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UPGRADING OF CORROSION DAMAGED RC BEAMS USING MECHANICALLY FASTENED CFRPCOMPOSITES

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ABSTRACT
Reinforced Concrete structures are suffering from various deteriorations like corrosion, cracks, spalling and large deflection. These deteriorations are caused by various factors such as aging, corrosion of steel reinforcement, environmental effects and accidental impacts on the structure. There are several options available for retrofitting the structural members of the existing reinforced concrete structures. Bonding of thin steel plates is the common method of retrofitting. Nowadays, bonding using fiber reinforced polymer sheets on to the damaged members helps to increase load carrying capacity, ductility and stiffness of the damaged structure. Such technique is an effective way to improve the flexural and shear performance of the reinforced concrete damaged structure. This project mainly focused on retrofitting the corrosion damaged reinforced concrete beams using mechanically fastened carbon fiber reinforced laminates. This type of retrofitting increases the load carrying capacity of the corrosion damaged reinforced concrete beams. It also increases the flexural and fatigue strength of the damaged reinforced concrete beam. Here, the general review of literature on the reinforced concrete structures, in which FRP used for strengthening purpose, is briefly presented and they were listed in the references at the end of the report.

CHAPTER– 1

INTRODUCTION

1.1 General

The development of external bonding of High-strength fiber reinforced polymer (FRP) composites is the potential technique over the steel plates in structural strengthening and upgrades of damaged or deteriorated members. Before the introduction of fiber reinforced polymer strengthening technologies, one popular technique for upgrading reinforced concrete beams was the use of external epoxy-bonded steel plates. This method suffers deterioration problem caused by the corrosion of the steel. There is wide range of techniques available to repair or strengthen structurally deficient and functionally aged structures. One such technique is adding FRP as external bonded reinforcement to the structure for upgrading reinforced concrete beams was the use of externally epoxy-bonded steel plates.

Every year building owners and managers are faced with the costs of repairing concrete that spalls when the reinforcing steel corrodes, usually due to the presence of salt. Removal, patching and the application of waterproofing membranes are some of the treatments that, alone or in combination, have traditionally been used to rehabilitate corrosion-damaged concrete. Steel corrosion is a major cause of deterioration which disrupts the cover zone of reinforced concrete members. As steel corrodes, there is a corresponding loss in cross- sectional area and in turn reduction occupy a larger volume than the original steel, which exerts substantial tensile forces on the surrounding concrete

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and causes it to crack and hence loss of structural bond stress between the reinforcement and concrete. Repair and rehabilitation of RC structures can only be successful if the new materials interact effectively with the parent concrete.

CHAPTER-2

LITERATURE REVIEW

A.H.Al-Saidy and K.S.Al-Jabri (2011):

Investigated the effect of damaged concrete cover on the behavior of corroded concrete beams repaired with CFRP sheets. This experimental program consisted of RC rectangular beam specimens exposed to accelerated corrosion. The corrosion rate was varied from 5% and 15% which represents loss in cross-sectional area of the steel reinforcement in the tension side. Half of the damaged beams were repaired by bonding CFRP sheets to the tension side to restore the strength loss due to corrosion. The other half of the beams was cleaned by removing spalled concrete cover and rusted bars were thoroughly cleaned. A new layer of concrete was cast to replace the removed spalled concrete cover. Then the CFRP sheets were attached to the new layer of concrete. Corroded beams showed lower stiffness and strength than control beams. Strength of damaged beams due to corrosion was restored to the undamaged state when repaired with CFRP sheets for all repaired beams, but the stiffness was almost unchanged.

CHAPTER - 3

3. PROPERTIES OF MATERIALS

- ➢ **Cement**
- ➢**Fine Aggregate**
- ➢**Course Aggregate**

Material Properties:

The concrete used in this study was a ready-mix concrete with expected 28 day target strength of 27.6MPa. Transverse steel reinforcement consisted of grade 40 reinforcing bars while all longitudinal reinforcement was grade 60 reinforcing bars. The CFRP sheets used for the shear strengthening in this study has tensile strength of 3792MPa, elastic modulus of 228GPa and ultimate strain of 0.017. The FRP laminated used as plates for the mechanical anchorage systems was a glass and carbon hybrid pultruded strip embedded in a vinyl ester resin, originally developed to have a high bearing capacity. The thickness and width of FRP sheet were 3.2mm and 102mm. The fastening system for the mechanical anchorages was commercial steel wedge anchors available in the market with a diameter of 12.7mm and a total length of 152.4mm.
study investigates the effect of the adhesive setting time on the modal parameters and examines the sensitivity of each bending mode to the increase of the adhesive setting time. Moreover, this study investigates the effect of the setting time on the modal parameters as tools to assess repaired RC beams with CFRP sheets. They have concluded that, the early age of the setting time shows a rapid increase in the modal parameters up to the 5th day. This gradually increases further up to the eleventh or 15th day and eventually becomes constant on the 18th day. The frequency for the first mode is the most sensitive to the setting time, while for the sixth mode is the least sensitive in terms of natural frequency.

