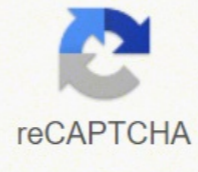




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N. Aravind\*, Amiya K. Samanta, Dilip Kr. Singha Roy, and Joseph V. Thanikal

## Flexural strengthening of Reinforced Concrete (RC) Beams Retrofitted with Corrugated Glass Fiber Reinforced Polymer (GFRP) Laminates

**Abstract:** Strengthening the structural members of old buildings using advanced materials is a contemporary research in the field of repairs and rehabilitation. Many researchers used plain Glass Fiber Reinforced Polymer (GFRP) sheets for strengthening Reinforced Concrete (RC) beams. In this research work, rectangular corrugated GFRP laminates were used for strengthening RC beams to achieve higher flexural strength and load carrying capacity. Type and dimensions of corrugated profile were selected based on preliminary study using ANSYS software. A total of twenty one beams were tested to study the load carrying capacity of control specimens and beams strengthened with plain sheets and corrugated laminates using epoxy resin. This paper presents the experimental and theoretical study on flexural strengthening of Reinforced Concrete (RC) beams using corrugated GFRP laminates and the results are compared. Mathematical models were developed based on the experimental data and then the models were validated.

**Keywords:** GFRP laminates; corrugated profile; load carrying capacity; epoxy resin; reinforced concrete

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### 1 Introduction

Strengthening of RC beams is necessary to obtain the expected lifespan of structures. Life span of RC beam may reduce because of improper beam design, ingress of

chemical agents etc. Strengthening of RC beams using steel plates and FRP composites are most common globally. In order to minimize the disadvantages of steel such as corrosion, high unit weight, connection difficulties; many researchers have tried various FRP composites such as Aramid, Glass and Carbon. In future, Fibre Reinforced Polymer (FRP) materials could play an important role for the construction industry [1]. Nowadays, retrofitting work for RC structural members, GFRP composites are commonly used because of its excellent properties such as high strength, less weight to strength ratio, noncorrosive nature and easy handling.

Several investigations on strengthening of RC beams using different FRP composites and adhesives are studied and discussed. So far researchers have varied the thickness, position, orientation and number of layers for retrofitting work.

Hamid Saadatmanesh and Mohammad, have studied experimentally the characteristics of five rectangular beams retrofitted using GFRP plates at tension zone with epoxy resins [2]. It was concluded that the GFRP plate strengthened beams resist more loads and reduces crack width. Slobodan Rankovic et al., has done experimental study on RC beams strengthened with Near Surface Mounted (NSM) reinforced FRP composites [3]. Kang Seok Lee., has adopted different technique for shear and flexural strengthening of existing RC structures using chopped strand carbon or glass fibers mixed with epoxy and vinyl ester resins sprayed on sides and soffit of concrete beams with compressed air [4]. Recently, Hui Peng has done experimental study on reinforced concrete beams strengthened with pre-stressed near surface mounted CFRP strips [5]. Rami A. Hawileh has studied the behavior of RC beams strengthened with externally bonded hybrid fiber reinforced polymers [6]. Muhammad Masood Rafi and Ali Nadjai., studied high temperature effect on RC beams with CFRP bars and compared with normal temperature [7]. Previous research on strengthening works reveals that more layers of FRP materials applied, the higher flexural strength would be achieved [8]. This

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## Glass Fiber Reinforced Concrete Exclusive Assets and Applications in Construction

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### ABSTRACT

Glass Fiber Reinforced Concrete or (GFRC) is a composite that has glass fibers instead of steel strands for its reinforcement. Removing the steel reinforcement not only weakened, but also omitted steel erosion, corrosion, and their future repair costs, steel reinforcement costs, optimal coverage, and etc.

In this research, several sources were studied to determine and clarify GFRC's applications in order to compare its featured properties with other fibers. Different figures and tables provided that show and compare physical and mechanical properties of GFRC and other fiber reinforcement.

GFRC can be used wherever a light, strong, weather resistant, attractive, fire resistant, impermeable material is required. It has remarkable physical and mechanical assets. GFRC properties are dependent on the quality of materials and accuracy of production method. Despite its wide range applications in architecture the chief goal is to show and introduce important structural purposes, for instance: anti rust characteristics of GFRC made it a good replacement for water and sewer pipes and tanks, a thin protective layer of GFRC on concrete beams and columns can increase their durability in fire as well as low temperatures and generally it is a good replacement for susceptible materials in difficult environments.

