



Tanta University



Faculty of Engineering

A Thesis Submitted for the Partial Fulfillment for the Degree of
MASTER OF SCIENCE IN ENGINEERING

(STRUCTURAL ENGINEERING)

Entitled

**Shear Strengthening of RC Beams Using Hybrid
System of SHCC /Steel Plates**

By

Eng. Mohamed Khaled Mohamed Abozaid

Demonstrator at Pharos University in Alexandria, Egypt

B. Sc. Construction and management engineering, Pharos University, 2017

(Distinction with Honor Degree)

Prof. Dr. Hamdy Mohy El-Din Afefy

Professor of Concrete Structures,
Faculty of Engineering, Pharos
University On leave from Tanta
University

Under Supervision of

Assoc. Prof. Ahmed Taha Baraghith

Associate Professor, Structural Engineering
Department, Faculty of Engineering, Tanta
University

Dr. Ali Hassan Abdelmawgood

Assistant Professor, Structural Engineering Department
Faculty of Engineering, Tanta University

2022

ACKNOWLEDGEMENTS

First and foremost, piers and thanks to **Allah**, the Most Gracious, the Most Merciful and peace are upon His Prophet.

I'd like to thank all those who have helped me during this study. My sincere thanks are to my supervisors **Prof. Dr. Hamdy Mohy El-Din Afefy, Assoc.Prof. Ahmed Taha Baraghith, and Dr. Ali Hassan Abdelmawgood** for their great help, encouragement throughout this work, valuable comments and sound guidance. Moreover, they all have supported me unconditionally during the entire study which kept me motivated and help me to finalize my master thesis.

In particular, I'd like to express my special thanks to **Dr. Ali Hassan** thesis advisor for his valuable guidance, supervision, encouragement, timely help that he generously offered during this work, creative criticism and for his meticulous revision and advices at the final stages of this thesis.

Great thanks also extend to **Eng. Mohamed Aboelwafa and Mohamed Hindawi** for their help during this thesis.

The author would like also to express her deepest appreciations to his family especially **my father, my mother, my sister, and my brother** for their support through the course of this research and for their encouraging and praying for me during all my studies.

Mohammed Utaled, 2022

ABSTRACT

This thesis aimed to investigate the applicability of strengthening reinforced concrete (RC) beams using hybrid SHCC/steel plates. It studied experimentally and analytically the shear performance of reinforced concrete beams strengthened by hybrid SHCC/steel plates. The hybrid SHCC/ steel plates have been prepared, cured, and then used to strengthen shear-deficient reinforced concrete (RC) beams. The used hybrid SHCC/ steel plates have rectangular cross-sections of 100mm width and 20mm thickness made of strain-hardening cementitious composite (SHCC) material and reinforced with mild steel plates of 1 mm thickness having different reinforcement ratios (1.4, 2.8, and 4.2%). The motivation of using such reinforced composite plates is to make use of the mutual benefit between the used materials where the internal steel plate alleviates the cracks localization manifested by plain SHCC material after cracking, while the SHCC material protects the steel plates against corrosion.

Experimental test results showed that the use of hybrid SHCC/ steel plates significantly increased the ultimate shear capacity of the strengthened beams. Besides, inclined configuration of the hybrid SHCC/ steel plates showed higher performance compared to that exhibited by vertical configuration from both the ultimate capacity and shear cracks characteristics viewpoints. Beam S3-P56-100-45, strengthened by inclined hybrid SHCC/ steel plates, showed the best performance. It exhibited about 126% increases in the ultimate capacity compared to the control un-strengthened beam. On the other hand, the corresponding increase of similar beam reinforced with vertical plates was about 88%.