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Investigation of the Strength and Durability of Partially Replacing Cement with GGBS and Alccofine

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ABSTRACT: Many concrete research projects are underway around the world to achieve high strength and improve longevity to extend the life of the material. In this study, cement is replaced with an ultrafine material called Alccofine at different percentages and GGBS at a constant grade M60. The continuous water content of 0.3 was found in the concrete proportions. As a result, Cryso premia K570, a 0.3 percent superplasticizer, is used to improve workability. The concrete samples are cast and cured for seven and twenty-eight days, respectively, under normal conditions. Concrete specimens were subjected to mechanical tests such as compressive strength, flexural strength, broken tensile strength, and toughness tests such as water permeability and the RCPT. The optimum strength was achieved at 15 percent Alccofine and 30 percent GGBS, according to mechanical properties. The percentage of cement that should be replaced with Alccofine and GGBS was investigated. The chloride permeability in all of the mixes is very poor, according to ASTM. The aim of this research is to investigate the physical characteristics and durability of M60 grade concrete with partial replacement of cement with GGBS and Alccofine, as well as to determine the best Alccofine material to mix in concrete.

KEYWORDS: Alccofine, GGBS, Strength, Replacement of Cement, Strength Tests.

I. INTRODUCTION

Concrete is the world's most commonly used human-made construction tool. Concrete's creation and usage had a slew of environmental and social ramifications. Cement production has risen in tandem with the rise in concrete demand. As a result, a significant amount of greenhouse gas emissions, primarily CO₂, are released from limestone during the pyro-processing of clinker, causing environmental damage. We can use supplementary cementitious materials like GGBS and Fly ash, Silica fume, Rice husk ash, Metakaolin, and Alccofine instead of cement to solve this issue. Many experiments are being conducted to improve the efficiency of high-performance concrete. High-strength, long-lasting concrete is known as HPC. HPC has two main characteristics: a high cement/binder content and a low w/c ratio. The workability and retention of concrete with these characteristics are insufficient. Due to this flaw, high-range water-reducing agents, such as superplasticizers, are used in concrete to boost the flowability and ease of placement and increase the holding period, which aids in the transportation of concrete mix. Cryso Premia K570, a superplasticizer, was used in this analysis. Alccofine 1203 is a low calcium silicate product that is manufactured in India. It has distinct properties that improve 'concrete efficiency' in both fresh and hardened levels. Alccofine 1203 is a regulated granulation product with a high glass content and high reactivity. It enhances the properties of fresh and hardened concrete, resulting in high-performance environmental concrete. Alccofine increases the early strength and longevity of concrete when used in it. Alccofine 1203 outperforms all other supplementary materials used in concrete because of its specific chemical structure and ultra-fine particle size. This material is used to construct high-rise buildings, particularly marine structures, precast elements, and bridges. Concrete's durability is characterized as its ability to withstand weathering and any other deterioration method. When exposed to the atmosphere, durable concrete can retain its original shape, quality, and serviceability. Many measures are used to determine the durability of concrete, including water permeability, acid attack, sulphate attack, sorptivity, and RCPT (Rapid Chloride Permeability Test). The RCPT test methods were used in this study's water permeability test. One of the best methods for determining concrete durability is looking at its resistance to chloride penetration.



