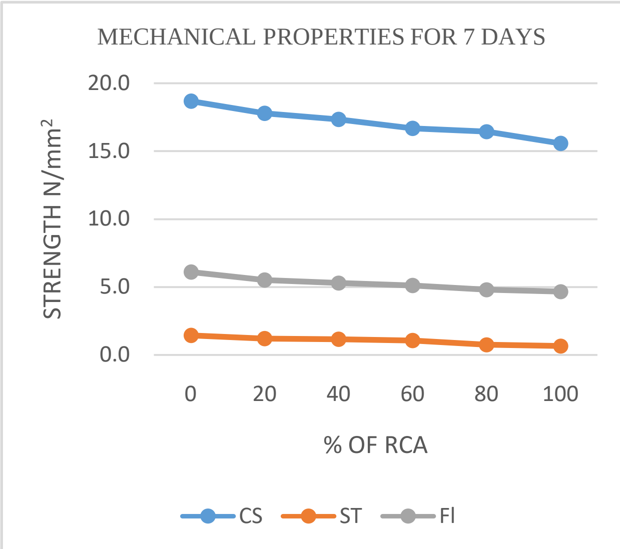

Fig 1: Mechanical properties for 7 days

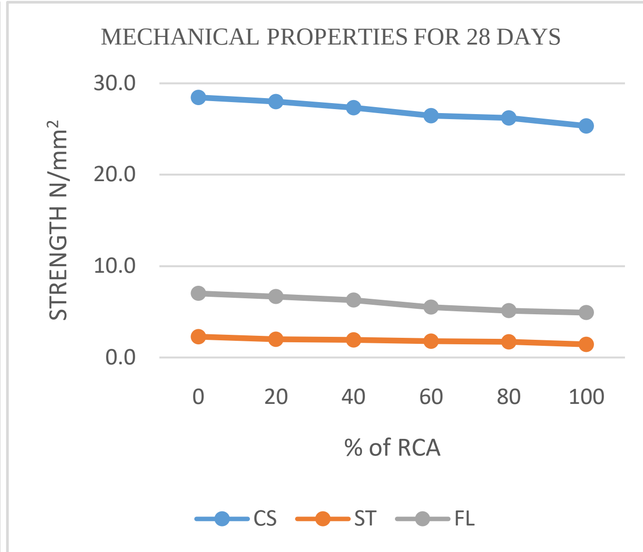

Fig 2: Mechanical properties for 28 days

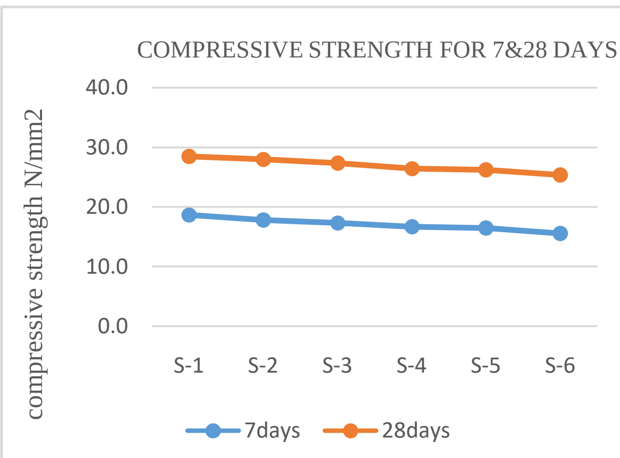

Fig 3 : Compressive strength for 7&28 days

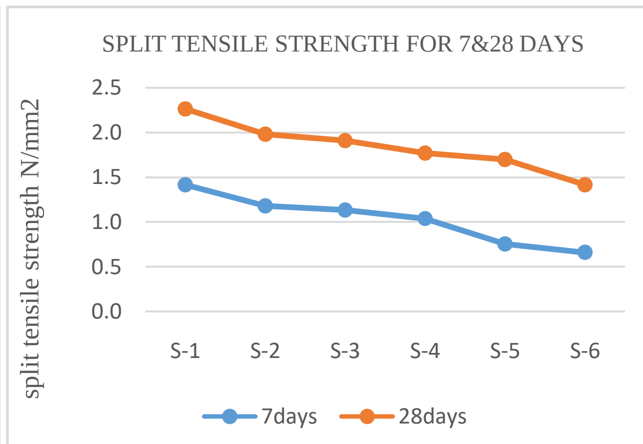

Fig 4: Split tensile strength for 7 & 28 days

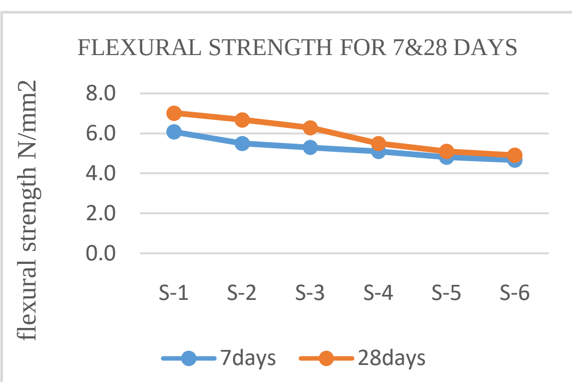

Fig 5: Flexural strength for 7&28 days

VI. CONCLUSIONS

The following conclusions are drawn from the experimental study carried.

1. The compressive strength split Tensile strength and flexural strength are decreased as the usage of RCA is increased
2. The workability is reduced as the usage of RCA increases.
3. The workability reduces due to the usage of GGBS and flyash.

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