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Study on Strength properties of concrete containing Ground Granulated Blast Furnace Slag(GGBFS) as partial replacement of Cement and Ceramic Aggregates Concrete.

Mr. Atul Koushal[1], Mr.Sourabh Lalotra[2], Mrs. Shivani Bhardwaj[3]

[1](M.Tech) Student, Sri Sai Group of Institutes, Badhani, Pathankot, India

[2]Assistant Professor, Sri Sai Group of Institutes, Badhani, Pathankot, India

[3]Assistant Professor, Sri Sai Group of Institutes, Badhani, Pathankot, India

Abstract: **Growth in the concrete production and the consumption increase in nature have led to a fast decline in available natural resources. A high volume of production has also generated a considerable amount of waste materials which have adverse impact on the environment. The scale of such problems makes researchers to investigate other sources of raw materials in order to reduce the consumption of energy and available natural resources. So in this regard, waste reuse and recycling are among modern society's environmental priorities, and considerable effort is devoted to achieve these objectives and contributing in protecting the world against global warming.**

In the present experimental work Blast furnace slag and ceramic waste aggregates has been used extensively used as a replacement material for Portland cement and natural aggregates respectively in concrete materials to improve strength properties of concrete and brings environmental and economic benefits together, such as resource conservation and energy savings. M35concrete grade was designed in which the cement was partially replaced by GGBFS by 0%,25%,50% & 75% and natural coarse aggregates will be replaced by ceramic Tile waste by 0%,15%,30% &45%. The workability and strength parameters were investigated. The results concluded that there is increase in workability and strength parameters up to certain percentage of replacement by Ground Granulated Blast Furnace Slag and ceramic waste Aggregates.

Keywords: **Ground Granulated Blast Furnace Slag(GGBFS), Marble Dust Concrete, Strength properties, concrete**

I. GENERAL

The versatility, durability, sustainability, and economy of concrete have made it the world's most widely used construction material. Concrete is a family of different material like binding material (cement, flyash), fine aggregate, coarse aggregate and water. Often, additives and reinforcements are included in the mixture to achieve the desired physical properties of the finished material. When these ingredients are mixed together, they form a fluid mass that is easily molded into shape. Over time, the cement forms a hard matrix which binds the rest of the ingredients together into a durable stone-like material with many uses. The aim is to mix these materials in measured amounts to make concrete that is easy to: Transport, place, compact, finish and which will set, and harden, to give a strong and durable product. The amount of each material (ie cement, water and aggregates) affects the properties of hardened concrete [1-8].

The proportions of each material in the mixture affects the properties of the final concrete. These proportions are best measured by weight. Measurement by volume is not as accurate, but is suitable for minor projects. The proportions of various ingredients are determined by proper mix design [9].

RICE HUSK ASH

Rice husk is an agricultural residue which accounts for 20% of the 649.7 million tons of rice produced annually worldwide. The produced partially burnt husk from the milling plants when used as a fuel also contributes to pollution and efforts are being made to overcome this environmental issue by utilizing this material as a supplementary cementing material [10].

RHA generally referred to an agricultural by-product of burning husk under controlled temperature of below 800 °C. The process produces about 25% ash containing 85% to 90% amorphous silica plus about 5% alumina, which makes it highly pozzolanic. RHA possibly compensate the problem of recycling huge quantity of husk wastes to be landfilled due to lacking of knowledge about its commercial benefits. Rice husk ash (RHA) possesses high pozzolanic activities and very suitable as partial replacement of cement in concrete [11]. Rice husk is produced in millions of tons per year as a byproduct material from agricultural and industrial processes. After full combustion of rice husk, it produced 20–25% RHA by weight. RHA contains non-crystalline silica and it could be a suitable partly replacement for Portland cement [12].

QUARRY DUST

Quarry dust is a byproduct of the crushing process which is a concentrated material to use as aggregates for concreting purpose, especially as fine aggregates. In quarrying activities, the rock has been crushed into various sizes; during the process the dust generated is called quarry dust and it is formed as waste. So it becomes as a useless material and also results in air pollution. Therefore, quarry dust should be used in construction works, which will reduce the cost of construction and the construction material would be saved and the natural resources can be used properly.