II. LITERATURE REVIEW

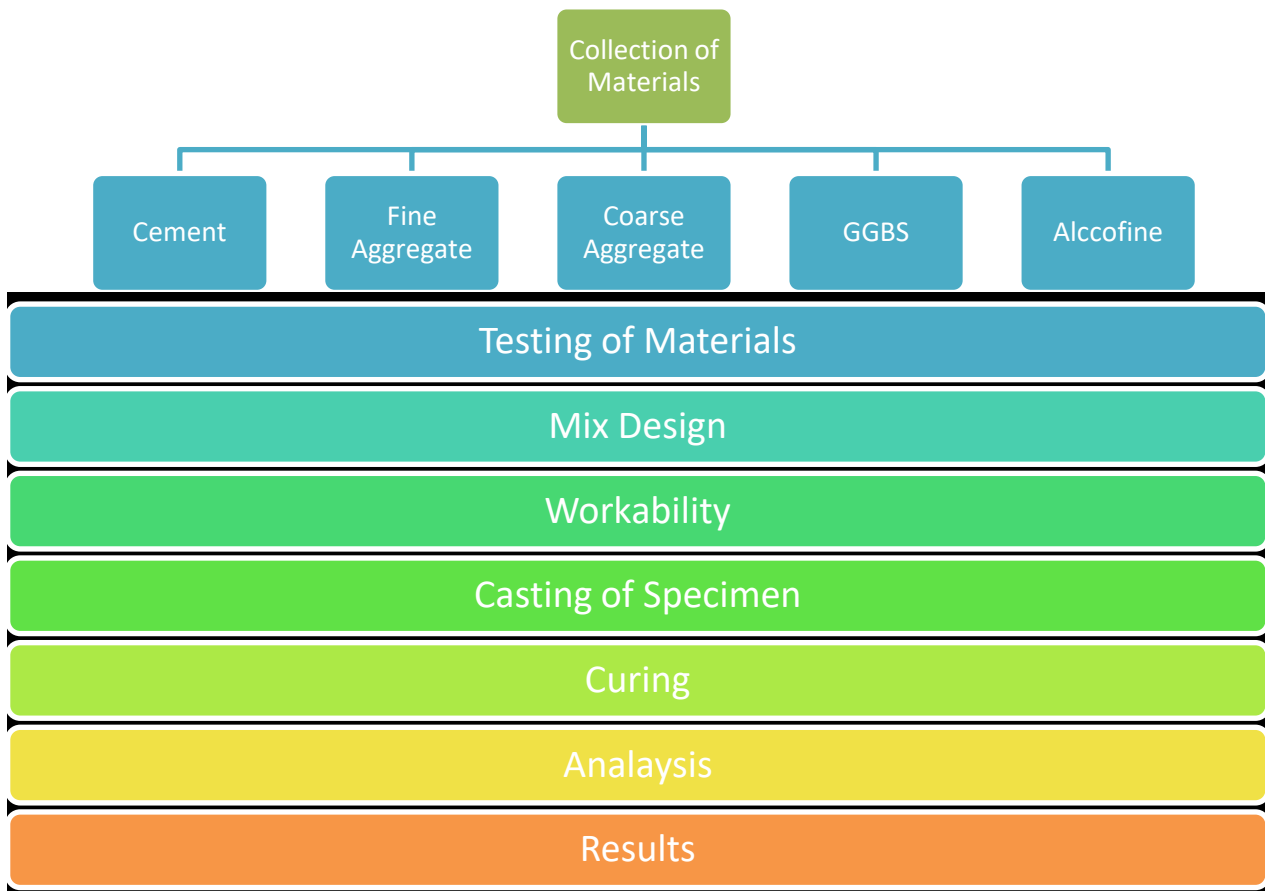
Siddharth 2014 et al.

The author of this Research Paper discusses the efficiency of concrete in terms of compressive strength. Demands in the construction industry are driving up the market for high-performance concrete. Over the last few years, efforts to improve the performance of concrete have suggested that cement substitute products and mineral and chemical admixtures will enhance the strength and durability of concrete. Pozzolanic materials such as alccofine (GGBS) and fly ash can be used to make highly durable concrete composites. The concrete specimens were cured using standard moist curing methods at room temperature.

Saravanan 2019 et al.

The author of this research paper discusses the toughness of concrete when alccofine and GGBS are added. The most significant component of Concrete is Portland cement. A large-scale cement plant consumes a lot of energy and produces many unwanted products (CO₂), which negatively impacts the atmosphere and depletes natural resources. This benefit to the environment has prompted researchers to investigate industrial by-products as supplementary cementitious material in concrete production. In light of this, materials such as silica fume (SF), ground granulated blast furnace slag (GGBS), rice husk ash, fly ash (FL), Metakaolin, alccofine (AL), micro-fine content & others are being tested to wholly or partially replace cement in concrete without losing its strength, while also reducing greenhouse gas emissions and ensuring a sustainable waste management system.

III. METHODOLOGY



Fine aggregate: Sand or crushed stone with a diameter of less than 9.55mm are often used as fine aggregates. Fine aggregates are described as aggregates that have passed through a 4.75mm sieve. Fine aggregate is used to fill voids in coarse aggregate and to improve workability. According to the specifications of IS 383:1970, the fine aggregates used in the project work are zone II. The sand from the Godavari River is used in the construction.

Coarse aggregate: Coarse aggregate is a building material made up of rock quarried from field deposits such as river gravel, crushed stone from rock quarries, and previously used concrete. The most common diameter range used was 9.5mm to 37.5mm. The scale of aggregates used in this project is 20mm and 12.5mm. For coarse aggregate, the IS 2386-1986 code is used.

Water: Both mixing and curing were carried out with potable water. Potable water is described as water with a pH of 7 or less. The concrete mixture contains fresh tap water. Water is classified as IS:10500-2012.

GGBS: The by-product of blast furnace slag used to produce iron or steel is GGBS. Blast furnaces work at about 1500°C and are fed with a balanced mixture of limestone & iron ore. The blast furnace has molten iron and molten slag as iron ore, coke, and limestone melt. The molten slag floats on. Since it is lighter, it is placed on top of the molten iron. The molten slag is mainly made up of silicates and alumina from the iron ore, with some oxides from limestone thrown in for good measure. Cooling molten slag with high-pressure water jets is part of the granulating process. The slag is rapidly quenched, and granular particles of less than 5mm are formed. Rapid cooling prevents larger crystals, resulting in granular calcium-alumina silicates that are 95% non-crystalline. Drying and grinding the granulated slag to an excellent powder (GGBS) in a vertical roller mill or rotating ball mill is the next step.

