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Development and Applications of
FRP Reinforcements (DA-FRPR'21)

Editor:
Radhouane Masmoudi



American Concrete Institute
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Preface

Fiber-reinforced polymer (FRP) reinforcements for concrete structures and civil engineering applications have become one of the innovative and fast-growing technologies to stop the rapid degradation of conventional steel-reinforced concrete infrastructure. FRP reinforcements for construction can be divided into three main types: 1. External sheets or plates to rehabilitate and repair existing concrete and masonry structures, and in some cases steel and wood structures; 2. Internal FRP bars or tendons for new and existing reinforced concrete structures, and 3. FRP stay-in-place forms to be filled with unreinforced or reinforced concrete. A considerable and valuable development and application's work has been accomplished during the last three decades, leading to the development of numerous design guidelines and codes around the world, making the FRP-reinforcement technology one of the fast-growing markets in the construction industry. During the ACI Concrete Convention, Fall 2021, four full sessions were sponsored and organized by ACI Committee 440. Session S1 was focused on the bond and durability of internal FRP bars; Session S2 on codes, design examples, and applications of FRP internal reinforcements; Session S3 on external FRP reinforcements; and Session S4 on new systems and applications of FRP reinforcements, such as CFFT post-tensioned beams, GFRP-reinforced concrete sandwich panels, FRP-reinforced masonry walls, CFFT under impact lateral loading, near-surface mounted FRP-bars, and GFRP-reinforced-UHPC bridge deck joints.

I would like to address my sincere thanks to the reviewers for their valuable dedication to review the submitted papers. Thanks to the authors for their patience during the review process. A special thanks to ACI Committee 440 Chairs, William J. Gold and Maria Lopez, for their support and collaboration in organizing these four full sessions! Thanks to Barbara Coleman, ACI SP & Session Coordinator, for her collaboration in organizing the full sessions and during the editing of the SP publication.

This ACI Special Publication is dedicated to my love Dima and my three children Nour, Alae, and Layana!

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Chair of ACI Subcommittee 440D, "Research Development and Applications
(of Fiber-Reinforced Polymer Reinforcements)

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TABLE OF CONTENTS

SP-356—1

Bond Study of Corrosion-Free Reinforcement Embedded in Eco-Friendly Concrete1-35
Authors: Ali F. Al-Khafaji, John J. Myers, and Hayder H. Alghazali

SP-356—2

Numerical Investigation on Mechanical Splices for GFRP Reinforcing Bars 36-45
Authors: Nafiseh Kiani, Steven Nolan, and Antonio Nanni

SP-356—3

Preliminary Experimental Results of the Bond Between GFRP Bars and Concrete 46-60
Authors: Mohammad Minhajur Rahman, Xudong Zhao, Tommaso D'Antino,
Zahra Ameli, Francesco Focacci, and Christian Carloni

SP-356—4

Development Length of GFRP Rebars in Reinforced Concrete Members under Flexure 61-71
Authors: Alvaro Ruiz Empananza, Francisco De Caso, and Antonio Nanni

SP-356—5

Modeling of Thermal Spalling for a GFRP-Reinforced Concrete Slab 72-87
Authors: Jun Wang and Yail J. Kim

SP-356—6

Evaluation of Progressive Damage in GFRP Bars – Low and Large Strain
Experimental Program and Numerical Simulations 88-108
Authors: Piotr Wiciak, Maria Anna Polak, and Giovanni Cascante

SP-356—7

Evaluation of FRP Bars and Meshes Used as Secondary Reinforcement for
Nonstructural Concrete Members for Building Code Compliance109-119
Authors: Mahmut Ekenel, Hossein Raghani, Francisco De Caso y Basalo, and
Antonio Nanni

SP-356—8

Reliability of Compression Controlled FRP RC Flexural Members Designed
Using North American Codes and Standards: Comparison and FRP Material
Resistance/Strength Reduction Factor Calibration120-130
Authors: Fadi Cerdas and Adam Hassan

SP-356—9

Implementation of GFRP-Reinforced Concrete Draft Code Provisions 131-151
Authors: Isaac Higgins, Vicki Brown, and Brendan Kearns

SP-356—10

Design and Driving Performance of Two GFRP-Reinforced Concrete Piles152-169
Authors: Roberto Rodriguez, Vanessa Benzecry, Steven Nolan, and Antonio Nanni

