

Lieping Ye
Peng Feng
Qingrui Yue

Volume I: FRP for Future Structures

Advances in FRP Composites in Civil Engineering

Proceedings of
the 5th International Conference on
FRP Composites in Civil Engineering
(CICE 2010)

September 27-29, 2010
Beijing, China



TSINGHUA
UNIVERSITY PRESS

Lieping Ye

Peng Feng

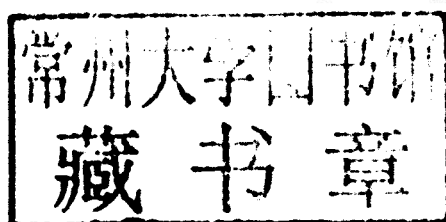
Qingrui Yue

Advances in FRP Composites in Civil Engineering

Volume I: FRP for Future Structures

Proceedings of the 5th International Conference on FRP Composites in Civil Engineering
(CICE 2010), September 27-29, 2010, Beijing, China

With 1279 figures



Editors

Lieping Ye

Department of Civil Engineering

Tsinghua University

Beijing 100084, P.R. China

Email: ylp@tsinghua.edu.cn

Peng Feng

Department of Civil Engineering

Tsinghua University

Beijing 100084, P.R. China

Email: fengpeng@tsinghua.edu.cn

Qingrui Yue

Science & Technology Department

Metallurgical Corporation of China Ltd.

Beijing 100028, P.R. China

E-mail: yueqr@vip.163.com

版权所有，侵权必究。侵权举报电话：010-62782989 13701121933

图书在版编目(CIP)数据

第5届土木工程复合材料国际会议论文集 = Advances in FRP Composites in Civil Engineering : 英文 /

叶列平, 冯鹏, 岳清瑞主编

—北京: 清华大学出版社, 2010.9

ISBN 978-7-302-23910-9

I. ①第… II. ①叶… ②冯… ③岳… III. ①土木工程-复合材料-国际学术会议-文集-英文 IV. ①TU599-53

中国版本图书馆CIP数据核字(2010)第187086号

责任编辑: 徐晓飞

责任校对: 王淑云

责任印制: 孟凡玉

出版发行: 清华大学出版社

<http://www.tup.com.cn>

社 总 机: 010-62770175

投稿与读者服务: 010-62776969, c-service@tup.tsinghua.edu.cn

质 量 反 馈: 010-62772015, zhiliang@tup.tsinghua.edu.cn

地 址: 北京清华大学学研大厦 A座

邮 编: 100084

邮 购: 010-62786544

印 装 者: 北京雅昌彩色印刷有限公司

经 销: 全国新华书店

开 本: 210×297 印 张: 63

字 数: 1880千字

版 次: 2010年9月第1版

印 次: 2010年9月第1次印刷

印 数: 1~700

定 价: 480.00元(全两册)

Lieping Ye
Peng Feng
Qingrui Yue

Advances in FRP Composites in Civil Engineering

Volume I: FRP for Future Structures

**Proceedings of the 5th International Conference on FRP Composites in Civil Engineering
(CICE 2010), September 27-29, 2010, Beijing, China**

The 5th International Conference on FRP Composites in Civil Engineering (CICE 2010)

September 27-29, 2010, Beijing, China

Organized by



清华大学

Tsinghua University

Tsinghua University



中国冶金科工集团有限公司
CHINA METALLURGICAL GROUP CORPORATION

中国冶金科工股份有限公司
METALLURGICAL CORPORATION OF CHINA LTD.

China Metallurgical Group Corporation

Sponsored by



International Institute
for FRP in Construction



www.cces.net.cn

中国土木工程学会

CHINA CIVIL ENGINEERING SOCIETY

China Civil Engineering Society



National Natural Science
Foundation of China



China Composites Industry Association



The Chinese Ceramic Society



Nanjing HiTech Composites Co., Ltd

Preface

Applications of fiber reinforced polymer (FRP) composites in civil engineering have increased significantly in the past two decades. As FRPs are non-corrosive, high-strength and lightweight, their use in civil infrastructure has extended from the strengthening of existing structures to new construction. FRP therefore has wide application prospects in civil engineering. The Fifth International Conference on Composites in Civil Engineering, CICE 2010 (www.cice2010.net) was held in Beijing on September 27-29, 2010. CICE 2010 was organized by the Department of Civil Engineering, Tsinghua University and China Metallurgical Group Corporation. It is the official conference of the International Institute for FRP in Construction, IIFC (www.iifc-hq.org). The aim of this conference is to provide an international forum for all concerned with the application of FRP composites in civil engineering to exchange and share recent advances in both research and practice. The CICE conference series started with CICE 2001 (www.cse.polyu.edu.hk/cice) in Hong Kong, China, initiated by Professor Jin-Guang Teng. The next conference in the series, CICE 2004 (www.adelaide.edu.au/cice2004) was chaired by Dr Rudi Seracino, held in Adelaide, Australia, in December 2004, followed by CICE 2006 (www.iifc-hq.org/cice2006) chaired by Professors Amir Mirmiran and Antonio Nanni, held in Miami, USA, in December 2006, and CICE 2008 (www.cice2008.org) chaired by Professor Masoud Motavalli, held in Zurich, Switzerland, in July 2008.

