Research Report

Of

EFFECTS OF ELEVATED TEMPERATURE CURING ON GLASS TRANSITION TEMPERATURE OF CFRP/CONCRETE BOND

MASTER OF SCIENCE

IN

STRUCTURAL ENGINEERING, 2016/2017

By

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EFFECTS OF ELEVATED TEMPERATURE CURING ON GLASS TRANSITION TEMPERATURE OF CFRP/CONCRETE BOND

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The Dissertation was submitted to the Department of Civil Engineering of the University of Moratuwa in partial fulfillment of the requirement for the Degree of Master of Science

Department of Civil Engineering
University of Moratuwa
August 2021

Declaration

I confirm that, except where indicated through the proper use of citations and references, this is my original work. I confirm that subject to final approval by the Board of Examiners of the University of Moratuwa, a copy of this Dissertation may be placed upon the shelves of the library of the University of Moratuwa and may be circulated as required.

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W. K.K. Rathnasiri Date

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To the best of my knowledge, the above particulars are correct.

_____ _____

Prof. Gamage, J.C.P.H (Supervisor) Date

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MSc in Structural Engineering, 2016/2017,
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Abstract

Strengthening of existing structures made out of concrete, all around the world is an increasing requirement due to many reasons like aging, insufficient maintenance, and the degradation due to environmental impact, as well as due to increases of the applied loads and due to requirement of complying with the modern standards. Carbon Fiber Reinforcement Polymer, CFRP, one of the budding and potential technologies in the structural strengthening process. As such lots of researchers who wish to continue their higher studies and knowledge gaining in structural engineering have involved researchers in structural strengthening using CFRP.

Laying CFRP fabrics and composites using epoxy adhesives, along the external surfaces of structural elements are the popular method for a strengthening of structural capacities. These externally laid CFRP fabrics are subjected to elevated temperatures due to environmental conditions. The exposure to such elevated temperature affects the strength of the CFRP/Concrete bonds, because of the low glass transition temperature (T_g) of these epoxy adhesives that have been used to create the bond between CFRP and concrete substrate.

A slight increment of T_g is also contributed to enhancing environmental resistance of strengthened outdoor members which directly expose to the environmental fluctuations. Curing of the CFRP/epoxy/concrete bond in an elevated temperature environment may enhance the bond performance while improving its T_g. However, it is important to ensure a safe temperature range in curing without affecting the performance of the concrete part of the system. This study focuses on determining the safe temperature range, which may be used as raised temperature curing of the CFRP/Concrete composites and determination of bond characteristics for the corresponding temperature applied for curing.

A total of twenty-five single strap joints were prepared under two different curing conditions. The impact of curing at moderately elevated temperature (75°C) on CFRP/Concrete bond strength was examined for both ambient and elevated temperature conditions.

The test results revealed that the raised temperature curing has a remarkable effect on the T_g of CFRP/Concrete bond. A considerable improvement of T_g was noted in the joint with elevated temperature curing when matched with the ambient temperature cured CFRP/Concrete specimens. The strength degradation of the bond for a certain temperature exposure is also reduced with increased T_g of the joint.

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W. K. K. Rathnasiri

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List of symbols, notations, abbreviations, and acronyms

CFRP – Carbon Fiber Reinforcement Polymer

T_g - Glass Transition Temperature

FRP – Fiber Reinforcement Polymer

FEM – Finite element modeling

US – United States

UV – Ultra Violet