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# Strengthening and Crack prevention of Conventional RC Structure by Retrofitting Technique

**Dr.A.M.Arun mohan[1], Mrs.S.Bharathi[2], Mrs.S.Thahira Banu[3], Mrs.K.Nagarubini[4], Mrs.S.Anbumeena[5]**

[1]*Associate professor,Civil Engineering,Sethu Institute of Technology,Kariapatti*
[2,3,5]*Assistant professor,Civil Engineering,Sethu Institute of Technology,Kariapatti*
[4]*Final Year M.E Student, Department of Structural Engineering, Sethu Institute of Technology , Kariapatti*

## ABSTRACT

Retrofitting method is followed for Concrete structures when the cracks are formed. In our project we use the retrofitting technique as a strength improvement technique in the construction stage. The present study focuses on the behaviour of conventional concrete cylinders strengthened using Glass Fibre Reinforced Polymer Wrap (GFRP) subjected to loading. Specimens were casted considering two cases, self cracking the specimen to retrofit with the fibres and wrapping the conventional specimens to prove the strength improvement.

**Keywords: Glass Fibre Reinforced Polymer, Ductility, Wraping.**

## 1 INTRODUCTION

Cracks in the concrete structures were early signs of distress which have to be diagnosed properly, otherwise the repair of same crack takes place again and again causing loss of time, money and endangering the safety of the structure. The structural cracks need more attention than non-structural cracks. The repair materials and methodology were different depending upon types of cracks, their locations such as joints, structural members etc. and conditions dry or moist

The loss of cementitious materials, as well as the corrosion- induced reduction in cross-section areas of steel reinforcement leads to drastic reductions in the structural integrity and load-carrying capacity of columnar supporting elements. To make a remedy for insufficient capacity, the structures need to be replaced or strengthened. Different types of strengthening materials are available in the market. Examples of these are Ferro cement, Steel plates; Fibre reinforced Polymer (FRP) laminate, Latex and Epoxy resin. Fibre Reinforced Concrete (FRC) is a concrete made primarily of hydraulic cements, aggregates and discrete reinforcing fibres.

## 2 LITERATURE REVIEW

**RaphaelleSadone and Julien Mercier (2022)** Structures can be submitted to severe conditions, especially earthquakes. Specimens consisted of 0.25 x 0.37 x
2.50m3 columns connected to a 1.25 x 1.00 x 1.00m3RC stubs. Strengthening of reinforced concrete structures was then a matter of concern. Externally bonded Fibre-Reinforced Polymers (FRP) were emerging as a valuable solution for structural strengthening but design rules have to be established concerning their application for seismic strengthening. For This purpose, an experimental campaign carried out on full-scale reinforced concrete (RC) columns has been undertaken.

**S.Eshghi and V.Zanjanizadeh (2008)**This paper explains an experimental research program on the use of GFRP (Glass Fibre-Reinforced Polymer) for retrofitting small-scale slender R/C columns to enhance seismic performance. An important deficiency in many existing non-ductile reinforced concrete frames was the inability of the columns to undergo significant deformations while maintaining their load-carrying capacity. As a result, relatively brittle modes of column failure, accompanied by soft storey structural failure mechanisms, were possible. Providing additional confinement to the columns allows them to behave in a more ductile manner Three columns were tested after being retrofitted with GFRP Wrapps at the potential plastic hinge zone, while three others were tested in the "as-built" condition. In general, the common mode of failure for the "as-built" samples was a brittle failure due to bond deterioration of the lap-spliced longitudinal reinforcement. Test results suggest that GFRP Wrapps can significantly increase the flexural strength and ductility of slender rectangular reinforced concrete columns.

**E. Senthilkumar (2010)** In the last few decades, moderate and severe earthquake have struck different places in the world, causing severe damage to reinforced concrete (RC) Structures. Retrofitting of existing structures was one of the major challenges that modern civil engineering structures has demonstrated that most of them will need major repairs in the near future This external confinement of concrete by high strength fiber reinforced polymer (FRP) composite can significantly enhance the strength and ductility and will result in large energy absorption capacity of structural members. FRP material, which were available in the form of sheet, were being used to strengthen a variety of RC elements to enhance the flexural, shear, and axial load carrying

**Ahmed Khalifa et al. (2011)**Fibre reinforced polymer (FRP) materials were continuing to show great promise for use in strengthening reinforced concrete (RC) structures. The objective of This study was to review the current research on shear strengthening with FRP and propose design algorithms to compute the contribution of FRP to the shear capacity of RC flexural members. Methods for computing the shear capacity based on the stress level to cause tensile fracture of the FRP sheet (which may be less than ultimate due to stress concentrations) and based on delimitation of the sheet from the concrete surface were presented. Areas which have the potential for further development were also discussed