This conference is also sponsored by the China Civil Engineering Society (CCES) and its FRP Application Committee, the China Composites Industry Association (CCIA), the Chinese Ceramic Society FRP Committee, and the National Natural Science Foundation of China (NSFC).

A total of 210 papers are included in the proceedings, while 7 keynotes and 203 papers are being presented. All papers are included in two volumes. Volume I, FRP for Future Structures, covered a range of topics including follows focusing on the new construction.

- FRP Materials and Sustainability
- All FRP Structures
- FRP Hybrid Structures and Concrete-Filled FRP Tubes
- Smart FRP Structures
- Concrete Structures Reinforced or Prestressed with FRP
- Long-Term Performance
- Fire, Impact and Blast Loading
- Education, Applications and Design Guidelines

Volume II is FRP Strengthening Structures covering the following topics.

- Bond and Interfacial Stresses between FRP and Concrete
- Confinement of Concrete by FRP in Compression
- Flexural Strengthening of Concrete Beams and Slabs
- Shear Strengthening of Concrete Beams
- Strengthening of Concrete Columns, Walls, and Frames
- Strengthening of Steel Structures
- Strengthening of Masonry and Timber Structures

The papers are authored by experts in the field from 30 different countries around the world, including Argentina, Australia, Belgium, Brazil, Canada, China, Czech Republic, Egypt, France, Germany, Greece, India, Iran, Iraq, Italy, Japan, Korea, Lithuania, Malaysia, Netherlands, Pakistan, Poland, Portugal, Singapore, Spain, Switzerland, Thailand, Turkey, UK, and USA. The technical papers in proceedings not only address analytical and experimental work, but also cover field applications, and design and construction guidelines. Comparing the papers in this set of proceedings with those published in the early CICE conferences, it is clear that we have paid more attention to FRP for new structures, new applications, and long-term behaviors.

The valuable articles in the proceedings would not have been possible without the help, dedication, and collaboration of numerous individuals. First and foremost, we thank the authors for meeting our various submittal deadlines, allowing this document to represent the most current work on the subjects from around the world. We would also like to thank the Organizing Committee and the International Scientific Committee of the conference for their relentless efforts in making this conference to happen. It is also important to thank the Executive Committee, the Advisory Committee, and the Council of IIFC for their support throughout this process.

The Editors

Lieping Ye

Professor

Department of Civil Engineering, Tsinghua University
Beijing, China

Peng Feng

Associate Professor

Department of Civil Engineering, Tsinghua University
Beijing, China

Qingrui Yue

Professor

China Metallurgical Group Corporation
Beijing, China

September 20, 2010

Message from the President of IIFC

Recent years have seen rapidly growing interest in the application of fibre-reinforced polymer (FRP) composites in construction around the world, in terms of both research activities and practical implementations. Indeed, FRP composites are being hailed as a new generation of construction materials, following steel and concrete. Against this background, the International Institute for FRP in Construction (IIFC) was formed in 2003 to promote and coordinate world-wide activities in this area. One of the important activities of IIFC is the organization of a biennial official conference series, as well as biennial regional conferences.

As President of IIFC, I would like to take this opportunity to express my sincere appreciation to Professor Lieping Ye, Chair of CICE 2010, and his team for devoting so much time and energy to make this conference a great success. I would also like to thank all others who contributed to this success in different ways, including members of the Organizing Committee, the International Advisory Committee and many others. The strong support for CICE 2010 shown by the international civil engineering FRP research community is a testimony to the importance and significance of this conference.

There is no doubt that a major impact of IIFC has been the sponsorship of international symposia and conferences. This will continue with this CICE conference and the 6th CICE conference scheduled for 2012 in Rome. Registration fees at such conferences imply that IIFC dues are waived for the year in question. Other advantages of IIFC membership are the FRP International newsletter, complimentary copies of conference proceedings, and participation in various working groups. We are striving to enhance the benefits of IIFC membership, and are open to all suggestions and ideas for doing so. I would like to conclude with a request to all members of the Institute: please inform your colleagues of the activities of IIFC and encourage them to join our vibrant organization.

Kenneth W. Neale

President IIFC

September 20, 2010

Committees

Conference Chairs

Lieping Ye, Tsinghua University, Beijing, China

Qingrui Yue, China Metallurgical Group Corporation, Beijing, China

General Secretary

Peng Feng, Tsinghua University, Beijing, China

International Scientific Committee

Chairman: K. W. Neale (Canada)

B. Bakht (Canada)	P. Y. Huang (China)
C. E. Bakis (USA)	L. C. Hollaway (UK)
L. C. Bank (USA)	A. Ilki (Turkey)
N. Banthia (Canada)	V. M. Karbhari (USA)
J. A. Barros (Portugal)	A. Katz (Israel)
B. Benmokrane (Canada)	T. Keller (Switzerland)
L. Bisby (UK)	R. Kotynia (Poland)
C. Burgoyne (UK)	P. Labossière (Canada)
J. F. Chen (UK)	H. Li (China)
E. Cosenza (Italy)	W. Q. Liu (China)
L. De Lorenzis (Italy)	L. L. Luo (China)
R. El-Hacha (Canada)	Z. T. Lu (China)
A. Fam (Canada)	A. Machida (Japan)
H. Fukuyama (Japan)	U. Meier (Switzerland)
M. Green (Canada)	A. Mirmiran (USA)
J. Grenestedt (USA)	M. Motavalli (Iran)
X. L. Gu (China)	G. Monti (Italy)
I. E. Harik (USA)	A. Mufti (Canada)
K. Harries (USA)	A. Nanni (USA)

D. J. Oehlers (Australia)	L. Taerwe (Belgium)
J. P. Ou (China)	T. Ueda (Japan)
M. D. G. Pulido (Spain)	G. Van Erp (Australia)
S. H. Rizkalla (USA)	P. Waldron (UK)
H. Seliem (Egypt)	J. Wang (China)
R. Seracino (USA)	Z. S. Wu (Japan)
J. Sim (Korea)	Y. Xiao (China/USA)
S. T. Smith (China)	Z. M. Xue (China)
B. Täljsten (Sweden)	W. C. Xue (China)
K. H. Tan (Singapore)	J. Yao (China)
J. G. Teng (China)	X. L. Zhao (Australia)
T. C. Triantafillou (Greece)	J. W. Zhang (China)

Organizing Committee

Y. Bai (Monash University, Australia)

X. B. Chen (China Metallurgical Group Corporation, China)

J. G. Dai (Hong Kong Polytechnic University, China)

J. Deng (Guangdong University of Technology, China)

Z. C. Deng (Beijing University of Technology, China)

P. Feng (Tsinghua University, China)

Y. J. Kim (North Dakota State University, USA)

R. Li (China Metallurgical Group Corporation, China)

X. Z. Lu (Tsinghua University, China)

B. L. Wan (Marquette University, USA)

Y. L. Wang (Dalian University of Technology, China)

G. Wu (Southeast University, China)

Z. H. Yan (California Department of Transportation, Sacramento, USA)

Y. X. Yang (China Metallurgical Group Corporation, China)

CONTENTS

Vol. I FRP for Future Structures

Keynote Papers	1
Innovative Textile-Based Composites for Strengthening and Seismic Retrofitting of Concrete and Masonry Structures	<i>Triantafyllou, T.</i> 3
Strengthening of Concrete, Metallic and Timber Construction Materials with FRP Composites	<i>Smith, S.T.</i> 13
Multifunctional and Robust Composite Material Structures for Sustainable Construction	<i>Keller, T.</i> 20
Hybrid FRP-Concrete-Steel Double-Skin Tubular Structural Members	<i>Teng, J.G., Yu, T., Wong, Y.L.</i> 26
Durability of GFRP Reinforcement Bars	<i>Bakis, C.E.</i> 33
FRP Design Using Structural Mechanics Models	<i>Oehlers, D.J., Haskett, M., Mohamed Ali, M.S., Lucas, W., Muhamad, R.</i> 37
Finite Element Modelling of FRP-to-Concrete Bond Behaviour Using the Concrete Damage Plasticity Theory Combined with a Plastic Degradation Model	<i>Chen, J.F., Tao, Y.</i> 45
FRP Materials and Sustainability.....	51
Fiber Reinforced Cementitious Composites (FRCC) Plate for the Anchoring of FRP Sheet on Concrete Member	<i>Jin, Q.X., Leung, C.K.Y.</i> 53
Study of Tensile Behavior for Interval Impregnated Hybrid Carbon/Basalt Fiber Sheet (C/BFS)	<i>Wu, G., Jing, W.J., Wu, Z.S.</i> 57
Statistical Studies on Material Behavior of CFRP Sheets under Uniaxial Loads and Its Application in Reliability Analysis.....	<i>Wang, W.W., Yang, W.</i> 61
Comprehensive Characterization of BFRP Applied in Civil Engineering	<i>Li, H., Xian, G.J., Xiao, B., Wu, J.Y.</i> 65
Influence of Elevated Temperature on the Mechanical and Thermal Performance of BFRP Rebar	<i>Wu, J.Y., Li, H., Xian, G.J.</i> 69
Composite Decks and Sustainable Development: a Case Study	<i>Drissi-Habti, M., Chapeleau, X., Cournée, S.</i> 73
Matrix and Fabric Impregnation Influence on Textile Reinforcement Concrete Behaviour	<i>Contamine, R., Si Larbi, A., Hamelin, P.</i> 77
Discrete Fiber Reinforced Polyurea for Hazard Mitigation	<i>Carey, N.L., Myers, J.J.</i> 81
Experimental Research on the Fundamental Mechanical Properties of Presoaked Basalt Fiber Concrete	<i>Ma, J.X., Qiu, X.M., Cheng, L.T., Wang, Y.L.</i> 85
All FRP Structures	89
Shear Buckling of GFRP Beam Webs	<i>Manshadi, B.D., Vassilopoulos, A.P., Keller, T.</i> 91