II. LITERATURE REVIEW

S.N.Raman et.al (2011) This paper presents the findings from experimental work undertaken to evaluate the suitability of quarry dust as a partial substitute for sand in high-strength concrete containing rice husk ash. Two grades of High Strength Concrete mixes, to achieve were designed with and without the incorporation of RHA. Quarry dust was then used in the mixes containing RHA as a partial substitute for sand, in quantities ranging from 10% to 40%. The results showed the mixes containing 20% quarry dust were chosen as the optimum mix design for both grades of concrete. The results also suggests that incorporating RHA improves the properties of concrete and compensates the negative effects of concrete containing Quarry dust only.

Maurice E. Ephraim et.al (2012). This research work was experimentally carried out to investigate the effects of partially replacing Ordinary Portland cement with our local additive Rice Husk Ash which is known to be super pozzolanic in concrete. The percentage replacement level was upto 25%. The results concluded that strength properties improves by using RHA in concrete.

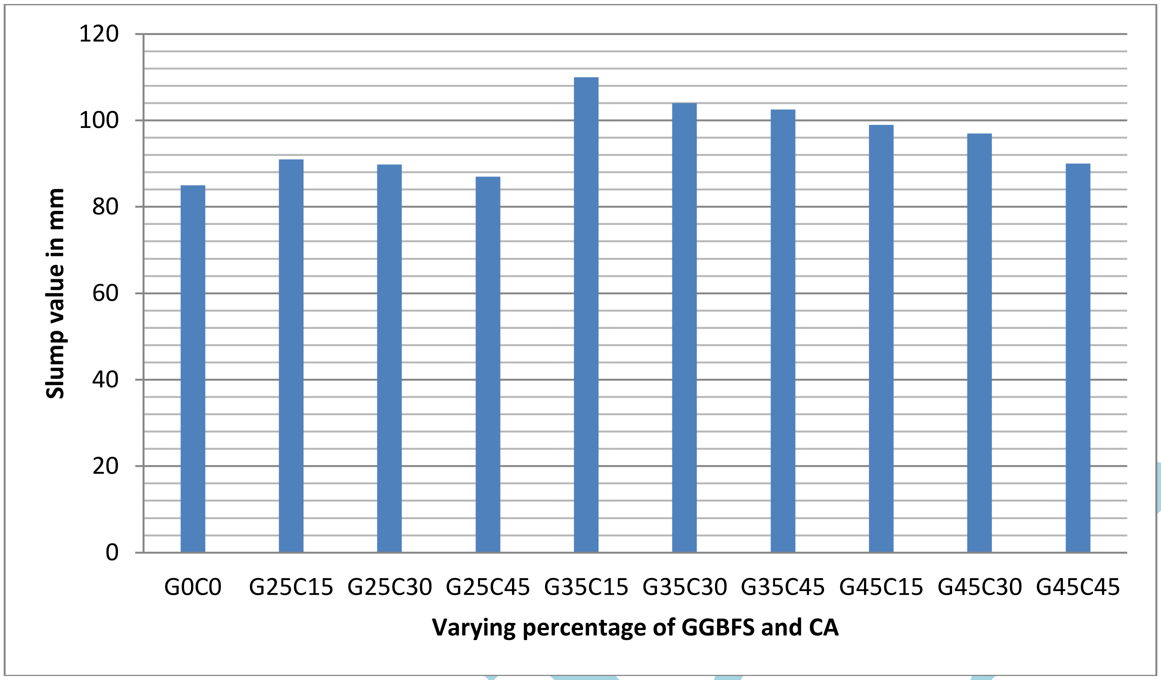
Godwin A. Akeke et.al (2013) This research was experimentally carried out to investigate the effects of introducing Rice Husk Ash as a Partial Replacement of Ordinary Portland Cement on the Structural Properties of Concrete. A study was carried out on its flexural properties to determine their moduli of rupture as well as its tensile strength characteristics for the determination of cracking. The compressive strength and workability tests suggests that RHA could be substituted for OPC at up to 25% in the production of concrete with no loss in workability or strength. Based on the results of split Tensile Strength test, it is convenient to state that there is no Substantial increase in Tensile Strength due to the addition of RHA. The Flexural strength studies indicate that there is a marginal improvement with 10 to 25% RHA replacement levels [13].

