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A STUDY ON STRENGTH AND DURABILITY OF GFRC WITH PARTIAL REPLACEMENT OF CEMENT AND SAND WITH SILICA FUME AND M-SAND

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ABSTRACT
This study aimed to identify on the strength and durability of Glass Fiber Reinforced Concrete (GFRC) with partial replacement of cement and sand with silica fume and M-sand aimed to investigate the effects of incorporating these materials on the properties of GFRC. Silica fume is a byproduct of silicon metal production, known for its pozzolanic properties that enhance the strength and durability of concrete. Manufactured sand (M-sand) is an alternative to river sand, often used in construction due to its reduced environmental impact. This study explores how replacing traditional components with silica fume and M-sand influences the performance of GFRC. In Mix concrete with different amount of M sand such as 10%, 20%, 30% and 40% are partially replacement of natural sand. In Mix concrete of 0% 5% 10% 15% & 20% of Silica fume as replacement of to improve the quality of concrete. In additional, 0.05% of glass fibers are added to concrete to create glass fiber-reinforced concrete (GFRC).

Keywords:
Strength, Durability, Glass Fiber Reinforced Concrete (GFRC), Cement, Sand, Silica Fume and M-Sand

INTRODUCTION

The Glass Fiber Reinforced Concrete (GFRC) is a composite material made of cement, fine aggregates, water, chemical admixtures, and alkali-resistant glass fibers. It offers high strength, durability, and design flexibility, making it a popular choice in construction. The addition of silica fume and M-sand as partial replacements for cement and sand, respectively, can potentially improve the mechanical properties and sustainability of GFRC.
Glass Fiber Reinforced Concrete (GFRC) is a composite material made of cement, sand, water, and alkali-resistant glass fibers. It is known for its high strength, durability, and versatility in architectural In this experimental study, the researchers investigated the effects of partially replacing cement and sand with silica fume and M-sand on the strength and durability of GFRC.
The study involved preparing different mixes of GFRC with varying proportions of silica fume and M-sand as partial replacements for cement and sand, respectively. The specimens were then subjected to various tests to evaluate their compressive strength, flexural strength, water absorption, and durability characteristics.
The results of the experimental study indicated that the partial replacement of cement with silica fume and sand with M-sand had a significant impact on the properties of GFRC. The compressive strength and flexural strength of GFRC improved with the incorporation of silica fume and M-sand. Additionally, the use of these materials led to reduced water absorption and enhanced durability of GFRC.
Based on the findings of the study, it can be concluded that the partial replacement of cement and sand with silica fume and M-sand can enhance the strength and durability of GFRC. This suggests that incorporating these supplementary materials in GFRC mixes could lead to improved performance in structural applications.

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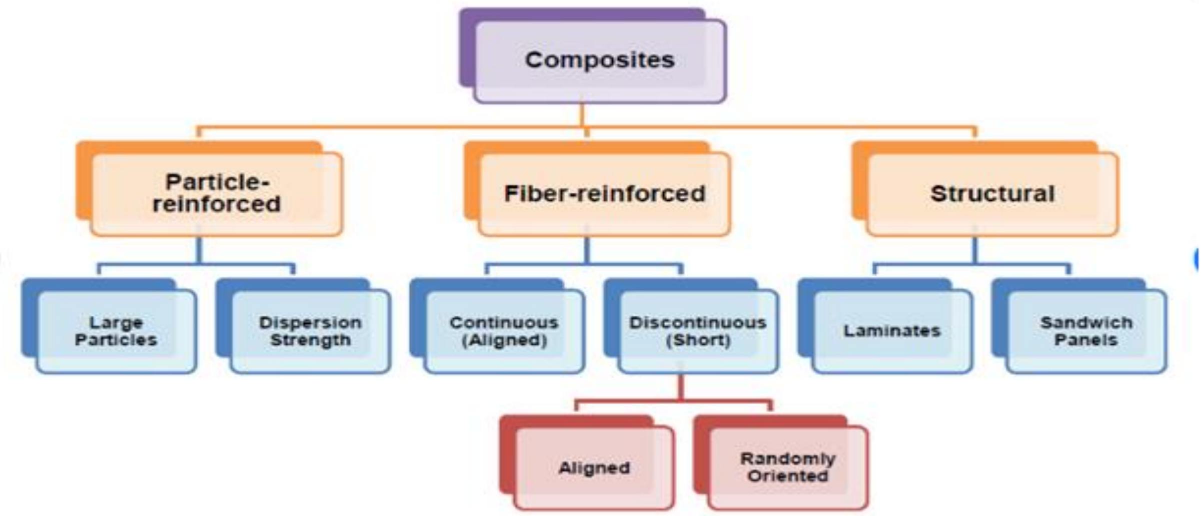

Figure no. 1 Composite materials classification

OBJECTIVES

The objectives of studying Glass Fiber Reinforced Concrete (GFRC) with silica fume and M-sand can vary depending on the specific research goals and desired outcomes. However, some common objectives of such a study may include:

1. To compare the hardened properties of concrete with different amount of M sand such as 10%, 20%, 30% and 40%.
2. To compare the hardened properties of concrete with different amount of 0% 5% 10% 15% & 20% of Silica fume as replacement of Cement to improve the quality of concrete.
3. In additional, 0.05% of glass fibers are added to concrete to create glass fiber-reinforced concrete (GFRC).
4. To utilize IS 10262:2009 to create the mix design for M30 grade concrete and using the slump cone test to determine the workability.