Key Words: (Fiber Reinforcement, Glass Fiber, GFRC, Composite, Lightweight Concrete, Durable).

### I. Introduction

Undoubtedly one of the most important materials in worldwide construction industry that is vastly in use is concrete.



[Figure 1.a], Concrete

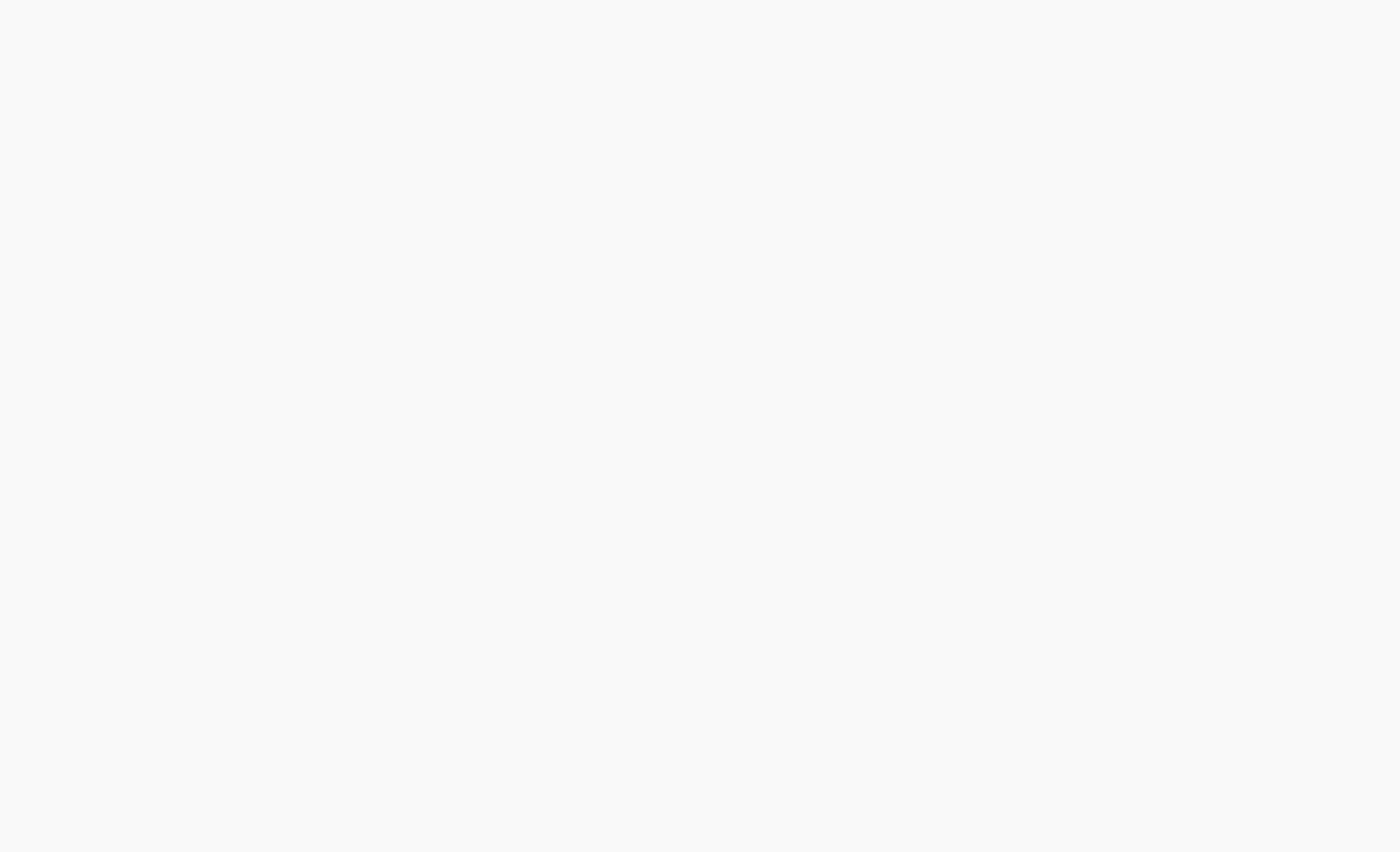


[Figure 1.b], Concrete block









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