FRP INTERNATIONAL

the official newsletter of the International Institute for FRP in Construction

Vol. 18, No. 2 September, 2021

IIFC has a website:

WWW.IIFC.ORG

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Message from the President

Dear IIFC Members and Readers of FRP International

We are quickly nearing the end of 2021 and our flagship event, CICE 2020/2021, will soon be upon us (8-10 December 2021, https://cice2020.org/en/). I do hope that you find the opportunity to attend and also to contribute to the conference. As you can appreciate, travelling remains fluid and hence the conference Chair, Professor Alper Ilki, will continue to keep the membership informed about the format as well as other key aspects of the conference.

Our IIFC award winners for 2021 will be presenting Keynote lectures at CICE 2020/2021. They include Professor Jian-Fei Chen (IIFC Medal) and Professor Libo Yang (Distinguished Young Researcher Award). Congratulations to Professors Chen and Yang. We learn more about our award winners in this edition of the newsletter.

The IIFC Executive Committee continues to work on a range of initiatives, in order to provide benefit to the IIFC members and to also advance the application of FRP composites in construction. Selected activities include:

Website: A new IIFC website is under development as the current website is limited in functionality and is off-line on occasions. The new website will have key functional enhancements such as (i) members only portal with ability to update details, (ii) payment facility, (iii) membership renewal and integrated membership records, and (iv) storage space for committees (e.g. ExCom). Our Webmaster, Professor João Correia, is taking the lead on this initiative. Please contact joao.ramoa.correia@tecnico.ulisboa.pt should you have any suggestions or comments regarding the current as well as the new website.

PracNote: A PracNote (i.e. Practice Note) is a new initiative that commenced in 2020. It is a practice-oriented guide focusing on a single topic related to the application of fibre-reinforced polymer (FRP) composites in civil infrastructures and in the service of the engineering profession and society. PracNotes present specific direction on a particular issue or solutions to a practical problem, and they are an important mechanism for the transfer of accumulated knowledge into practical implementation. The initiative is headed by Professor Dawn Cheng. Please connect with dawcheng@ucdavis.edu should you have content to contribute.

IIFC Meetings and Elections at CICE 2020/2021: The IIFC coordinates several meetings and elections at the CICE conferences. Such activities at the upcoming CICE 2020/2021 conference include (i) General Meeting of IIFC membership, (ii) meeting of IIFC Council, (iii) meeting of IIFC Executive and Advisory Committees, (iv) IIFC Council elections, (v) IIFC Fellow elections, and (vi) award of CICE 2025 host. More information about all these activities will be forthcoming. In the meantime, the call for Expressions of Interest for hosting CICE 2025 has been made to the IIFC membership and it is also included in this edition of the newsletter.

I trust you will enjoy reading this edition of FRP International. In order to keep providing high quality content to our readers, we are always on the lookout for articles as well as information to publish in our newsletter. If you do have content to contribute then please contact the Editor, Professor Peng Feng, on fengpeng@tsinghua.edu.cn.

I welcome feedback that you may have about the IIFC. Please feel free to email me directly on scott.smith@adelaide.edu.au. Feel free to also email members of the Executive, whose details can be found here https://www.iifc.org/organisation/executive-comittee/.

Yours Sincerely,
Scott Smith
IIFC President
The University of Adelaide, Australia

Welcome to CICE 2020/2021

Dear CICE 2020/2021 Participants,

We hope that you are all fine during this difficult time.

We are working hard and following the developments about COVID-19 to finalize the format of the conference either as hybrid or online. **The format of the conference will be announced later this month of October. In any case, all registered participants will have the option of attending the conference on-line.**

We have announced that the conference proceedings would be published in July 2021. However, for further benefit of authors and all parties, in communication with IIFC, we have decided to **publish the Conference Proceedings through the reputable publisher Springer.**

With this new option, the CICE 2020/2021 proceedings will have a DOI number (along with an ISBN) and the proceedings will be indexed by SCOPUS, COMPENDEX and WEB OF SCIENCE (with a WOS number).

This, on the other hand, will cause a delay in publication of the proceedings. We hope that, with this new arrangement, the CICE 2020/2021 proceedings will be distributed to all registered participants before the Conference in November 2021.

The proceedings will be accessed freely through all libraries with a contract with Springer. All IIFC members will have free access to the conference proceedings from IIFC web site one year after publication date.

Kind regards and looking forward to meet online or face-to-face in Istanbul in December.

Conference Chair: Prof. Dr. Alper Ilki

On behalf of CICE 2020/2021 Organization Committee

Call for proposals for IIFC official conference in 2025 (CICE 2025)

Dear IIFC Members,

The CICE (International Conference on FRP Composites in Civil Engineering) conference series started with CICE 2001 in Hong Kong, China and became the official conference series of IIFC in 2003. It has then travelled to Adelaide (Australia) in 2004, Miami (USA) in 2006, Zurich (Switzerland) in 2008, Beijing (China) in 2010, Rome (Italy) in 2012, Vancouver (Canada) in 2012, Hong Kong (China) in 2016, Paris (France) in 2018, and Istanbul (Turkey) in 2021.