USED MATERIALS

Cement

Limestone and clay that have been calcined are ground into a very fine, grey powder to create cement. One of the binding agents used in this project is cement. The other ingredients are joined together by a paste made of cement and water. It is being utilized Ordinary Portland Cement (43 grade) in accordance with IS:8112-1989.On cement, numerous tests were carried out.

Figure no 2 Cement

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Fine aggregate

Throughout the project, clean river sand with a maximum size of 4.75 mm that complied with Zone I of IS 383-1970 was used as fine aggregate. Sand is a naturally occurring granular substance made up of small pieces of rock and mineral. According to IS:2386, tests are conducted on the physical characteristics of fine aggregate, such as specific gravity, fineness modulus, and water absorption. Sand can further be further classified into fine, medium, and coarse categories based on its fineness modulus (FM), as shown below:

1. Fine sand, FM 2.20 to 2.60
2. Medium sand, FM 2.60 to 2.90
3. Coarse sand, FM 2.90 to 3.20.

Figure no 3 Fine Aggregates

Coarse Aggregates

All material that is retained on an IS sieve with a mesh size of at least 10 mm and a maximum size of 80 mm is referred to as coarse aggregates. Examples of coarse aggregate include natural picked gravel, crushed gravel, crushed stone, and other materials. The greatest size generally employed on the project, 63 mm, is the largest size that coarse aggregates must be graded from 10- mm up to. The aggregate grade is determined by the intended mix. According to IS:383-1970, utilised coarse aggregate should abide by the grading restrictions specified for its nominal size as nearly as practicable.

The maximum aggregate size is typically determined by the sieve size on which a certain percentage or more of the particles are retained. The greater the maximum aggregate size, the lower the surface area per unit volume that must be covered by the cement paste of a particular water-cement ratio.

Therefore, it might be cost-effective to employ the highest size of maximum aggregate if the coarse, strength, workability, and durability requirements are satisfied.

Figure no. 4 Coarse Aggregates

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Glass Fiber

Glass fibre reinforced concrete (GFRC) is made up of glass fibres, cement hydration products, or cement and sand. Glass fibres are employed as concrete reinforcement. In Russia, glass fibres were first utilised to strengthen cement and concrete. The highly alkaline Portland cement matrix, however, corroded them. As a result, the UK and other nations have developed alkali resistant glass fibres. Glass fibres can be found as concrete, wool, ropes, chopped strand mats, continuous rovings, woven fabric, and ropes. To shield glass fibres from Portland cement's alkali attack, epoxy resin compounds have also been tested on them.High strength glass made with magnesium alumina silicates. Used where high strength, high stiffness, extreme temperature resistance, and corrosive resistance is needed.

Figure no 5 Glass Fibers

Silica Fume

Silica fume, also known as micro- silica, is a (no crystalline) amorphous silicon dioxide polymorph of silica. It is an ultrafine powder collected as a byproduct of the production of silicon and ferrosilicon alloy and consists of spherical particles with an average diameter of 150 nm particle. The main application field is as pozzolanic material for high-performance concrete. It is often confused with fumed silica. However, the process of production, characteristics of particles and fumed silica fields of application are all different from those of silica fume.

Production of Silica Fume

Silica fume is a by-product of high purity quartz carbothermic reduction with carbonaceous materials like coal, coke, wood chips, in electric furnaces in the production of silicon and ferrosilicon alloys. The main source of silica fume is produced as a by-product during the extraction of iron ore.

Figure no 6 Silica fume,

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M Sand
With its high specific gravity, M Sand is a fine material that can be used in place of some of the sand in concrete
mixes to improve density, strength, and corrosion resistance of concrete structures. More applications for M Sand include the following:

- Bearings and filter parts.
- Machine parts.
- Hand Warmers.
- High strength/wear-resistant parts.
- Magnetic materials.
- Friction parts (mainly automobile parts).
- As a fuel.

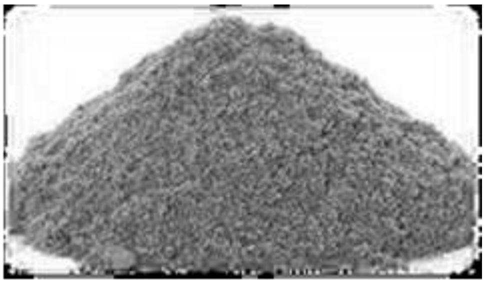

Figure no 7 M Sand

CONCLUSION

1. In conclusion, the study on GFRC with partial replacement of cement and sand with Silica Fume and M-sand contributes valuable knowledge to the field of concrete technology.
2. By exploring innovative ways to enhance the properties of GFRC while promoting sustainability in construction practices, this research paves the way for more eco-friendly building materials.
3. the practical application of GFRC with silica fume and M-sand.
4. It may address potential challenges in implementation, cost-effectiveness, environmental benefits, and future research directions related to enhancing GFRC through sustainable practices.

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