Shear Wrinkling of GFRP Webs in Cell-Core Sandwiches	
..... <i>Manshadi, B.D., Vassilopoulos, A.P., de Castro, J., Keller, T.</i>	95
Pin-Bearing Strengths for Design of Bolted Connections in Pultruded Structures	
..... <i>Zafari, B., Mottram, J.T.</i>	99
Development of an Effective Joining Method for a Pultruded Hybrid CFRP/GFRP Laminate	
..... <i>Nguyen, D.H., Mutsuyoshi, H., Shiroki, K., Ishihama, T.</i>	103
A Consistent Design Concept for Bolted Connections in Standardized GFRP-Profiles	
..... <i>Oppe, M., Knippers, J.</i>	107
Composite Behavior of a Pultruded Hybrid CFRP-GFRP Beam with UFC Deck	
..... <i>Mutsuyoshi, H., Shiroki, K., Nguyen, D.H., Ishihama, T.</i>	111
Sensitivity Studies on Local Flange Buckling Equations for Pultruded Beams and Columns	
..... <i>McCarthy, M.J., Bank, L.C.</i>	115
Analytical Study on Buckling Modes of Simply Supported Delaminated Composite Beams	
..... <i>Zhu, B., Zhou, D., Liu, W.Q.</i>	119
Interlaminar Behavior of Paulownia Wood Sandwich Composites with Grooves	
..... <i>Wan, L., Liu, W.Q., Fang, H., Zhou, D.</i>	123
GFRP Structures Subjected to Dynamic Action	
..... <i>Boscato, G., Russo, S.</i>	127
GFRP Members in Free Vibrations Field, Dynamic Parameters of Profiles and 3D Structure	
..... <i>Boscato, G., Russo, S.</i>	131
Experimental Design on Multi Layers of LVL Fiber Reinforced Wood Composite Using Bagasse as Core Structure	
..... <i>Meekum, U.</i>	135
Shear Behavior of Glue-Laminated Composite Sandwich Beams	
..... <i>Manalo, A., Aravinthan, T., Karunasena, W.</i>	139
Flexural Behavior of FRP Reinforced Glulam Beams	
..... <i>Zhou, Q., Xiao, Y.</i>	144
Trial Design of Cable-Stayed Bridges Using Hybrid Composite Girders and Applicability to Free Passage Over Railway	
..... <i>Nakamura, H., Maeda, K., Mutsuyoshi, H., Yaginuma, K., Matsui, T.</i>	148
Performance Based Design of Laminated FRP Box Girders for Short Span Bridges	
..... <i>Almansour, H., Cheung, M.</i>	152
A Design Concept for an All Composite Road Bridge	
..... <i>Leo, B., Chakraborty, A., Khennane, A.</i>	156
Mechanical Model and Analysis of FRP Woven Web Structures	
..... <i>Qi, Y.J., Feng, P., Ye, L.P.</i>	160
GFRP-Polyurethane Sandwich Panels under Reversed Bending Fatigue	
..... <i>Hale, M., Fam, A.</i>	164
Development and Experimental Verification of a Pedestrian Slab Bridge Using GFRP Pultrusion Profiles	
..... <i>Fujita, S., Maeda, K., Nakamura, H., Kitayama, N., Watanabe, T.</i>	168
Study on Dynamic Characteristics of Light-Weight FRP Footbridge	
..... <i>Jin, F.F., Feng, P., Ye, L.P.</i>	173
Honeycomb Fiber-Reinforced Polymer Sandwich Panels for Fish Culture Tanks	
..... <i>Davalos, J.F., Vantaram, A., Chen, A., Ray, I., Plunkett, J.D.</i>	177
FRP Hybrid Structures and Concrete-Filled FRP Tubes	183
Hybrid FRP-Concrete Structural Member: Research and Development in North America	
..... <i>Chen, D., El-Hacha, R.</i>	185