**G. Maariappan& R. Singaravadivelan (2013)** Reinforced Concrete (RC) buildings designed for WAS 456-2000 have been found to be weak in adequate sewasmic design provwasions, capacity design considerations and detailing for ductile behaviour. Experimental tests RC frames have shown that the excessive damage or failure of beam-column joints, in particular exterior (or corner) joints

## 3 MATERIALS USED AND MIX DESIGN

Concrete is a mixture of cement, fine aggregate, Coarse aggregate and water with or without a suitable admixture in required proportion. The mix design was done for M20 grade of concrete as per 10262:2009. Glass Fibre Reinforced Polymer(GFRP) has been used for strengthening the Concrete Cylinders and Epoxy resin is used as a binder. The Conventional concrete cylinders and GFRP Wrapped cylinders were cast and compression test were carried out.

## 4 EXPERIMENTAL INVESTIGATIONS

A Concrete mix is prepared with the proportions arrived by mixed design as 1:1.5:3 with water cement ratio of 50%. The cylinder mould cleaned and greased or oiled thinly. Metal moulds are sealed to their base plates to prevent loss of water. The cylinders are filled with concrete in three layers, tamping each layer with 35 strokes using a tamper.

Moulds were filled completely, smoothed off the tops evenly, and cleaned up for any concrete outside the cubes. The specimens are left to set for 24 hours. Then the moulds and immersed the concrete cylinders in a water basins for a period of 7, 14, 21days. After curing period, the specimens take out into the water and place it separately.

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**Description of Specimen**

| Sl.no | Type of Specimen | Curing Period | | | TOTAL |
|---|---|---|---|---|---|
| | | 7 days(A) | 14 days(B) | 21 days(C) | |
| 1. | Specimen cylinders | 2 | 2 | 2 | 6 |
| 2. | Specimen cylinder with two wrapped GFRP | 2 | 2 | 2 | 6 |
| 3. | Specimen cylinder with four wrapped GFRP | 2 | 2 | 2 | 6 |
| 4. | Cracked cylinder with four wrapped GFRP | 2 | 2 | 2 | 6 |
| | Total no of cylinders | 8 | 8 | 8 | 24 |

**5 RESULTS AND DISCUSSIONS**

Conventional concrete cylinders were cast for M20 grade and kept for curing and the cylinders were then wrapped by Glass Fibre Reinforced Polymer (GFRP) with the use of Epoxy resin binder. After the specimens were wrapped, they are cured and after it were tested and then the results were compared with conventional concrete cylinders.

**COMPRESSIVE STRENGTH OF CYLINDERS AT 21DAYS**

| **Description** | | **Name** | **Weight of Specimen Kg** | **Load Kn** | **Compressive strength N/mm²** | **Average N/mm²** |
|---|---|---|---|---|---|---|
| Specimen cylinders | | A5 | 3.840 | 343 | 4.367 | **4.290** |
| | | A6 | 3.836 | 331 | 4.214 | |
| Specimen Cracked and Wrapped | | B5 | 3.975 | 320 | 4.074 | **4.201** |
| | | B6 | 3.980 | 340 | 4.329 | |
| Specimen Wrapped without Cracking | 2 Wrapp | C5 | 3.930 | 365 | 4.647 | **4.570** |
| | | C6 | 3.926 | 353 | 4.494 | |
| | 4 | C11 | 4.165 | 402 | 5.118 | |

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| | | | | | | |
|---|---|---|---|---|---|---|
| | Wrapp | C12 | 4.160 | 397 | 5.054 | **5.086** |

**COMPARISION OF RESULTS**

| CYLINDERS | | 7DAYS | 14DAYS | 21DAYS |
|---|---|---|---|---|
| Normal specimen cylinders | | 2.501 | 2.705 | 4.290 |
| Specimen Cracked and Wrapped | | 2.972 | 3.662 | 4.201 |
| Specimen Wrapped without Cracking | **2 Wrapp** | 2.711 | 3.647 | 4.570 |
| | **4 Wrapp** | 4.048 | 4.252 | 5.086 |