CICE 2020/2021, the 10th official conference of the IIFC, will be held in 2021 in Istanbul, Turkey.

CICE 2023, the 11th official conference of the IIFC, will be held in 2023 in Rio de Janeiro, Brazil.

I am now writing to call for proposals from interested organisations for hosting and organising CICE in 2025, the 12th International Conference on FRP Composites in Civil Engineering (CICE 2025). Your proposal should contain the following details:

(1) Proposed Chair of the Local Organising Committee;

(2) Tentative composition of the Local Organising Committee;

(3) Tentative dates of conference and justification for the choice of dates (conference names and dates (if known) should be identified that are scheduled for 2025 that could conflict with CICE 2025);

(4) Type of conference venue (hotel or campus etc.);

(5) How the proceedings will be published (hardcopy full papers; CD; USB Flash Drive etc.);

(6) Tentative registration fee. Based on the IIFC constitution, the registration fee for all delegates (including keynote speakers) must include the IIFC membership fee for the following two years (i.e. $100 USD for full members and Fellows, $25 USD for students). The total membership fee owing is to be electronically transferred to the IIFC account at the conclusion of the conference. There is an expectation that the fees charged at the actual conference should not deviate considerably from the fees proposed in the bid;

(7) Availability of affordable accommodation including types of accommodation and their approximate costs per night;

(8) Attractiveness of the conference city in terms of three aspects: (a) Technical (e.g. because there are many FRP applications in your region/country); (b) Geographical (e.g. the region has not had an international conference on FRP); (c) Social aspects (e.g. a location with many interesting sights to explore);

(9) Any financial support from your organisation. The conference organiser will be expected to organise the underwriting of the conference;

(10) Any other aspects that make your proposal attractive (e.g. publication of papers in journal special issues; pre- or post-conference short course for local engineers + conference participants).

(11) Contingency and/or plan for hybrid or partially hybrid conference should the need arise (e.g. COVID)

Please submit your proposals by email to me at cejgdai@polyu.edu.hk by 1 November 2021.

The Local Organising Committee will be supported by the IIFC Executive Committee (IIFC ExCom) in the setting-up of the International Scientific Committee and in publicising the event. The Local Organising Committee may also recommend Keynote Speakers but the decision ultimately lies with the IIFC ExCom. A Chair of the Local Organising Committee will automatically become a member of the IIFC Executive Committee from CICE 2025 for one term as the CICE Conference Coordinator.

The IIFC will give out its usual best paper awards to papers presented at the conference and published in the proceedings. The IIFC will also present an IIFC Medal and a Distinguished Young Researcher award. The winner of the IIFC Medal will be invited to give the IIFC Distinguished Lecture and the winner of the Distinguished Young Researcher award will be invited to deliver one of the keynote lectures.

If you are not interested to host this conference yourself, but would like to nominate a particular institution or location for CICE 2025, please also email your suggestions to me for consideration by the IIFC ExCom.

All proposals will be assessed by the IIFC ExCom. Proposals shortlisted by the ExCom will be submitted to the IIFC Council for decision at its next meeting at CICE 2020/2021 in Turkey (possibly online). Proposers of the shortlisted proposals will be invited to deliver a short

presentation at the Council meeting in Turkey (possibly online). The IIFC ExCom will work closely with the wining team to maximise the likelihood of a successful conference.

It should be noted that the ownership of the conference lies with the IIFC. Should an unlikely situation arise where disagreements between the Local Organising Committee and the IIFC ExCom cannot be resolved through negotiation, the IIFC reserves the right to withdraw the award of the conference to the Local Organising Committee and to award it to an alternative team. The winning team will be requested to sign a Memorandum of Understanding with the IIFC to ensure the smooth running of the conference.

Best regards,

Jian-Guo Dai

IIFC Vice-President

Winners of the 2021 IIFC Awards

2021 IIFC Medal

Professor Jian-Fei CHEN

Southern University of Science and Technology, China

Professor Jian-Fei Chen is awarded the 2021 IIFC Medal for his many distinguished research contributions to FRP Composites for Construction especially for his pioneering work on the theory of FRP-strengthened RC structures, for the impact of his research in practice evidenced by the adoption of his work in design standards and guidelines throughout the world, and for his decades long foundational contributions to the IIFC.

2021 Distinguished Young Researcher Award

Professor Libo YAN

Technical University of Braunschweig, Germany

Professor Libo Yan is awarded the 2021 Distinguished Young Researcher Award for his contributions to the application of FRP composites to civil infrastructure, and especially for the promotion of natural FRP composites.