Hybrid FRP-Concrete Structural Member: Research and Development in Europe and Asia	
.....	<i>Chen, D., El-Hacha, R.</i> 191
Experimental Study on Flexural Behaviour of Hybrid GFRP/ Concrete Bridge Deck	
.....	<i>Liu, Y.Q., He, J., Fan, H.F., Chen, A.R., Dai, L.</i> 197
Experimental Study of GFRP-Concrete Hybrid Beams	
.....	<i>Zhao, F., Chen, C.H., Lou, W.J., Feng, P.</i> 202
In-Situ Load Tests and FE Modeling of Concrete Bridge with FRP Stay-in-Place Forms	
.....	<i>Wan, B.L., Foley, C.M.</i> 207
Structural Performance Evaluation of Precast FRP-Concrete Composite Deck with Concrete Wedge for Cable-Stayed Bridge	
.....	<i>Park, S.Y., Cho, K., Kim, S.T., Cho, J.R., Kim, B.S.</i> 211
Static and Fatigue Behaviors of Precast FRP-Concrete Composite Deck for Cable-Stayed Bridge	
.....	<i>Cho, K., Park, S.Y., Kim, S.T., Kim, B.S.</i> 215
Experimental Studies on FRP-Concrete Composite Deck with FRP Perfobond Shear Connectors	
.....	<i>Xue, W.C., Ge, C., Tan, Y., Wang, Y.S.</i> 219
Numerical and Experimental Investigation of Concrete-Filled FRP Tube	
.....	<i>Chung, W., Jang, H., An, Z.O.</i> 224
An Experimental Investigation into the Behaviour of Filament Wound Hybrid FRP-Concrete Beam	
.....	<i>Chakraborty, A., Khennane, A., Morozov, E.V.</i> 228
Experimental Study on Bending Performances of FRP-Concrete Composite T-Beams with Prefabricated BFRP Shell	
.....	<i>Zhu, H., Zhang, P., Wu, G., Wu, Z.S.</i> 232
A Comparative Study of Various FRP Shear Connectors for Sandwich Concrete Walls	
.....	<i>Woltman, G.D., Tomlinson, D.G., Fam, A.</i> 237
Smart FRP Structures	241
Effectiveness of Smart Dampers for Hybrid FRP Cable in Long- Span Cable-Stayed Bridge	
.....	<i>Wang, X., Wu, Z.S.</i> 243
A Smart FRP-Concrete Composite Beam Using FBG Sensors	
.....	<i>Wang, Y.L., Hao, Q.D., Ou, J.P.</i> 248
Smart CFRP Systems–Fiber Bragg Gratings for Fiber Reinforced Polymers	
.....	<i>Käseberg, S.F., Holschemacher, K.</i> 252
Sensor CFRP-Sheets for the Controlled Strengthening and Retrofitting of Reinforced Concrete Members	
.....	<i>Holschemacher, K., Käseberg, S.F.</i> 256
Electrically Conductive Nanocomposite Coating for Strain and Health Monitoring	
.....	<i>Luo, J.L., Li, H., Xian, G.J.</i> 260
Smart Composites for Durable Infrastructures – Importance of Structural Health Monitoring (SHM)	
.....	<i>Drissi-Habti, M.</i> 264
Concrete Structures Reinforced or Prestressed with FRP	269
Experimental Study on the Tension Stiffening Effect of GFRP RC Elements	
.....	<i>Baena, M., Turon, A., Torres, L., Miàs, C., Barris, C., Barbeta, G.</i> 271
Behavior of High-Strength Concrete Beams Reinforced with Different Types of Flexural Reinforcement and Fiber	
.....	<i>Yang, J.M., Min, K.H., Shin, H.O., Yoon, Y.S.</i> 275
Deflection Behaviour of Concrete Beams Reinforced with Different Types of GFRP Bars	
.....	<i>El-Gamal, S., AbduRahman, B., Benmokrane, B.</i> 279
Behavior of Continuous Concrete Beams Reinforced with FRP Bars	
.....	<i>El-Mogy, M., El-Ragaby, A., El-Salakawy, E.</i> 283

