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# A Study on Glass Fibre as an Additive in Concrete to Increase Concrete Tensile Strength

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**ABSTRACT**

*- The present day world is witnessing the construction of very challenging and difficult civil engineering structures. Glass fiber (also spelled glass fibre) is a material consisting of numerous extremely fine fibers of glass. Quite often, concrete being the most important and widely used material is called upon to possess very high strength and sufficient workability properties. Efforts are being made in the field of concrete technology to develop such concretes with special characteristics. Researchers all over the world are attempting to develop high performance concretes by using fibres and other admixtures in concrete up to certain proportions. Glass-fibre reinforced concrete (GRC) is a material made of a cementatious matrix composed of cement, sand, water and admixtures, in which short length glass fibres are dispersed. It has been widely used in the construction industry for non-structural elements, like façade panels, piping and channels. GRC offers many advantages, such as being lightweight, fire resistance, good appearance and strength. To increase the applications of Glass Fibre Reinforced High-Performance-Concrete (GFRHPC) in India, greater understanding of GFRHPC produced with locally available materials and indigenously produced mineral admixtures is essential.*

**KEYWORDS: glass fibre, additive, concrete, rigid pavement, utilization, tensile strength**

## INTRODUCTION

Glass wool, which is commonly known as "fiberglass" today, however, was invented in 1938 by Russell Games Slayter of Owens-Corning as a material to be used as insulation. It is marketed under the trade name Fiberglas, which has become a genericized trademark. Glass fiber also called fiberglass. It is material made from extremely fine fibers of glass Fiberglass is a lightweight, extremely strong, and robust material. Although strength properties are somewhat lower than carbon fiber and it is less stiff, the material is typically far less brittle, and the raw materials are much less expensive. Its bulk strength and weight properties are also very favorable when compared to metals, and it can be easily formed using molding processes. Glass is the oldest, and most familiar, performance fiber. Fibers have been manufactured from glass since the 1930s.

## TYPES OF FIBER

Steel fiber, Glass fiber, Polypropylene Fiber, Asbestos fiber, Organic fiber, Vegetable fiber, Carbon fiber, Polyester fiber etc. are various types of fiber available in world. Fiber technology is one of the fastest updating technologies today. There are currently 2,00,000 metric tons of fibers used for concrete reinforcement.

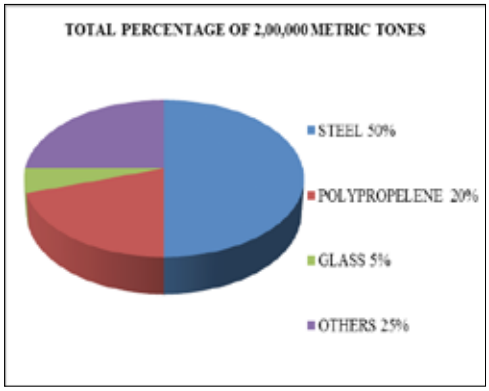



**Figure 1 Fiber used in concrete reinforcement in world**

Source: Fly ash utilization in construction – presents status & future prospects TYPES OF GLASS FIBER As to the raw material glass used to make glass fibres or nonwovens of glass fibres, the following classification is known:

**TABLE: 1**
**TYPES OF GLASS FIBER**

| | |
|---|---|
| A-glass | With regard to its composition, it is close to window glass. In the Federal Republic of Germany it is mainly used in the manufacture of process equipment. |
| C-glass | This kind of glass shows better resistance to chemical impact. |
| E-glass | This kind of glass combines the characteristics of C-glass with very good insulation to electricity. |
| AE-glass | Alkali resistant glass. |

Generally, glass consists of quartz sand, soda, sodium sulphate, potash, feldspar and a number of refining and dying additives. The characteristics, with them the classification of the glass fibres to be made, are defined by the combination of raw materials and their proportions. Textile glass fibres mostly show a circular.

## PROPERTIES OF GLASS FIBER

- **Thermal**

Glass fibers are useful thermal insulators because of their high ratio of surface area to weight. However, the increased surface area makes them much more susceptible to chemical attack. By trapping air within them, blocks of glass fiber make good thermal insulation, with a thermal conductivity of the order of 0.05 W /(m·K).

- **Tensile**

The strength of glass is usually tested and reported for "virgin" or pristine fibers—those that have just been manufactured. The freshest, thinnest fibers are the strongest because the thinner fibers are more ductile. The more the surface is scratched, the less the resulting tenacity.

**TABLE: 2**
**PROPERTIES OF GLASS FIBRE**

| Fiber type | E-glass | S-2 glass |
|---|---|---|
| Tensile strength (MPa) | 3445 | 4890 |
| Compressive strength (MPa) | 1080 | 1600 |
| Density (g/cm3) | 2.58 | 2.46 |
| Thermal expansion µm/(m°C) | 5.4 | 2.9 |
| Softening T (°C) | 846 | 1056 |
| Price Rs./kg | 100 | 1000 |

Source: http://en.wikipedia.org/wiki/Glass_fiber

## FIBERS IN RIGID PAVEMENT

Pavements are composite materials that bear the weight of pedestrian and vehicular loads. Pavement thickness, width and type should vary based on the intended function of the paved area.

**Pavement thickness:** It is determined by four factors: environment, traffic, base characteristics and the pavement material used.

**Pavement Width:** As with thickness, pavement width should vary based on its intended use. Interstate highways will obviously need to be much wider than local residential roads. Similarly, the parking lot serving a regional shopping center will be much larger than one for a neighborhood convenience store.

Rigid pavements have sufficient flexural strength to transmit the wheel load stresses to a wider area below. Compared to flexible pavement, rigid pavements are placed either directly on the prepared sub-grade or on a single layer of granular or stabilized material. Since there is only one layer of material between the concrete and the sub-grade, this layer can be called as base or sub-base course.

