APPLICATION OF CFRP COMPOSITE FOR SUSTAINABLE SOLUTION OF CORRODED SLAB SYSTEM DUE TO LOW NOMINAL COVER

CASE STUDY ON NERD SLAB SYSTEM

Chathuri Kaushalya Ganewattha

198047V

Degree of Master of Science

Department of Civil Engineering

University of Moratuwa

Sri Lanka

February 2023

APPLICATION OF CFRP COMPOSITE FOR SUSTAINABLE SOLUTION OF CORRODED SLAB SYSTEM DUE TO LOW NOMINAL COVER

CASE STUDY ON NERD SLAB SYSTEM

Chathuri Kaushalya Ganewattha

198047V

A thesis submitted in partial fulfilment of the requirements for the degree Master of Science in Civil Engineering

Department of Civil Engineering

University of Moratuwa

Sri Lanka

February 2023

DECLARATION

I declare that this is my work. This thesis does not incorporate without acknowledgment any material previously submitted for a degree or diploma in any other university or institute of higher learning. To the best of my knowledge and belief, it does not contain any material previously published or written by another person except where the acknowledgment is made in the text.

Also, I grant to the University of Moratuwa the non-exclusive right to reproduce and distribute the thesis, in whole or in part in print, electronic or other media. I retain the right to use this content in whole or part in future works (such as articles or books).

Signature: UOM Verified Signature Date:26.02.2023

The above candidate has carried out research for the master's under my supervision.

Name of the supervisor: Prof. (Mrs.) J C P H Gamage

Signature of the supervisor: UOM Verified Signature Date: 26.03.2023

ACKNOWLEDGEMENT

Under my postgraduate research project, I had the opportunity to gain valuable experience of applying the theoretical knowledge gathered throughout the four years to produce significant findings for the well-being and development of the community. There are several persons whom I must pay my honest gratitude for their help towards the successful completion of the research project and report.

First, I am very grateful for the valuable guidance and encouragement given by my research supervisor, **Prof. (Mrs.) J.C.P.H. Gamage**, Professor in the Department of Civil Engineering, University of Moratuwa. Without her support and guidance, I might not have achieved this great target. Further, I am thankful to **Prof. A.A.D.J Perera**, Senior Professor in the Department of Civil Engineering, University of Moratuwa, for his great support to achieve this target, and **C.Eng. (Mrs) J.A.C Krishanthi, C. Eng. P.N.S Amaradasa**, Engineers from NERD Center, Ja Ela, for the progress evaluation and providing valuable instructions to move forward in my research direction.

Next, I would like to express my gratitude to **Mr. D.M.N.I Dissanayaka**, technical officer and non-academic staff in the Structural Testing and Computer Laboratories in the Department of Civil Engineering, University of Moratuwa.

C K Ganewattha

Department of Civil Engineering

University of Moratuwa

26.02.2023

ABSTRACT

Carbon Fiber Reinforced Polymer (CFRP) strengthening technique had been shown excellent performance in externally strengthening reinforced concrete (RC) elements due to their superior properties compared to the alternative strengthening techniques. A substantial number of studies have been done to study the behavior of externally bonded CFRP strengthened RC elements. However, as per the knowledge, while most studies have focused on the external strengthening of RC beams using CFRP, and very few studies have focused on strengthening the pre-stressed beams and slabs.

Pre-stressed concrete is most popular building technique in construction buildings. Steel corrosion is recognized as the most serious and dominant mechanisms of deterioration for concrete structures. Subsequently, the capacity of the pre-tension elements decreases after exposure to corrosion. NERD center slab system faces such unacceptable losses in load carrying capacity, stiffness, and ductility due to severe corrosion in pre-stressed beams. This study focuses on how CFRP can go for a load increment after reaching its ultimate load carrying capacity.

The test procedure was arranged in two stages. The first stage testing was used to show the performance/ behavior of composite slab specimen and pre-stressed beam, with the application of load. The second stage of testing was carried out to make comparison between the structural performance of retrofitted and strengthen specimens. Specimens were selected for retrofitting after application of loading in stage 1. The total of 12 specimens were exposed to the loading and behavior of each of the specimen were observed. Specimens were selected as slabs and eight number of them were composite slabs with or without shear links which have overall dimensions equal to 1800 * 600 mm and other four were pre-stressed beams with overall dimensions of 1800 mm in length. In this study, CFRP is proposed as the economical solution which does not touch the structural integrity of the structure.

All the specimens were tested using universal loading machine. In stage 1, specimens were loaded up to its ultimate failure. In stage 2, all the tested specimens were retrofitted using CFRP. In total number of six specimens were used for retrofitting. Another six specimens were also strengthened using CFRP before loading. In each stage of loading several observations were done. Such as mode of failure, cracking width distribution, ultimate load, and each composite panel's corresponding deflection were also recorded.

In stage 1, flexural and shear cracks propagated in the pre-stressed beam and the beam failed at the applied load of more than 50 kN. Stage 2 focused on the performance/ behavior of the retrofitted and strengthened specimen after application of CFRP. The results from stage 2 showed a considerable reduction (nearly 20%) in loading of retrofitted/ strengthened composite slabs compared to control specimens. Difference in failure pattern is caused for this discrepancy in load demand of second stage. The experimental results showed some satisfactory performance in regaining the lost strength of the composite specimens due to corrosion.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES