A Study on Strengthening the R.C. Columns by Fibres

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Abstract

Due to ageing, poor maintenance, corrosion caused by poor environmental conditions, and accidental events such as earthquakes, concrete structures can deteriorate. With ever-increasing demands, the necessity to update degraded civil engineering infrastructure becomes even more pressing. As a result, restoring and retrofitting civil engineering infrastructure has been recognised as a critical problem that has to be addressed. Glass fibre is a novel material that is particularly successful in reinforcing work and is made up of tightly spaced glass and resins. The basic idea is that large strains occur in the vicinity of the reinforcement. The magnitude of the strain is determined by the distribution and subdivision of reinforcement throughout the mass of concrete. This paper investigates the strengthening of reinforced concrete columns using glass fibre laminates. The usage of Glass fibre as exterior confinement to concrete specimens is studied in this research. The efficiency of confinement is determined by comparing the behaviour of retrofitted specimens to that of ordinary specimens.

Keywords: *Glass Fibre Laminates, Glass And Resins, Concrete Deterioration Retrofitting*

INTRODUCTION

GENERAL

Concrete has a fragile aspect and is low in tension. The idea of employing fibres to enhance the properties of building materials is not new. Early uses included straw reinforcement in mud bricks, horsehair reinforcement in plaster, and asbestos reinforcement in pottery. Continuous reinforcing in concrete (reinforced concrete) improves strength and ductility but requires precise placement and labour competence. Alternatively, the incorporation of discrete fibres in plain or reinforced concrete may give a superior option.

The modernisation of fibre reinforced concrete (FRC) began in the early 1960s. When fibres are added to concrete, it becomes homogenous and isotropic. When concrete fractures, randomly oriented fibres begin to operate, halting crack development and propagation and increasing strength and ductility. FRC failure modes are either fibre-to-matrix bond failure or material failure. Fibre-reinforced concrete (FRC) is a kind of concrete that contains fibre components that boost structural stability. It is made up of short discrete fibres that are evenly dispersed and orientated randomly. Steel fibres, glass fibres, synthetic fibres, and natural fibres are all types of fibre that provide different qualities to concrete.

Furthermore, the character varies when concretes, fibre materials, geometrical distribution, direction, and densities change.

The Evolution of Fiber Reinforced Concrete

The use of fibres or as reinforcement is not a new notion. Fibres have been utilised for reinforcement since antiquity. Horsehair was traditionally used in mortar and straw in mud bricks. Asbestos fibres were employed in concrete in the early 1900s. The notion of composite materials emerged in the 1950s, and fibre-reinforced concrete was one of the areas of discussion. Once the health dangers of asbestos were revealed, a substitute for the chemical in concrete and other construction materials became necessary. Steel, glass (GFRC), and synthetic fibres such as polypropylene fibres were utilised in concrete by the 1960s. Today, research on novel fibre reinforced concretes is ongoing.

METHODS AND MATERIALS

Cement

The PPC grade 53 is used.

Steel

Steel reinforcing bars of Fe500 grade are tested to failure using a universal testing machine. The test is carried out in accordance with I.S. 1786:2008.

Water

The water used for mixing should be fresh, clean, and drinkable. Organic materials, silt, oil, sugar, chloride, and acidic material should be largely absent from the water. It should have a pH of 7 to avoid lowering the pH of the mortar slurry. Although saltwater is not permitted, chlorinated drinking water may be utilised.

The epoxy resin

Epoxy resins are good tensile strength binding agents. They are chemical preparations with compositions that may be altered as needed. Just prior to application, the epoxy components are mixed. Because of its low viscosity, the product can also be injected into small cracks. High viscosity epoxy resins can be used for surface coating as well as filling larger cracks and holes. The strength of an epoxy mixture is determined by the curing temperature and technique of application.

Accelerator and epoxy resin

Glass fibre

Glass fibre is available in various shapes and sizes on the market. It has proved critical to employ the suitable size and form and the correct kind for the appropriate application.

Among the commonly accessible glass fibre varieties are:

- E Glasses
- R R Glasses
- D Glasses
- GLASS C
- A.E. Glass Inc.

A-glass: In terms of composition, it is similar to the window glass. It is primarily utilised in producing process equipment in the Federal Republic of Germany.

