International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 06 Issue: 02 | Feb 2019 www.irjet.net p-ISSN: 2395-0072

EXPERIMENTAL STUDY ON RETROFITTED RC- BEAMS

Aastha[1], Dr. R.R. Singh[2]

[1]Ph.D. Student, Civil Engineering Department, Punjab Engineering College (Deemed To Be University), Chandigarh, India
[2]Professor & Head, Department of Civil Engineering, Punjab Engineering College (Deemed To Be University), Chandigarh, India

---

Abstract - Structures are in a phase of faster deterioration due to adverse environmental conditions. Most of the reinforced concrete structures reached their life time and time has come to repair/strengthen them. Various retrofitting techniques have been started in the field of construction and a brief of some of the techniques is mentioned in the study. The awareness among the people regarding retrofitting techniques is quite low. This study primarily deals with the use of Basalt Fiber Reinforced Polymer bars and sheets for strengthening the RC beams. In this work the BFRP bars and sheets are used to enhance the flexural capacity of the RC beams under four-point loading conditions and retrofitted at various pre-loading conditions. The load deflection characteristics are studied for various pre-loading conditions using BFRP bars, sheets and the combinations. The BFRP bars and sheets are introduced into the pre-cracked beam by the use of epoxy adhesive. The study considered the comparison of retrofitted beam of 50% & 70% preloading conditions with the control beam. The enhancement of ultimate load carrying capacity was above 25% in all the cases also the use of bi-directional BFRP sheets increased the capacity by more than 40% and the combinations increased the capacity by more than 50%. Slipping/de-bonding is not observed in the bars but the sheets showed de-bonding with the concrete under ultimate loading conditions.

1. INTRODUCTION

Deterioration of a structure means that it has lost its life but not the importance which arise the need to be restored and enhance its life which is done by retrofitting. The main purpose of retrofitting is to enhance the structural capacities of structure that is damaged. Traditional structure retrofitting was performed by the method of bonded steel plates which lead to the several disadvantages such as difficult and time consuming application, and lack of durability. Introduction of new material fibre-reinforced-polymer in the market for aging infrastructure which still getting attention for structural retrofitting lead to improvement of strength and durability of the structures.

Fibre reinforced polymers (FRP) which are also known as "composites" are materials composed of fibre reinforcements and polymer resin. The reinforcements impart strength and stiffness while the resin is an adhesive matrix that bonds the fibres. The resin matrix transfers the applied loads to the reinforcing fibres and protect the fibres from environmental attack. FRP composites are composed of fibre reinforcements and a resin matrix that bonds the fibres. Such composites can also include core materials, fillers, and other additives to provide unique performance attributes. Matrix resin chemistries include unsaturated polyester, viny ester, epoxy, phenolic and polyurethane resins. Unsaturated polyester resins are the most common of the resins utilized in FRP composites. The strength characteristics and mechanical properties of FRP composite's dependents on the type, amount and orientation of fibre reinforcement which including glass, carbon, aramid, and natural fibres.

Over the time, various types of fibres were introduced like carbon FRP_(CFRP), glass FRP_ (GFRP), aramid FRP_(AFRP) with the increase in FRP technology there was introduction of new FRP in market which is basalt fibres. However, basalt-FRP (BFRP) bars are the most recent FRP composite materials developed to enhance the safety and reliability of structural systems compared to GFRP, CFRP, and AFRP composites

Basalt is a natural, hard, dense, dark brown to black volcanic igneous rock originating at a depth of hundreds of kilometres beneath the earth and resulting the surface as molten magma. And its grey, dark in colour, formed from the molten lava after solidification.

1.1 Various Techniques for Retrofitting

1. Strengthening by using externally FRP sheet wrapping on the tension face of RC flexural members.
2. Near-Surface-Mounted (NSM) technique which involves cutting grooves into the concrete cover and bonding FRP reinforcing bars inside the grooves through the use of adhesive. This method of strengthening is a promising technology for increasing the flexural and shear capacity of reinforced concrete member.

2. Materials

Basalt fibre reinforced polymer bars and sheets

BFRP spirally wound deformed bar with nominal diameter of 10mm was used for NSM reinforcement . The ultimate tensile capacity of the BFRP bar is 1000MPa, tensile modulus of elasticity of 50GPa and elongation min value is 2.5%. The epoxy used for NSM technique. This epoxy has tensile strength of 35 Mpa, bond strength of 14MPa U-wrapping was performed using 300 GSM (Grams per Square Meter) BFRP unidirectional and plain fabric by wet-layup procedure Ultimate tensile strength in the primary fibre direction >1500MPa, elongation at break 2.2%, tensile modulus of elasticity 26.1GPa.

Beam dimension and reinforcement

The beam length is 700mm and the span between the supports is 600mm. The beams were loaded under four-point bending with two concentrated loads following ASTM standards. The spacing between two concentrated loads is 200mm. The cross section of the beam is a square with a depth of 150mm. All beams were reinforced with four #3 steel bars with a nominal diameter of 10mm. Of four longitudinal bars, two bars were used as compression reinforcement and two bars were used as tension reinforcement. #3 with nominal diameter of 10mm, stirrups were used to resist the shear reinforcement and spaced at 75mm.

Reduces as compared to intial rough surface of recycled aggregate. With increase in the replacement of recycled aggregates immersed in 5% sodium silicate solution workability of mix decreases.

3. CONCLUSIONS

On the basis of results and discussions, the following conclusions are drawn:

1. Both uni-directional and bi-directional wrapping of preloaded beam significantly improved the ultimate load carrying capacity by 26.82% and 46.91% w.r.t control beam.
2. In both uni-directional and bi-directional U-wrapping 70% pre-loading conditions retrofitting proved more promising.
3. Beams which were strengthened with NSM and u wrapping showed the increase in ultimate load capacity and was more than 50% w.r.t control beam in all the cases.

REFERENCES

1. Atutis, M., Valivonis, J. and Atutis, E. (2017) 'Experimental study of concrete beams prestressed with basalt fiber reinforced polymers. Part I: Flexural behavior and serviceability', Composite Structures. Elsevier Ltd. doi: 10.1016/j.compstruct.2017.01.081.

2. Cai, J., Pan, J. and Zhou, X. (2017) 'Flexural behavior of basalt FRP reinforced ECC and concrete beams', Construction and Building Materials. Elsevier Ltd, 142, pp. 423–430. doi: 10.1016/j.conbuildmat.2017.03.087.

3. Campione, G. et al. (2015) 'Behavior in compression of concrete cylinders externally wrapped with basalt fibers', Composites Part B: Engineering. Elsevier Ltd, 69, pp. 507–586. doi: 10.1016/j.compositesb.2014.10.008.

4. Conference, W. and Engineering, E. (2004) '13 th World Conference on Earthquake Engineering REHABILITATION OF HISTORICAL BUILDINGS SUBJECTED TO SEISMIC HAZARDS, A METHODOLOGY', (1598).

5. Elgabbas, F. et al. (2016) 'Experimental testing of basalt-fiber-reinforced polymer bars in concrete beams', Composites Part B: Engineering. Elsevier Ltd, 91, pp. 205–218. doi: 10.1016/j.compositesb.2016.01.045.

6. Ge, W. et al. (2015) 'Flexural behaviors of hybrid concrete beams reinforced with BFRP bars and steel bars', Construction and Building Materials. Elsevier Ltd, 87, pp. 28–37. doi: 10.1016/j.conbuildmat.2015.03.113.