SP-356—11

Assessment of Shear Strength Design Models for Fiber-Reinforced Concrete
Deep Beams Reinforced with Steel or FRP Bars170-190
Authors: Ahmed G. Bediwy and Ehab F. El-Salakawy

SP-356—12

Effects of Masonry Infill Retrofit with FRP Materials on The Seismic Behaviour of RC Frames191-202
Authors: Gianni Blasi, Daniele Perrone, and Maria Antonietta Aiello

SP-356—13

Literature Review on External Carbon-Fiber-Reinforced Polymer (CFRP) Reinforcements for Concrete Bridges203-223
Authors: Mohamed Ahmed, Slimane Metiche, and Radhouane Masmoudi

SP-356—14

Nondestructive Evaluation of Reinforced-Concrete Slabs Rehabilitated with Glass Fiber-Reinforced Polymers.....224-237
Authors: Wael Zatar, Hai Nguyen, and Hien Nghiem

SP-356—15

Finite Element Modeling of The Bond-Slip Behavior of CFRP Anchors238-257
Authors: José Luis Jiménez and Hernán Santa María

SP-356—16

Effect of Prestressing Ratio on Concrete-Filled FRP Rectangular Tube Beams Tested in Flexure258-272
Authors: Asmaa Abdeldaim Ahmed, Mohamed Hassan, and Radhouane Masmoudi

SP-356—17

Numerical Evaluation of a New Concrete Sandwich Panel Containing UHPC Wythes, and GFRP Reinforcement and Connectors273-290
Authors: Akram Jawdhari and Amir Fam

SP-356—18

Flexural Design of Masonry Walls Reinforced with FRP Bars Based on Full-Scale Structural Tests291-311
Authors: Nancy Torres, J. Gustavo Tamalán, Antonio Nanni, Richard M. Bennet, and Francisco J. De Caso Basalo

SP-356—19

Behaviour of Circular Concrete-Filled FRP Tube Columns under Lateral Impact Loading: Numerical Study312-326
Authors: Maha Hussein, Abdallah, Hamzeh Hajiloo, and Abass Braimah

SP-356—20

Nonlinear Finite Element Modeling of Continuous RC Beams Strengthened with Near Surface Mounted FRP Bars327-346
Authors: Majid M.A. Kadhim, Akram Jawdhari, and Mohammed Altaee

SP-356—21

Ultimate And Fatigue Responses of GFRP-Reinforced, UHPC-Filled, Bridge Deck Joints347-374
Authors: Imad Eldin Khalafalla and Khaled Sennah

Bond Study of Corrosion-Free Reinforcement Embedded in Eco-Friendly Concrete

Ali F. Al-Khafaji, John J. Myers, and Hayder H. Alghazali

Synopsis: This paper presents an investigation of the bond performance of corrosion-free sand-coated glass fiber reinforced polymer bars (GFRP) implanted in two types of fly ash-based eco-friendly concrete. Steel reinforcement is prone to corrosion and is expensive to fix, therefore finding an effective alternative has become a must. One of these alternatives is GFRP bar. On the other hand, conventional concrete (CC) is not issueless, as it significantly affects the environment through its high-intensity CO₂ emissions. Thus, other alternatives have been looked into to mitigate the CO₂ problems. One of these alternatives is partially substituting Portland cement with another CO₂ emission-free material such as fly ash. In this study, two levels (50% and 70%) of high-volume fly ash concrete (HVFAc) were used to investigate their bond performance with GFRP bars. Cylindrical specimens were tested under the effect of pullout load. Furthermore, the bars were investigated chemically and microstructurally to see if the fly ash had some influence of the GFRP bar. For concrete, performance rank analysis was carried out to identify the best concrete mix in term of slump, unit weight, cost, and bond strength. In addition, to verify the experimental work, two-dimensional finite element models were built using translator elements to present the bond action between the concrete and its reinforcement. The results of investigation showed that the bond strength of GFRP bars were less than that of mild steel owing to GFRP bar deformation. In addition, CC resulted a higher bond strength than HVFAc. The bar analyses did not yield any obvious signs of microstructural deteriorations or chemical attack.

Keywords: Bond Assessment, Pullout, Fly Ash, GFRP bar, Finite Element, SEM, EDS, FiC, Performance Rank Analysis