C-glass: This kind of glass is more resistant to chemical assault.

E-glass: This kind of glass combines the properties of C-glass with excellent electrical insulation.

Alkali-resistant glass, abbreviated as AE-glass: Glass is made out of quartz sand, soda, sodium sulphate, potash, feldspar, and a variety of refining and dying chemicals. Therefore, the features, and the categorisation of the glass fibres to be produced, are dictated by the raw material combination and their proportions.

DISCUSSION AND RESULTS

Glass Fibers Improve the Properties of Concrete

1. Compressive strength - increased by roughly 20 – 30%.
2. Tensile strength–It is more robust than regular concrete.
3. Flexural Strength–Increased by about 25–30%.
4. Split Strength – Increased by 25% – 30%.
5. Impact strength - Increased and improved wear and tear resistance.
6. Permeability - Fiber inclusion improves permeability.
7. Corrosion – Greater resistance to atmospheric effects than standard concrete.

See Table 1

The mix shell is intended to produce concrete of M25 grade. The design mix requirements are as follows:

1. M25 is the grade classification.
2. Cement type: PPC 53 grade
3. Maximum nominal aggregate size: 20 mm
4. Cement content must be at least 330 kg/m3.
5. The maximum water-to-cement ratio is 0.40.
6. Severe exposure condition
7. Aggregate type: crushed angular aggregate
8. Cement content maximum: 450 kg/m3
9. Formalisation of specimens

The wooden formworks needed for casting the column have been installed, and the necessary reinforcing has been tied up in accordance with the column calculation. The given formwork and reinforcing details are shown in the image below. The columns are shaped in the round and square patterns. Normal Columns and Wrapped Columns are among the columns that are being cast. The column being used has a length (l) of 0.5m, a depth (d) of 0.20m, and a thickness (t) of 0.20m.

Mix design for M25 grade concrete

Cement	Fine aggregate	Coarse aggregate	Water content
425.80 kg/m3	646.41 kg/m3	1073.34 kg/m3	191.61 kg/m3
1	1.51	2.52	0.45

Using the same design and size assumptions, create a circular column with length (l) 0.5m and diameter (D) 0.15m. The columns are being cast and tested under static stress. For each grade, four normal and four wrapped columns are cast and cured in a laboratory for 7days, 14days, 21days, and 28days.

Specimen examination

The specimen will be removed from the curing tank at the end of the curing time. The first four columns determine the weight-bearing capability of each grade of the column. The fibre mats are wrapped to both sides of the column using Epoxy glue in the following four columns. Plastering is being applied to the fibre-wrapped columns in order to cover the fibre mat. For two weeks, the plastering surface was cured. The wrapped column will be tested after curing. **See Table 2**

The ultimate load of the normal specimen will be determined by testing four R.C. columns. The wrapped specimen's final load will be determined by testing the remaining four columns. The columns were then repaired using one layer of Glass fibre laminates and epoxy resin.

CONCLUSION

The usage of Glass fibre laminates looks to be a beneficial rehabilitative treatment for the existing member in distress in this project. It is a promising alternative material for reinforcing and repairing reinforced concrete components. Glass fibres increase RCC members' load-bearing capability and ductility. Eight reinforced concrete columns were cast and tested to failure in this experimental programme.

The wrapped columns and the standard columns were both tested to failure. The behaviour of the tested columns was then investigated. The primary goal of this experimental effort was to get access to an increase in the load-bearing capacity of concrete columns exposed to compressive load. The Glass Fiber Wrapping technique is highly successful in enhancing the load-bearing capacity of R.C. columns.

Table 2

No of days	Normal column	Wrapped column
7 days	380kN	450kN
14 days	400kN	500kN
28 days	440kN	550kN

Although the Glass Fiber Wrapping System has improved the performance of R.C. columns, additional experimental and analytical work on FRP enhanced R.C. structures is required. Glass Fibers may increase the flexural strength and ultimate load capacity of beams. According to the findings of this research, weight-bearing capacity rose by 1.25 times, or by 125 percent, compared to a standard column. Glass fibre mat is also cost-effective compared to other fibre materials, with GFRP sheet (A.E. Glass) costing just Rs.50/m2.

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