Study on Smart Construction Materials and Practices Using Glass Fiber in Reinforced Concrete

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Abstract. Glass-fiber reinforced concrete (GFRC) is a composite material made of a cementitious grid made out of concrete, sand, water and admixtures. In which glass filaments are scattered in short length. The Non-Structural components, as façade boards, funneling and channels has been generally utilized in the development business. GFRC gives various points of interest, for example, being lightweight, imperviousness to fire, great appearance and strength. Trial-tests are led for concrete with glass fiber and without glass fiber are led. The distinctions in compressive quality and flexural quality have been found in this investigation by utilizing 3D shapes of differing sizes. Various applications and advantages of GFRC appeared in the examination, techno-economic correlation with different kinds, the test results, and furthermore the financial calculations introduced demonstrate the capability of GFRC as an elective development material.

Keywords – Glass Fiber, RCC, GFRC

1. Introduction

Glass Fiber Reinforced Concrete (GFRC) or (GRC) is cement applied with fiber. In addition to sand, GFRC fuses hydration effects from asphalt, or lime, and glass fibers. Glass filaments were first developed and used in Russia for strengthening concrete and cement. Shockingly, the incredibly simple Portland concrete structure was consuming them and also Antacid stable glass strands h along those lines. In addition, GFRC is a type of solid that uses fine sand, concrete, polymer (normally an acrylic polymer), water, various admixtures and healthy antacid safe glass strands. Many blend plans can be accessed on different sites without reservation, but all give similarities in fixing extent. Glass fiber reinforced cementitious composites were primarily developed to build slim sheet segments, with a glue or mortar grid, and 0.5%, 1.0% 1.5%, fiber content. Different uses and applications were considered, either by making fortifying bars with permanent glass filaments consolidated and impregnated with plastics, or by making comparable small, rigid units, and impregnated with epoxy. During blending it is dispersed onto the solids. Glass threads are borne in a loop while liquid glass is drawn through the base of a warmed platinum tank or bushing by the form of fibers. At the same time 204 fibers are being drawn. They get tough out of the warmed tank while they cool. And they are grouped on a drum into a strand comprising of the 204 fibers. The fibers are covered with a sizing which protects the filament against weather and abrasion effects, as well as binding them together in the strand [2].

2. Literature Review

Any researches from the aforementioned analysis are as follows. Alam M A [1] studied Concrete is fragile
under stress because it is brittle. The use of fibers in concrete has greatly increased both its compressive as well as tensile strength. The concrete blends employed alkali resistant glass fibers. The benefits of technique improving and prestressing technology is the usage of steel insulation as high tensile steel wires has managed to solve concrete’s stress incapacity however, the toughness and cracking tolerance have not enhanced. Gaurav Tuli, Ishan Garg [2] have analyzed Plain concrete possess very low tensile strength, weak ductility and minimal cracking. The strain properties as well as the resistance to crack, ductility and flexure strength and toughness is improved when fibers are added in certain percentage in concrete. To improve the flexural strength of concrete various works have been done. Various forms of additives and add mixtures are used. Addition of glass fibers provides concrete resistance to tension [3]. Concrete is one of the most commonly known construction substance often provided by the use of materials which are accessible locally. The compressive power, tensile strength and the break tensile strength are significantly enhanced as these fibers are inserted into concrete. In this analysis, glass fiber concrete measurements were conducted by adding 0.5 percent, 1 percent and 1.5 percent cement by adding as an admixture. Varma [4] studied Glass fiber reinforced concrete as one of the most flexible construction methods that architects and engineers can use. Mainly made of asphalt, sand and special alkali resistant (AR) glass fibres, GRC is a thin, high-strength concrete with many building applications. The workability of concrete of M20, M30, M40 and M60 grades of concretes were estimated in terms of compaction factor for addition of 0.03% of glass fiber. It was observed that the addition of glass fibers, the compaction factor of 0.93 to 0.97 was maintained for almost all grades of concrete.

3. Principal aim of Study
In this test study, the objectives are as follows:

- Study the mix design aspects of GRC.
- Understanding the applications including GRC.
- Comparing GRC with different materials, for example, stone, aluminum, wood, glass, steel, marble and rock.
- Performing the laboratory test, for example, compressive, elastic and flexure by utilization of glass fiber in the solid pour.