Anzar Hamid Mir (2015) In this paper Attempts have been made to study the suitability of Quarry dust as sand replacing material and it has been found that Quarry dust improves the mechanical properties of concrete as well as elastic modulus. The optimum compressive strength is achieved at the proportion of fine to coarse with 60:40 ratio. The study suggests that stone dust is quite appropriate to be selected as the substitution of fine aggregate.

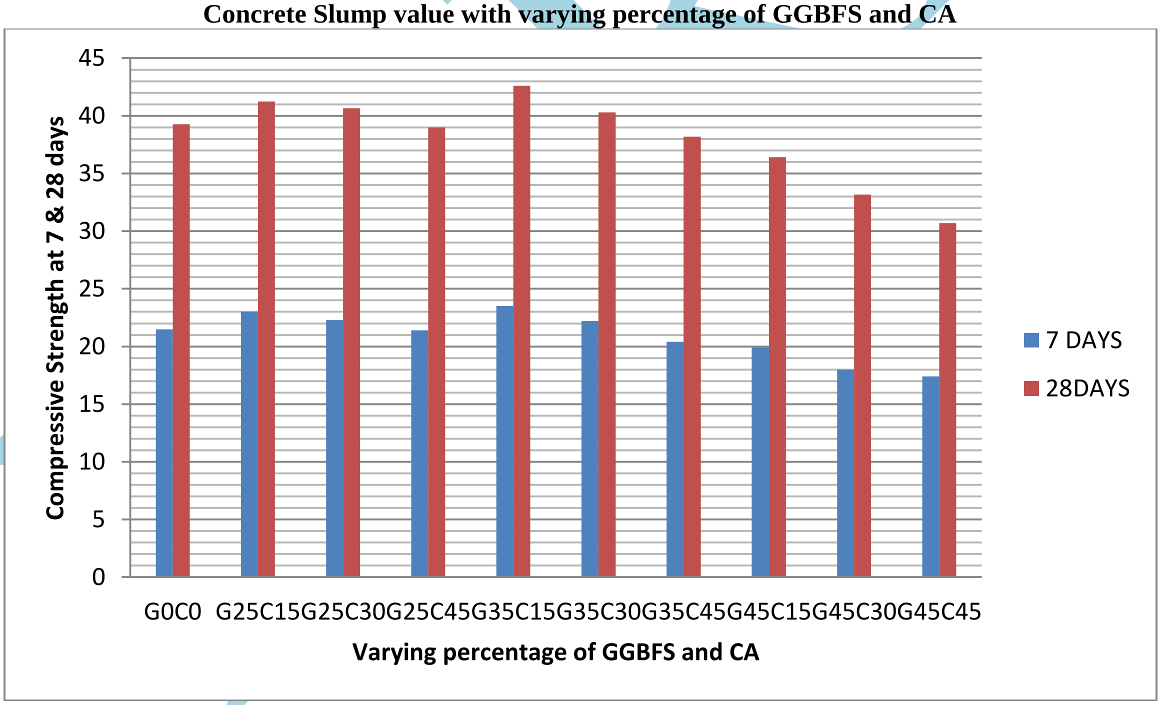
K. Shyam Prakash et.al (2016) in this experimental work it is concluded that the quarry dust can be used as a replacement for fine aggregate.finr aggragtes were replaced upto 100% and various tests conduscted on different concrete mixes. It is found that 40% replacement of fine aggregate by quarry dust gives maximum result in strength than normal concrete and then decreases from 50%. The compressive strength is quantified for varying percentage and grades of concrete by replacement of sand with quarry dust.

Kankipati Dinesh kumar et.al (2018) This investigation studies the partial replacement of cement by quarry dust of percentages 0%, 5%, 15%, 25%, 35% for M25 grade concrete. The rice husk ash is added in certain proportions such as 0%, 5%, 10%, 15% and 20% and strength tests were conducted on different mixes. Results concluded that replacement of quarry dust has its optimum strength at 25% for this rice husk ash is added. Results obtained from this gives better workability and increased in its hardened concrete properties compare to normal concrete.