### Types of Rigid Pavements

Rigid pavements can be classified into four types:

- Jointed plain concrete pavement (JPCP)
- Jointed reinforced concrete pavement (JRCP)
- Continuous reinforced concrete pavement (CRCP)
- Pre-stressed concrete pavement (PCP)

### Failure criteria of rigid pavements

Fatigue cracking has long been considered as the major or only criterion for rigid pavement design. The allowable number of load repetitions to cause fatigue cracking depends on the stress ratio between flexural tensile stress and concrete modulus of rupture. Of late, pumping is identified as an important failure criterion. Pumping is the ejection of soil slurry through the joints and cracks of cement concrete pavement, caused during the downward movement of slab under the heavy wheel loads. Other major types of distress in rigid pavements include faulting, spalling, and deterioration. So to reduce the cracks developed in the concrete, fibers are used to stick the concrete surfaces. It will not separate the particles of the materials used in concrete.

## BENEFITS OF GLASS FIBER REINFORCED CONCRETE (GFRC)

There are lots of good reasons to use GFRC for thin sections of concrete:

- Lighter weight: With GFRC, concrete can be cast in thinner sections and is therefore as much as 75% lighter than similar pieces cast with traditional concrete. According to Jeff Girard's blog post titled, The Benefits of Using a GFRC Mix for Countertops, a concrete countertop can be 1-inch thick with GFRC rather than 2 inches thick when using conventional steel reinforcement.
- High strength: GFRC can have flexural strength as high as 4000 psi and it has a very high strength-to-weight ratio.
- Reinforcement: Since GFRC is reinforced internally, there is no need for other kinds of reinforcement, which can be difficult to place into complex shapes.
- Consolidation: For sprayed GFRC, no vibration is needed. For poured, GFRC, vibration or rollers are easy to use to achieve consolidation.
- Equipment: Expensive equipment is not needed for poured or vibrated GFRC with a face coat; for sprayed GFRC, equipment generally costs about Rs. 50,000.
- Toughness: GFRC doesn't crack easily—it can be cut without chipping.
- Surface finish: Because it is sprayed on, the surface has no bug holes or voids.
- Adaptability: Sprayed or poured into a mold, GFRC can adapt to nearly any complex shape, from rocks to fine ornamental details.
- Durability: According to ACI 544.1R-96, *State of the Art Report on Fiber Reinforced Concrete*, "The strength of fully-aged GFRC composites will decrease to about 40 percent of the initial strength prior to aging." Michael Driver, division manager with Nippon Electric Glass, a major manufacturer of AR glass fibers, disagrees. "There's never a durability issue. Water can't get in—there are no cracks—and that's a durable material. GFRC will outlast precast concrete, cast stone, even some natural stone." Durability has been increased through the use of low alkaline cements and pozzolans.
- Sustainable: Because it uses less cement than equivalent concrete and also often uses significant quantities of recycled materials (as a pozzolan), GFRC qualifies as sustainable.

**TABLE: 3**
**APPLICATIONS OF GLASS FIBRE**

| Architecture | Building | Engineering |
|---|---|---|
| Prefabricated architectural cladding, architectural moldings and features, Environments & Landscaping. | Industrial and agricultural roofing, Walls and Windows, Renovation, Foundations and Floors, Modular Buildings. | Permanent Formwork, Utilities, Acoustics, Bridges and Tunnels, Water and Drainage. |

## CASE STUDY

"Effect of Glass Fibres on Ordinary Portland Cement Concrete" Deshmukh S.H., Bhusari J. P, Zende A. M

Concrete is a tension weak building material, which is often crack ridden connected to plastic and hardened states, drying shrinkage, and the like. Moreover, concrete suffers from low tensile strength, limited ductility and little resistance to cracking. In order to improve these properties, and attempt has been made to study the effect of addition of glass fibers in ordinary Portland cement concrete. In the present experimental investigation glass fibers in different percentage 0 to 0.1% has been studied for the effect on mechanical properties of concrete by carrying compressive strength test, flexural strength test and splitting tensile strength test. The results have shown improvement in mechanical and durability properties with the addition of glass fibers.

In this study, control mix A was designed as per IS 10262:1982 to achieve a target compressive strength of 20 N/mm2. The glass fibres of 0 %, 0.03%, 0.06% and 0.1 % by volume fraction of concrete were used.

**TABLE: 4**
**COMPRESSIVE STRENGTH, FLEXURAL STRENGTH, SPLITTING TENSILE STRENGTH TEST RESULTS AT 28 DAYS**

| Type of concrete | Average compressive Strength N/ mm2 | Average Flexural Strength N/ mm2 | Average Splitting Tensile Strength N/ mm2 |
|---|---|---|---|
| M-20 with 0.0% glass fiber | 23.93 | 3.344 | 3.22 |
| M-20 with 0.03% glass fiber | 26.07 | 3.587 | 3.31 |
| M-20 with 0.06% glass fiber | 26.6 | 3.654 | 3.63 |
| M-20 with 0.1% glass fiber | 29.54 | 3.99 | 4.58 |

## CONCLUSIONS

As we know the concrete is poor in taking tension so to improve its tensile strength we can add glass fibres due to which the filaments of glass fibre will not separate the particles of concrete. The addition of glass fibres into the concrete mixture marginally improves the compressive strength at 28 days. It is observed from the experimental results, that the compressive strength of concrete, flexural strength of concrete, splitting tensile strength of concrete increases with addition of Percentage of glass fibers. The 0.1% addition of glass fibers into the concrete shows better result in mechanical properties and durability.

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