Testing of Large-Scale Two-Way Concrete Slabs Reinforced with GFRP Bars	
.....Dulude, C., Ahmed, E., El-Gamal, S., Benmokrane, B.	287
Development Length of Glass Fiber Reinforced Plastic (GFRP)/Steel Wire Composite Rebar	
.....Hao, Q.D., Wang, Y.L., Ou, J.P.	292
Deformation Behavior of Concrete Two-Way Slabs Reinforced with BFRP Bars Subjected to Eccentric Loading	
.....Zhu, H.T., Zhang, Y.K., Gao, D.Y., Xiao, Z.L.	296
Experimental Study on the Flexural Behavior of Concrete Beam Hybrid Reinforced with FRP Bars and Steel Bars	
.....Ge, W.J., Zhang, J.W., Dai, H., Tu, Y.M.	301
Study on the Flexural Capacity of Concrete Beam Hybrid Reinforced with FRP Bars and Steel Bars	
.....Zhang, J.W., Ge, W.J., Dai, H., Tu, Y.M.	304
Experiments According to ETAG to Determine Friction Effects on Deviated CFRP-Strips	
.....Hwash, M., Knippers, J.	308
Study of Static Load Tests of Bond-Type Anchors for CFRP Tendons	
.....Cai, W.H., Zhang, J.W., Liang, S.T., Tu, Y.M.	313
Bond Type Anchorage Systems for Permanent High Strength CFRP Ground Anchors	
.....Sentry, M., Al-Mahaidi, R., Bouazza, A., Carrigan, L.	317
Flexure-Shear Analysis of Concrete Beam Reinforced with GFRP Bars	
.....Ramadass, S., Thomas, J.	321
Effect of Bond Parameters on Recoverability of RC Bridge Columns Reinforced with Ordinary Rebars and Steel Fiber Composite Bars.....	
Fahmy, M.F.M., Wu, Z.S., Wu, G.	325
Effect of Reinforcement Detailing on the Behavior of GFRP-RC Beam-Column Joints	
.....Mady, M., Hasaballa, M., El-Ragaby, A., El-Salakawy, E.	330
Long-Term Performance	335
Interfacial Crack Growth Behavior on RC Beams Strengthened with Prestressed CFL under Cyclic Bending Loads	
.....Zhou, H., Huang, P.Y., Li, Z.W., Zheng, X.H., Xie, J.H.	337
Effects on the Fatigue Lives of RC Beams Strengthened with CFL at Elevated Temperature under Cyclic Bending Loads	
Huang, P.Y., Wang, H.Y., Zhou, H., Guo, X.Y., Zhou, Z.L.	341
Fatigue-Loading Effect on RC Beams Strengthened with Externally Bonded FRP	
.....Ferrier, E., Limam, A., Hamelin, P., Quiertant, M.	344
Box Girders under Extreme Long-Time Static and Fatigue Loading	
.....Meier, U., Müller, R., Barbezat, M., Terrasi, G.P.	348
Experimental Study of Time-Dependent Behaviour of Concrete Members Reinforced with GFRP Bars	
.....Miàs, C., Torres, L., Turon, A., Baena, M., Vilanova, I., Llorens, M.	352
Hygrothermal Ageing of Basalt Fiber Reinforced Epoxy Composites	
.....Xiao, B., Li, H., Xian, G.J.	356
Moisture Diffusion in FRP Adhesively-Bonded Joints under Hot/Wet Environments	
.....Jiang, X., Kolstein, H., Bijlaard, F.S.K.	360
Durability of CFRP Bonding System under Freeze-Thaw Cycling	
.....Yun, Y.C., Wu, Y.F.	364
Bond Strength of Glass FRP Bars in Concrete Subjected to Freeze-Thaw Cycles and Sustained Loads	
.....Alves, J., El-Ragaby, A., El-Salakawy, E.	368
Long-Term Durability of FRP Cables under Maritime Conditions	
.....Nishizaki, I., Sasaki, I.	372
Temperature Effects on Full Scale FRP Bridge Using Innovative Composite Components	
.....Sirimanna, C.S., Islam, M.M., Aravinthan, T.	376