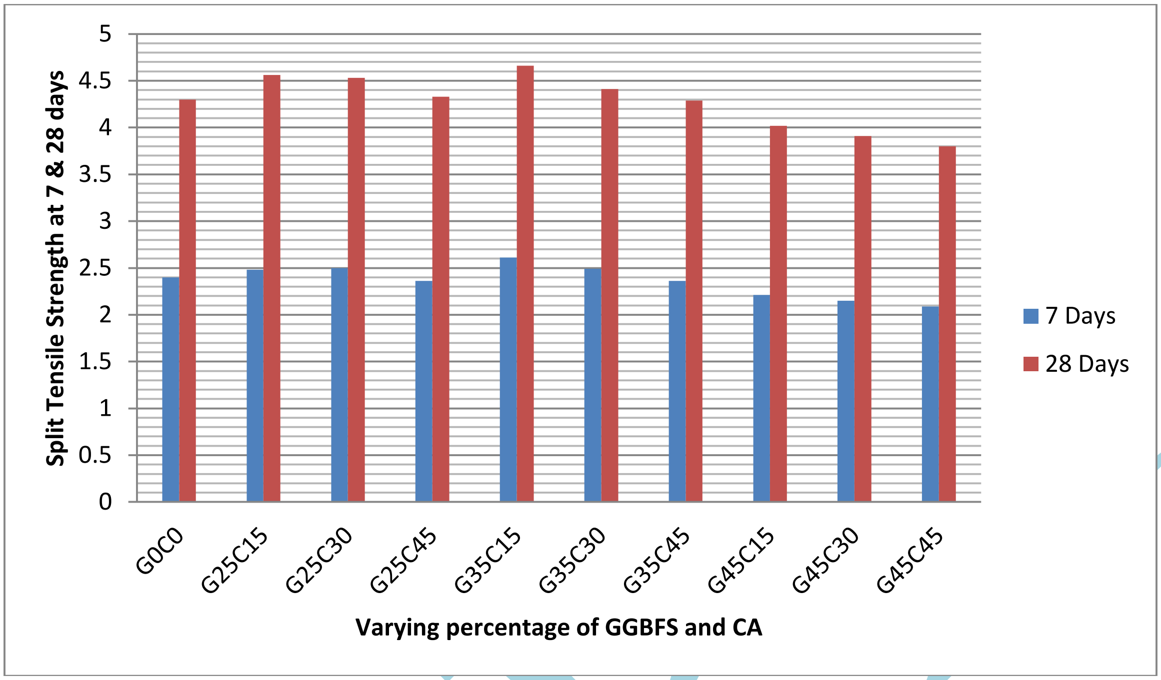
Mohammed Imran(2018) The present work is an attempt to understand the effect on concrete strength and durability characteristics of concrete by partial replacement of sand with quarry dust. This experimental study presents the variation in the strength and durability properties of concrete when replacing sand by quarry dust from 0% to 50% in interval of 10% .Various strength and durability tests conducted in the laboratory are compressive strength test, Flexural Strength test, Split tensile strength test, Acid resistant test, sulphate resistant test, Chloride resistant test and Water absorption test. Effect on mechanical properties with replacement of 20% sand with quarry dust resulted that there is increase in Compressive strength by around 10%, Split tensile strength by 15% and Flexure Strength by 10%.