T-beam ID	Test ID	Strengthening Scheme	Anchorage Type	Shear Reinforcement
1	RC-8-Control	None	Without	#3 @ 203 spacing

	RC-12-Control		anchorage	#3 @ 305 spacing
2	RC-8-S90-NA	Strip/90	Without anchorage	#3 @ 203 spacing
	RC-8-S90-DMA		Mechanical anchorage	
3	RC-12-S90-NA	Strip/90	Without anchorage	#3 @ 305 spacing
	RC-12-S90-DMA		Mechanical anchorage	
4	RC-12-S90-SDMA-PC	Strip/90	Sandwich panel mechanical anchorage	#3 @ 305 spacing
	RC-12- S90-HS-PC		Additional horizontal FRP strips	

NEED FOR THE RESEARCH

From the past research it was observed that there have been many investigations were reported on strengthening of RC structures using externally bonded CFRP systems besides only few researches are reported on the strengthening of RC structures using mechanically fastened CFRP systems. There is no guidelines/equation were proposed to predict the moment carrying capacity and failure mode of the RC Beam bonded by Mechanically Fastened FRP Composites. The aim of the present investigation is focuses on the upgrading of corroded RC beams using mechanically fastened CFRP composites.

CHAPTER 4

AIM OF INVESTIGATION PHASE II

The aim of the present investigation is upgrading of corroded RC Beams using Mechanically Fastened CFRP Composites. Unidirectional Carbon Fibre Reinforced Polymer (CFRP) used as continuous sheets and strips with several parameters such as,

1) Number of CFRP layers,
2) Fibre orientation,
3) Wrapping scheme and
4) Spacing between fasteners.

REFERENCE:

1. Habibur Rahman Sobuz, Ehsan Ahmed, Norsuzailina Mohamed Sutan, Noor Md. Sadiqul Hasan, Md. Alhaz Uddin, Md. Jahir Uddin, “Bending and time-dependent responses of RC beams strengthened with bonded carbon fiber composite laminates”, Construction and Building Materials, Vol.29, pp.597–61,2012.

2. Saeid Kakooei, Hazizan Md Akil, Abolghasem Dolati and Jalal Rouhi, “The corrosion investigation of rebar embedded in the fibers reinforced concrete”, Construction and Building Materials, Vol.35, pp.564–570, 2012.

3. J.F. Dong, Q.Y. Wang and Z.W. Guan, “Structural behaviour of RC beamsexternally strengthened with FRP sheets under fatigue and monotonic loading”, Engineering Structures, Vol. 41, pp.24–33, 2012.

DOI:10.46647/ijetms.2024.v08i02.035 ISSN: 2581-4621

4. Moatasem M. Fayyadh and H. Abdul Razak, “Assessment of adhesive setting time in reinforced concrete beams strengthened with carbon fibre reinforced polymer laminates”, Materials and Design, Vol.37, pp. 64–72, 2012.
5. R. Al-Rousan, R. Haddad and K. Al-Sa’di, “Effect of sulfates on bond behavior between carbon fiber reinforced polymer sheets and concrete”, Materials and Design Vol.43, pp.237–248, 2013.
6. I. Iskhakov, Y. Ribakov, K. Holschemacher and T. Mueller, “High performance repairing of reinforced concrete structures, Materials and Design”, Vol.44, pp.216–222, 2012.
7. Abdeldjelil Belarbi, Sang-Wook Bae and Antonio Brancaccio, “Behavior of full-scale RC T-beams strengthened in shear with externally bonded FRP sheets”, Construction and Building Materials, Vol.32, pp.27–40, 2012.
8. Zachary B. Haber, Kevin R. Mackie and Lei Zhao, “Mechanical and environmental loading of concrete beams strengthened with epoxy and polyurethane matrix carbon fiber laminates”, Construction and Building Materials Vol. 26, pp.604–612, 2012.
9. Alfredo M. Ceci, Joan R. Casas and Michel Ghosn, “Statistical analysis of existing models for flexural strengthening of concrete bridge beams using FRP sheets, Construction and Building Materials”, Vol.27, pp.490–520, 2012.
10. Rami A. Hawileh, “Nonlinear finite element modeling of RC beams strengthened with NSM FRP rods”, Construction and Building Materials, Vol. 27, pp.461–471, 2012.
11. S. Ahmad, A. Elahi, S.A. Barbhuiya and Y. Farid, “Use of polymer modified mortar in controlling cracks in reinforced concrete beams”, Construction and Building Materials Vol. 27, pp.91–96, 2012.
12. Koichi Kobayashi and Keitetsu Rokugo, “Mechanical performance of corroded RC member repaired by HPFRCC patching”, Construction and Building Materials (2012).
13. Rajeh Z. Al-Zaid, Abdulaziz I. Al-Negheimish, Mohammed A. Al-Saawani and Ahmed K. El-Sayed, “Analytical study on RC beams strengthened for flexure with externally bonded FRP reinforcement”, Composites: Part B Vol. 43, pp.129–141, 2013.
14. Fadi Oudah and Raafat El-Hacha, “A new ductility model of reinforced concrete beams strengthened using Fiber Reinforced Polymerreinforcement”, Composites: Part B (2012).
15. Hongyu Zhou and Thomas L. Attard, “Rehabilitation and strength sustainability of fatigue damaged concrete encased steel flexural members using a newly developed polymeric carbon fiber composite”, Composites: Part B (2012).
16. A.H. Al-Saidy and K.S. Al-Jabri, “Effect of damaged concrete cover on the behavior of corroded concrete beams repaired with CFRP sheets”, Composite Structures, Vol.93, pp.1775–1786, 2011.
17. Moatasem M. Fayyadh and Hashim Abdul Razak, “Assessment of effectiveness of CFRP repaired RC beams under different damage levels based on flexural stiffness, Construction and Building Materials”,Vol.37, pp.125–134, 2012.