Modeling the Effect of Repeated Loading on the Behaviour of CFRP Confined Bond of Corroded Reinforcement	<i>Abbas, S., Rteil, A.</i>	381
Effects of Accelerated Ageing on the Adhesive Bond Between Concrete Specimens and External CFRP Reinforcements	<i>Benzarti, K., Quiertant, M., Marty, C., Chataigner, S., Aubagnac, C.</i>	385
Parametric Analysis for Creep of High-Strength Concrete Columns Confined by AFRP	<i>Ma, Y.S., Wang, Y.F.</i>	390
Fire, Impact and Blast Loading		395
Glassy-Rubbery Transition Behavior of Epoxy Resins Used in FRP Structural Strengthening Systems	<i>Jaipuria, A., Flood, J.P., Bakis, C.E., Lopez, M.M., He, X.J.</i>	397
Fire Tests on RC Beams Strengthened with NSM	<i>Palmieri, A., Matthys, S., Taerwe, L.</i>	401
Fire Performance of Water-Cooled Cellular GFRP Columns	<i>Bai, Y., Keller, T., Hugi, E., Ludwig, C.</i>	405
Flexural and Punching Performances of FRP and Fiber Reinforced Concrete on Impact Loading	<i>Min, K.H., Yang, J.M., Yoo, D.Y., Yoon, Y.S.</i>	410
Protection of Aged Cement Clinker Silo against High Impact and High Temperature Discharge	<i>Lim, B.K., Yang, M.H.</i>	415
Nonlinear Response of Steel-Fiber Reinforced Concrete Beams under Blast Loading: Material Modeling and Simulation	<i>Haido, J.H., Abu Bakar, B.H., Jayaprakash, J., Abdul-Razzak, A.A.</i>	419
Fire Behaviour of CFRP Prestressed High Strength Concrete Slabs	<i>Terrasi, G.P., Stutz, A., Barbezat, M., Bisby, L.A.</i>	423
Finite Element Modeling of Insulated FRP-Strengthened RC Beams Exposed to Fire	<i>Dai, J.G., Gao, W.Y., Teng, J.G.</i>	428
Effect of Fire and High Temperature on the Properties of Self Compacted Concrete	<i>Helal, M.A., Heiza, Kh.M.</i>	433
Educations, Applications and Design Guidelines		441
IIFC Educational Modules on Polymer Composites in Construction	<i>Bisby, L.A.</i>	443
Challenges in the Design and Delivery of an Online Postgraduate Course in Fibre Composites	<i>Aravinthan, T.</i>	447
Virtual Practice with Computer Aided Software toward Better Understanding of RC Beams Strengthened by External Bonded FRP	<i>Ferrier, E., Hamelin, P., David, B.</i>	452
Structural Remediation of Unreinforced Brick Masonry Walls of Heritage Palace Building with Carbon Fibre Reinforced Polymers	<i>Savardekar, S.K., Jamaji, R., Raikar, K.R.</i>	456
Inspection, Analysis and Loading Test of a Slab Bridge Strengthened with FRP Laminates	<i>Yan, D.M., Wu, C.L., Li, J.B., Chen, G.D.</i>	460
Structural Performance of Concrete Bridge Deck with Internal FRP Reinforcement	<i>Wan, B.L., Foley, C.M.</i>	464
Guidelines for Design of Honeycomb FRP Sandwich Panels	<i>Chen, A., Davalos, J.F.</i>	468
Load-Bearing Properties of an FRP Bridge after Nine Years of Exposure	<i>Sasaki, I., Nishizaki, I.</i>	474
Cost Optimum Design of Structural Fibre Composite Sandwich Panel for Flooring Applications	<i>Awad, Z.K., Aravinthan, T., Zhuge, Y.</i>	478
Author Index		A-I

Vol. II FRP Strengthening Structures

Bond and Interfacial Stresses Between FRP and Concrete	483
Effect of Load Distribution on IC Debonding in FRP-Plated RC Beams	
.....Teng, J.G., Chen, G.M., Chen, J.F.	485
Effect of Bar-Cutoff and Bent-Point Locations on Debonding Loads in RC Beams Strengthened with CFRP Plates	
.....Eftekhar, M.R., Mostofinejad, D.	490
Meso-Scale Modelling of FRP-to-Concrete Bond Behaviour Using LSDYNA	
.....Li, X.Q., Chen, J.F., Lu, Y.	494
Investigation on Fracture Behavior of FRP-Concrete Interface under Direct Shear	
.....An, F.C., Cao, S.Y., Pan, J.L., Ge, Q.	499
Towards a Standard Test Method for Assessing FRP-to-Concrete Bond Characteristics	
.....Eveslage, T., Aidoo, J., Bro, W., Harries, K.A.	504
Examination of Interfacial Stresses due to Crack Propagation in FRP Retrofitted RC Beams	
.....Kabir, M.Z., Hojatkishani, A.	508
A Rigorous Solution for Interfacial Stresses in Plated Beams	
.....Narayanamurthy, V., Chen, J.F., Cairns, J.	512
Evaluation of the Bond Behavior at the Intermediate Crack Element with a Special Test Procedure	
.....Finckh, W., Zilch, K.	517
Numerical Modeling of the FRP/Concrete Interfacial Behavior of FRP Shear-Strengthened Beams	
.....Godat, A., Labossière, P., Neale, K.W.	521
Analysis of Interfacial Bond Stress of Bonding Anchors for FRP Tendon	
.....Zhao, Q.L., Li, F., Chen, H.S.	525
Debonding Behavior of Skew FRP-Bonded Concrete Joints	
.....Dai, J.G., Cao, Y.B.	529
Effectiveness of U-Shaped CFRP Wraps as End Anchorages in Predominant Flexure and Shear Region	
.....Khan, A.R., Ayub, T.	533
Behavior of an Innovative End-Anchored Externally Bonded CFRP Strengthening System under Low Cycle Fatigue	
.....Sadone, R., Quiertant, M., Chataigner, S., Mercier, J., Ferrier, E.	537
Experimental Investigation of CF Anchorage System Used for Seismic Retrofitting of RC Columns	
.....Sami, Q., Ferrier, E., Michel, L., Si Larbi, A., Hamelin, P.	541
Experimental Study on Grooving Detail for Elimination of Debonding of FRP Sheets from Concrete Surface	
.....Mostofinejad, D., Hajrasouliha, M.J.	545
Interfacial Behavior Between Mechanically Fastened FRP Laminates and Concrete Substrate	
.....Martinelli, E., Napoli, A., Realfonzo, R.	548
FRP-to-Concrete Joint Assemblies Anchored with Multiple FRP Anchors: Experimental Investigation	
.....Zhang, H.W., Smith, S.T.	553
Temperature and Water-Immersion Effect on Mode II Fracture Behavior of CFRP-Concrete Interface	
.....Imani, F.S., Chen, A., Davalos, J.F., Ray, I.	557
Ultrasonic Evaluation of CFRP-Concrete Interface for Specimens under Temperature and Water-Immersion	
Aging Effects Mahmoud, A.M., Ammar, H.H., Mukdadi, O.M., Ray, I., Imani, F.S., Chen, A., Davalos, J.F.	562
Modified Beam Bond Test on Externally Bonded and Near Surface Mounted FRP Strengthened RC Beams	
.....Kotynia, R.	567
Experimental Investigation on Bond of NSM Strengthened RC Structures	
.....Palmieri, A., Matthys, S.	572