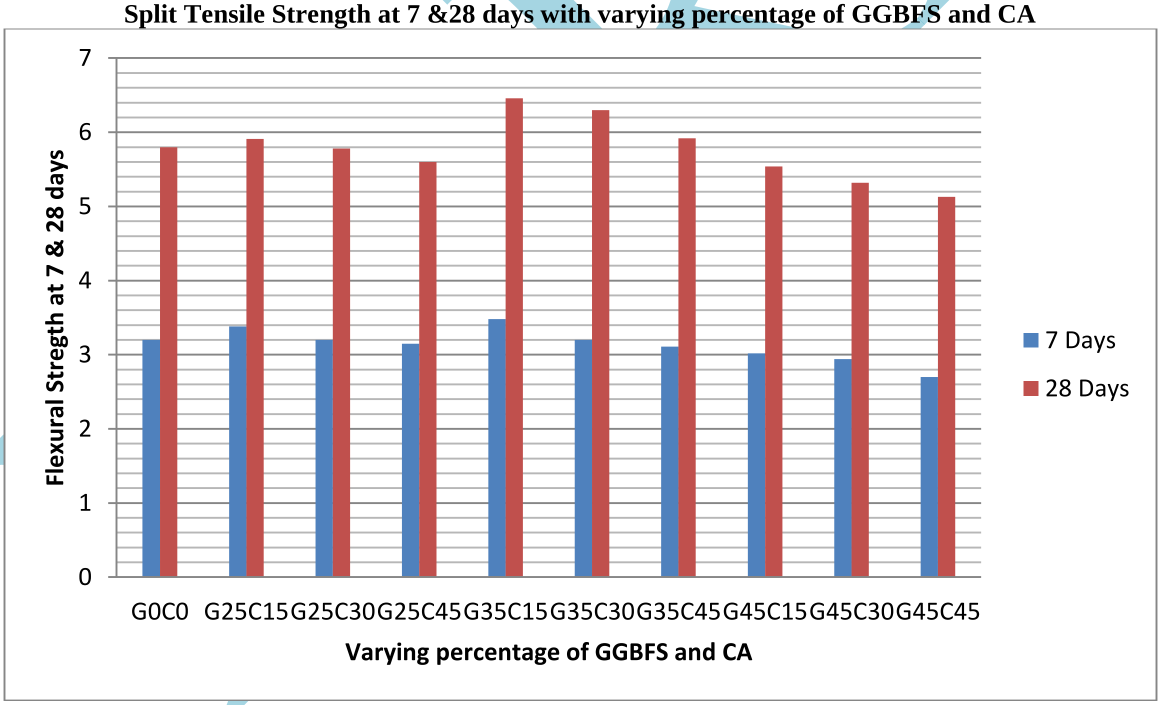
Concrete Slump value with varying percentage of GGBFS and CA



Compressive Strength at 7 &28 days with varying percentage of GGBFS and CA



Split Tensile Strength at 7 &28 days with varying percentage of GGBFS and CA



Flexural Strength at7 and 28 days with varying percentage of GGBFS and CA

III. CONCLUSIONS

1. The results of workability by Slump test method concluded that workability increases with the increase in the GGBS content. This may be attributed to the extended setting time property of GGBS. But increase in workability of concrete by GGBFS is limited to35 % replacement.
2. The workability results also concluded that increasing percentage replacement of Ceramic aggregates decreases the workability of concrete mix. This may be due to higher water absorption of Ceramic aggregates.
3. The compressive strength results concludes that compressive strength of concrete containing GGBFS and waste ceramic aggregates increases with increasing percentage of GGBFS but it is restricted upto 35%. . The increase in strength

may be contributed due to its fineness and better binding property with other ingredients.

4. It also concluded that with increasing percentage ceramic waste aggregates the value of compressive strength decreases. This may be due to low strength of ceramic aggregates and poor adhesion of inherent materials.

5. The maximum value of compressive strength at 28 days is obtained for concrete mix G35C15 is 42.6Mpa. It can be concluded from compressive strength results that G35C15 can effectively be used as structural concrete and it will prove economical in terms of strength and economy.

6. The test results of Split tensile strength and Flexural strength shows almost similar results as that of compressive strength. The results shows that with increase in percentage of GGBFS the split tensile and flexural strength of designed concrete increases upto 25% and beyond that it started decreases. Unlike GGBFS, introduction of ceramic waste lowers the strength as its percentage increases.

7. The maximum value of split tensile strength at 28 days is attained at G35C15 is 4.66.

8. The Flexural strength results concluded that maximum flexural strength attained at G35C15 is 6.46N/mm^{2}.

9. Concrete mix G35C15 can be considered as optimum mix in terms of strength and economy. Thus can be used as structural concrete without compromising its strength properties.

10. The over all cost of the concrete is reduced due to utilization of waste materials in concrete. These waste materials are available as free of cost or at very low prices in market. Thus introducing waste materials will lower the structure cost and contributes in protecting the environment.

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