Alccofine: Alccofine is an ultra-fine substance of the latest generation. With a specific size that is Unlike other hydraulic materials, this one is much smoother. Produced in India, such as cement and fly ash. Alccofine has unusual properties that improve the 'performance of concrete in both fresh and hardened states. Fine, micro-fine, and ultrafine particle sizes are represented in the Alccofine 1200 series by 1201, 1202 and 1203, respectively. The packing density of the paste portion is improved by Alccofine 1203. As a result, the amount of water used and the amount of admixture used is reduced, resulting in increased concrete strength and durability. Alccofine 1203 supports two types of hydration reactions: pozzolanic and hydraulic, thanks to its high CaO content. As a consequence, the pore structure becomes denser, and the strength gain is more significant.

IV. OBJECTIVES & USES

The main goal of this research is to obtain a lot of early intensity.

- To examine the compressive strength, break tensile strength, flexural strength, and toughness properties such as water permeability test, RCPT (Rapid Chloride Permeability Test) of Concrete made with various mixes of Alccofine and constant GGBS as a partial substitute for cement.
- To determine the best percentage of Alccofine to substitute cement.
- Strengthens and extends the life of a concrete building.
- Lower's temperature rises by reducing hydration heat.
- GGBS concrete has more excellent workability and is more accessible to position and compact.
- Reduce thermal cracking caused by a low-temperature increase at a young age.
- Excellent sulphate and chemical resistance
- Reduces permeability by eliminating voids in concrete.
- The alkali-silica reaction is strongly resisted.
- Chloride penetration can be reduced, which protects the steel from corrosion.

V. TESTS AND RESULTS

The capacity of a material or structure to bear loads on its surface without cracking or deflection is measured using a compressive strength test. The water-cement ratio, the composition of the concrete content, compaction, curing, and other factors all affect the concrete's compressive ability on a compression measurement unit. The concrete cubes are cast and water cured, then the moulds are removed, and the test specimens are left to cure for 24 hours. After 7 and 28 days of curing, these specimens are examined using a compression measuring machine. The sample should be subjected to a load before it fails. It's essential to keep track of the load at which the specimen fails. Load / cross-sectional area equals compressive power.



Fig. Compressive Strength Machine

Tensile test with a split One of the most fundamental and critical properties of concrete is its tensile strength, significantly impacting the degree and scale of cracking in structures. Furthermore, due to its porous nature, the concrete is very fragile under stress. As a result, it is unable to withstand direct pressure. As a result, when tensile forces surpass the concrete's tensile strength, cracks appear. As a result, the tensile strength of concrete must be determined to determine the load at which the concrete member can crack. The cylindrical specimen has a diameter of 150mm and a height of 300mm. $2p/Ld$. Split tensile test Where p denotes the load in kilograms of force. D = cylinder diameter L is the cylinder's volume.



Fig. Tensile Strength Machine

Testing for flexural strength Two steel rollers must be placed at a distance from center to center on the measuring machine's bed, on which the specimen will be supported (it changes with the size of specimens). Two equivalent rollers mounted on the third points of the supporting span, spaced at center-to-center width, shall apply the load. The load must be evenly distributed between the two loading rollers. All rollers are positioned. Until processing, make sure the surface of the specimen is clean. Prisms measuring 100mm x 100mm x 500mm were cast. $F_b = PL/BD^2$ or $3Pa/BD^2$ flexural strength: The distance between the fracture line and the closer support, measured along the tensile side of the prism's centreline. B = Specimen Width $22 D$ = Specimen depth L = Specimen Length P is the full load in kilograms.