4. Properties of Glass Fiber Reinforced Concrete
As the fiber provides the stack, the system provides perseverance and durability. These two elements are dependable at the stage where paired to cope with excessive burdens. It even forestalls lasting use and concoction. It establishes the elasticity by 10 percent and several times the opposition effect by around 100 times likewise of glass threads. It exhibited weariness of Glass fiber fortified cement (GFRC) as opposed to that of steel fiber reinforced cement (SFRC) when conducting cyclic stacking experiments on glass fiber concrete.

5. Experimental Work
In this experimentation, an endeavor has been made to discover the concrete strength and swapped concrete strength for M20 grade of cement. This examination decides the concrete materials properties and concrete quality. Mix design conveyed for M20 grade of concrete by IS 10262-2009 with water
concrete proportion of 0.45. Specimens were set up as indicated by the mix proportions and adding glass fiber to diminish the bleeding.

5.1. Batching up of materials
Appropriate quantity of materials was calculated by volume and mixed in following proportions:
- Volume of cement = 09.20 kg
- Volume of coarse aggregates = 23.66 kg
- Volume of fine aggregates = 29.87 kg
- Volume of water = 03.68 kg

The materials were mixed by machine mixing process.

5.2. Specification of Specimen
The number of specimens casted was as per the below-mentioned details.
The size of cube is 150 x 150 x 150mm, size of cylinder Diameter =150mm and Height=300mm, size of prism 100 x 100 x 500mm.

5.3. Compressive Strength
Compressive strength is the ability of a given material or part, when applied, to sustain loads that minimize the size of that material or structural part. In compression testing system as per IS 516: 1964, the Experimental test for the compressive strength of cubes was carried out. The cubes had been measured at 140 kg / cm² / min. And it registered maximum loads.

Compression Strength (N/mm²) = P/A Where,

\[ \text{Compression Strength (N/mm}^2\text{)} = \frac{P}{A} \]

![Graph showing compressive strength of GFRC](image)

**Figure 1.** Graph showing compressive strength of GFRC

P - Ultimate load (N)
A – Area of the cube (mm²)

5.4. Split tensile strength
Split tensile strength is known as the method of deciding concrete's tensile strength. A cylinder which splits across the vertical diameter is used to decide this. For cylinders the split tensile strength test was
conducted as per IS 516: 1964. The Experimental research was performed by putting a cylinder specimen horizontally between the loading surfaces of a universal device mac.

![Figure 2. Graph showing Split tensile strength Vs Age of concrete (GFRC)](image)

5.5. Flexural strength
Flexural strength is defined as the stability of a beam or slab to withstand or resist the failure in bending. Flexural strength is measured by loading unreinforced concrete beams with a span three times the depth. The flexural strength is expressed as “Modulus of Rupture” (MR) in N/mm². The MR is calculated as follows

6. Application and use of GFRC

6.1. Applications
The following are the applications of GFRC in the construction works:

- Building renovation works
- Drainage and Water work
- Tunnel lining panels and in bridge works
- Permanent formwork method of construction
- Architectural cladding
- Screens and Acoustic Barriers

6.2. Uses

- GFRC can outlive steel reinforced concrete and is extremely durable. It is also reliable and safe.
- Design Freedom.
- It is made from mold-state so GFRC can take up any shape and texture along with color.
- Requires low maintenance.
- Resistant to fires and climate.
- Economical and cost effective

7. Conclusion
These are the ends drawn from the examination on addition of glass fiber in concrete. With 0.5 percent addition of fiber, the addition in the compressive quality is 13 percent, the increment in flexural quality is 42 percent and the increment in split elasticity is 20 percent over regular cement. With 1 percent addition of fiber, the addition in the compressive quality is 35 percent, the addition in flexural quality is 75 percent and the increment in rigidity is 37 percent. Therefore, reinforcing with glass fiber contributes greatly in upgrading the compressive quality of cement and the expansion is 1.78 occasions that of typical cement. From the test outcomes, it is discovered that the glass fiber has the high flexural quality. Subsequent to warming the solid at 300°C for 2 hours, there is a decrease in the compressive quality. This outcome is appeared by the fireproof test. The decrease in the compressive quality is 32 percent over its unique quality without the addition of fiber. The decrease in the compressive quality is 25 percent over its unique quality by 0.5% addition of fiber. With 1 percent option of fiber, the compressive quality reduced by 10 percent over its unique quality. This exploratory examination shows a higher opposition of fiber strengthened cement to fire when contrasted with ordinary cement. Along these lines, glass-fiber concrete has superior fireproof-qualities. It is far more predominant than ordinary cement and it is likewise higher in flexural quality. Particularly, it is intended to fortify and offer strong steadiness to whichever material it projects in either concrete or GFRC.

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