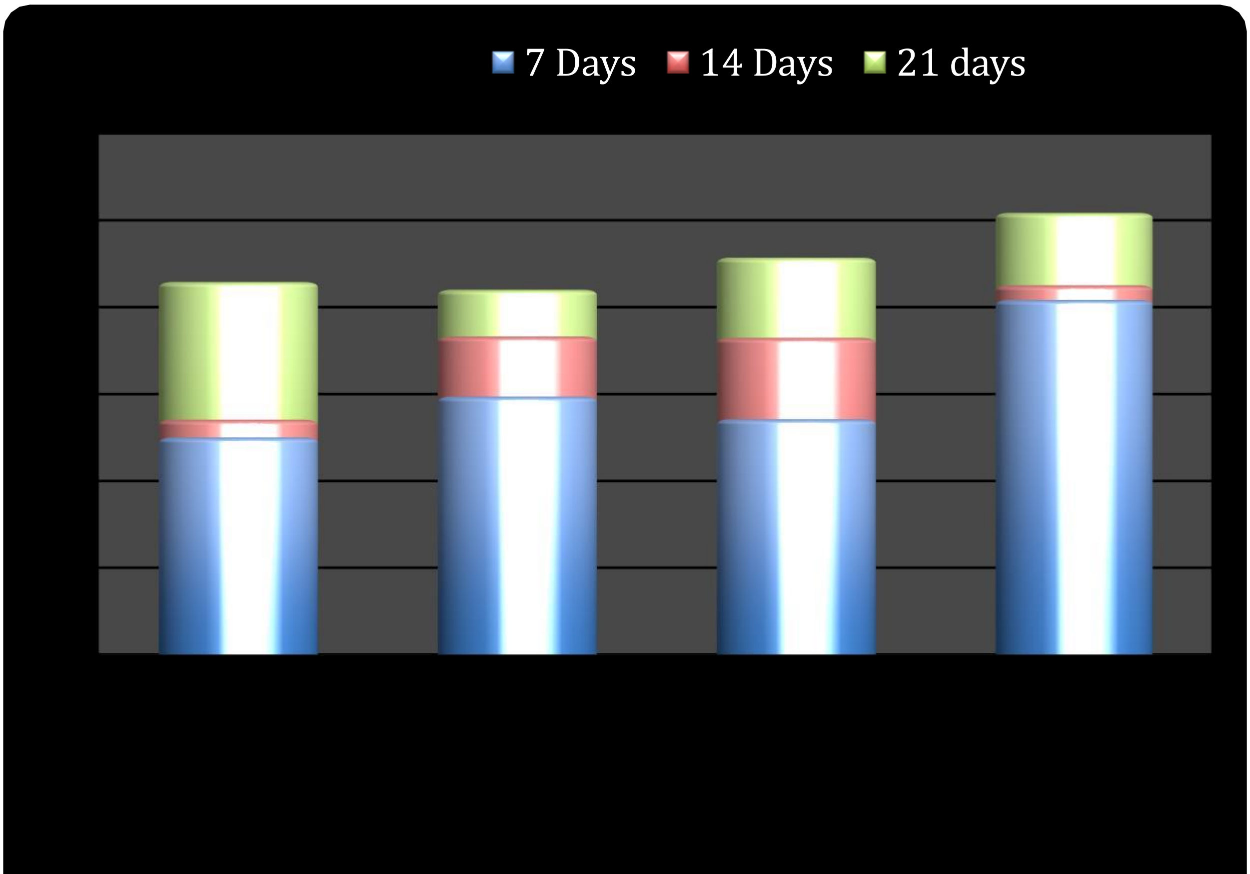


Fig.5.4 Comparison of Compressive strengths of cylinders for different curing

**CHAPTER 6**

From the experimental study it is evident that the usage of Glass Fibre Reinforced Polymer wrap helps to improve structural integrity and it also proved to be effective and showed increase in compressive strength than conventional concrete cylinders. Hence we can suggest GFRP Wrapp in the construction stage itself for avoiding future cracking considering the Quote that

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**Table 6.1 Comparison of % Increase in Strength with Specimen Cylinders**

| Curing Period | Specimen Cracked and Wrapped | Specimen Wrapped without Cracking | |
|---|---|---|---|
| | | 2 Wrapp | 4 Wrapp |
| 7 Days | 1.19% | 1.08% | 1.62% |
| 14 Days | 1.35% | 1.348% | 1.57% |
| 21 Days | 0.97%* | 1.065% | 1.186% |

***** indicates Decrease in Strength.

The result for Cracked and Retrofitted Specimen may vary in many cases since the Cracks self induced were uncontrolled where few specimen are induced with minor hair line cracks some were induced to deep cracks while a few specimen were totally disintegrated. Hence methods adopted to controlled cracking for the research to take place more specifically can give more accurate results

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