Bond Strength of BFRP Bars to Basalt Fiber Reinforced High-Strength Concrete	Bi, Q.W., Wang, H.	576
Bond Strength of FRP Rebar to Concrete: Effect of Concrete Confinement	Quayyum, S., Rteil, A.	581
Bond Strength of Fiber Reinforced Polymer (FRP) Bars in Autoclaved Aerated Concrete (AAC)	Ayudhya, B.I.N., Ungkoon, Y.	585
Bond Mechanism of Carbon Fiber Reinforced Polymer Grid to Concrete	Ding, L.N., Rizkalla, S., Wu, G., Wu, Z.S.	589
Confinement of Concrete by FRP in Compression		593
Effect of Geometric Discontinuities on FRP Strain Efficiency in FRP-Confined Circular Concrete-Filled Steel Tubes	Li, S.Q., Chen, J.F., Bisby, L.A., Hu, Y.M., Teng, J.G.	595
The Ultimate Condition of FRP Confined Concrete Columns: New Experimental Observations and Insights	Bisby, L.A., Stratford, T.J.	599
Bearing Strength of CFRP Confined Concrete	Scheffers, C.A., Sri Ravindrarajah, R., Reinaldy, R.	603
Confinement Behaviour of Eccentrically Loaded RCC Columns Using FRP Sheets	Chakrabarti, A.	607
Concrete Column Confinement with Mechanism-Based Composite Bistable Structures	Wan, C., Quon, C., Cheng, L.	610
Confined Circular and Square R.C. Sections: an Analytical Model for the Prediction of Ultimate Strength	Nisticò, N., Monti, G., Lovo, V.	614
Stress-Strain Modeling of Rectangular Concrete Columns Confined by FRP Jacket	Wei, Y.Y., Wu, Y.F.	618
Axial Behavior of FRP Jacketed Extended Rectangular Members Constructed with Low Strength Concrete	Akgun, D., Demir, C., Ilki, A.	622
Nonlinear Micromechanics-Based Finite Element Analysis of FRP-Rapped Concrete Columns Subjected to Axial Load	Baky, A., Demers, M., Yahiaoui, A., Neale, K.W.	626
Compressive Strength of Concrete Cylinders Confined with CFRP Wraps	Khan, A.R., Zafar, N.S.	630
Procedure for the Statistical Determination of the Design FRP-Confined Concrete Strength	Monti, G., Nisticò, N., Lovo, V., Alessandri, S., Santini, S.	634
Performance Evaluation of SFRP-Confined Circular Concrete Columns	Mashrik, M.A., El-Hacha, R., Tran, K.	638
Mechanical Behavior of Concrete Columns Confined by Laterally Pre-Tensioned FRP	Zile, E., Tamužs, V., Daugevičius, M.	642
Effect of CFRP and GFRP Confinement on Behavior of Square Lightweight Concrete Specimens	Oskoueï, A.V., Kivi, M.P., Boroujeni, S.T.	646
Confinement of Concrete Piles with FRP	Seliem, H.M., Ding, L.N., Rizkalla, S.	650
Three-Dimensional Finite Element Model for FRP-Confined Circular Concrete Cylinders under Axial Compression	Xiao, Q.G., Teng, J.G., Yu, T., Lam, L.	654
Numerical Analysis of Rectangular Reinforced Concrete Columns Confined with FRP Jacket under Eccentric Loading	Hajsadeghi, M., Alaei, F.J.	658
Flexural Strengthening of Concrete Beams and Slabs		663
Flexural Strengthening of Reinforced Concrete Beams with Textile Reinforced Concrete (TRC)	Si Larbi, A., Contamine, R., Ferrier, E., Hamelin, P.	665