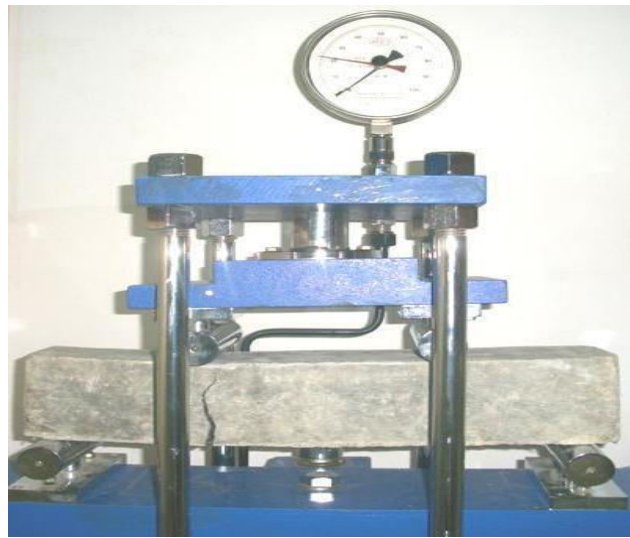


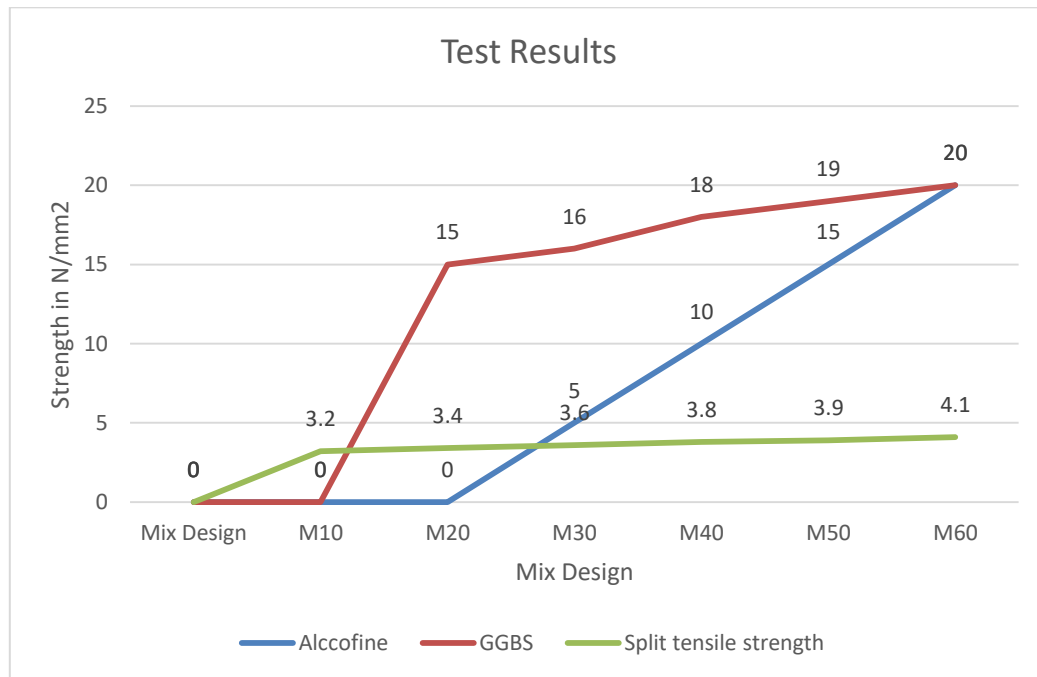
Fig. Flexural Strength Machine

The Royal College of Physicians and Surgeons of Canada Rapid Chloride Permeability Test and, according to ASTM C1202, to quickly determine concrete's resistance to chloride-ion penetration, this test method involves assessing its electrical conductivity. In this test, a 50mm thick, 100mm diameter cylindrical concrete sample is exposed to a 60V DC potential difference for 6 hours, with one end of the specimen in contact, and it has been linked to the charge passed in coulombs. The sample's surface taken from the curing tank should be washed, and the specimens should then be put in a closed desiccator, and the air sucked for 1 hour using a vacuum pump in this distilled water introduced into the desiccator to submerge the specimens, followed by a vacuum pump running for 1 hour to fill the pores with distilled water. The specimen is removed from the desiccator and placed in a testing mould with silicon sealant to avoid leakage. The chemicals are then poured into the mould, and an electrode is attached to the mould with a constant 23-volt DC power supply. The charge was registered for 6 hours at a half-hour interval.



Fig. RCPT Machine

Test for Water Permeability Permeability refers to the amount of water that percolates into concrete under pressure and the ability of concrete to withstand material penetration. Concrete used in water-retaining systems exposed to the elements must be watertight or impermeable to prevent water from leaking out of the structure. The water-cement ratio, water content, porosity, compaction, and other factors influence permeability. The permeability of concrete determines the durability of concrete structures.



VI. CONCLUSION

- Alccofine was used as a partial cement replacement, resulting in high early strength.
- Compared to all other blends, Concrete of M60 grade with 15% and Compressive, split tensile, and flexural strength was higher in alccofine and 30% GGBS.
- Compared to traditional concrete, the inclusion of 30% GGBS and 15% Alccofine results in a 12 percent improvement in compressive power. As compared to standard concrete, the addition of 30 percent GGBS and 15 percent Alccofine increases split tensile strength by 19 percent.
- As compared to traditional concrete, the addition of 30 percent GGBS and 15 percent Alccofine increases flexural strength by 25%.
- All of the blends have a very low chloride permeability, according to ASTM C1202.

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