Professors Chen and Yan will deliver Keynote lectures at the upcoming CICE 2020/2021 conference scheduled this December in Istanbul, Turkey. Further details about the lectures will be provided by the conference Chair, Professor Alper Ilki, in due course.

The awards process was overseen by the IIFC Honours Committee which consists of the following members:

Dr. L.C. Bank, Georgia Institute of Technology, USA (Chair)

Prof. B. Benmokrane, University of Sherbrooke, Canada

Prof. A. Nanni, University of Miami, USA

Prof. S.T. Smith, University of Adelaide, Australia

Prof. J.G. Teng, Hong Kong Polytechnic University, China

FRP around the World

Application of BFRP grids for strengthening of Nanjing Yangtze River Bridge

Zhishen Wu[a, b, c], Xin Wang[a, b, c], Weidong He[b, c]

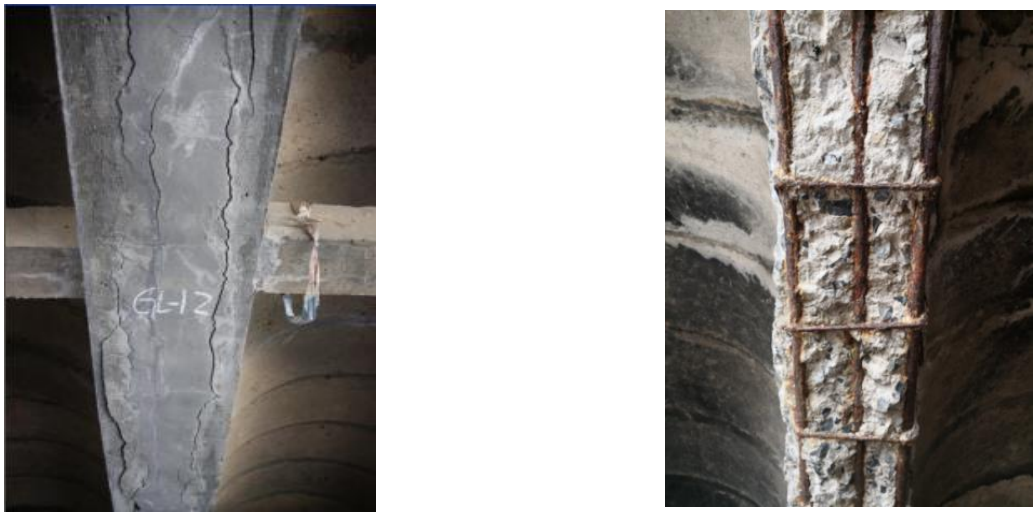
[a] National and Local Unified Engineering Research Center for Basalt Fiber Production and Application Technology, Southeast University, Nanjing 210096, China

[b] International Institute for Urban Systems Engineering, Southeast University, Nanjing 210096, China

[c] School of Civil Engineering, Southeast University, Nanjing 210096, China

Stretching across the Yangtze River northwest of Nanjing City, Nanjing Yangtze River Bridge (Fig. 1), or Nanking Yangtze River Bridge, is the first double-deck railway-highway bridge designed and built by China independently. The construction of the bridge started from 1960 and lasted for 8 years, with the lower railway put into use in September of 1968 and later the upper road opened to traffic in December in the same year. Owing to the extremely important historical, artistic and scientific values, the Nanjing Yangtze River Bridge is selected on the list of "China's 20th century architectural heritage".

Fig. 1. The Nanjing Yangtze River Bridge



(a) concrete cracking and peeling (b) steel bar corrosion

Fig. 2. Environmental distress of a double curved arch bridge

However, the long-term overload service, environmental effects and human factors have led to a lot of damage and structural safety problems in the Nanjing Yangtze River Bridge. The double curved arch bridge is a part of Nanjing Yangtze River Bridge, and degradation of the double curved arch bridge is particularly serious. This includes concrete cracking and peeling, steel bar corrosion, and concrete carbonization (the maximum carbonization depth of the concrete is close to 23 mm), as shown in Fig. 2.

In recent years, a modified increasing section strengthening method has been developed, in which two kinds of materials including steel bar and two-dimensional fiber-reinforced polymer (FRP) grids are adopted to reinforce the enlarged section, as shown in Fig. 3, where A and B are the cover thickness of the steel bar and FRP grids, respectively. According to GB 50010 standards [1], the value of A is usually greater than 35 mm. The steel bars are placed close to the existing RC member to increase the stiffness and load capacity of the RC member, while the FRP grids are installed outside the steel bars to improve the crack resistance of the enlarged section and, thereby, improve the durability of the RC member. This hybrid configuration of the FRP grids and steel bars offers longer service life than steel bars.

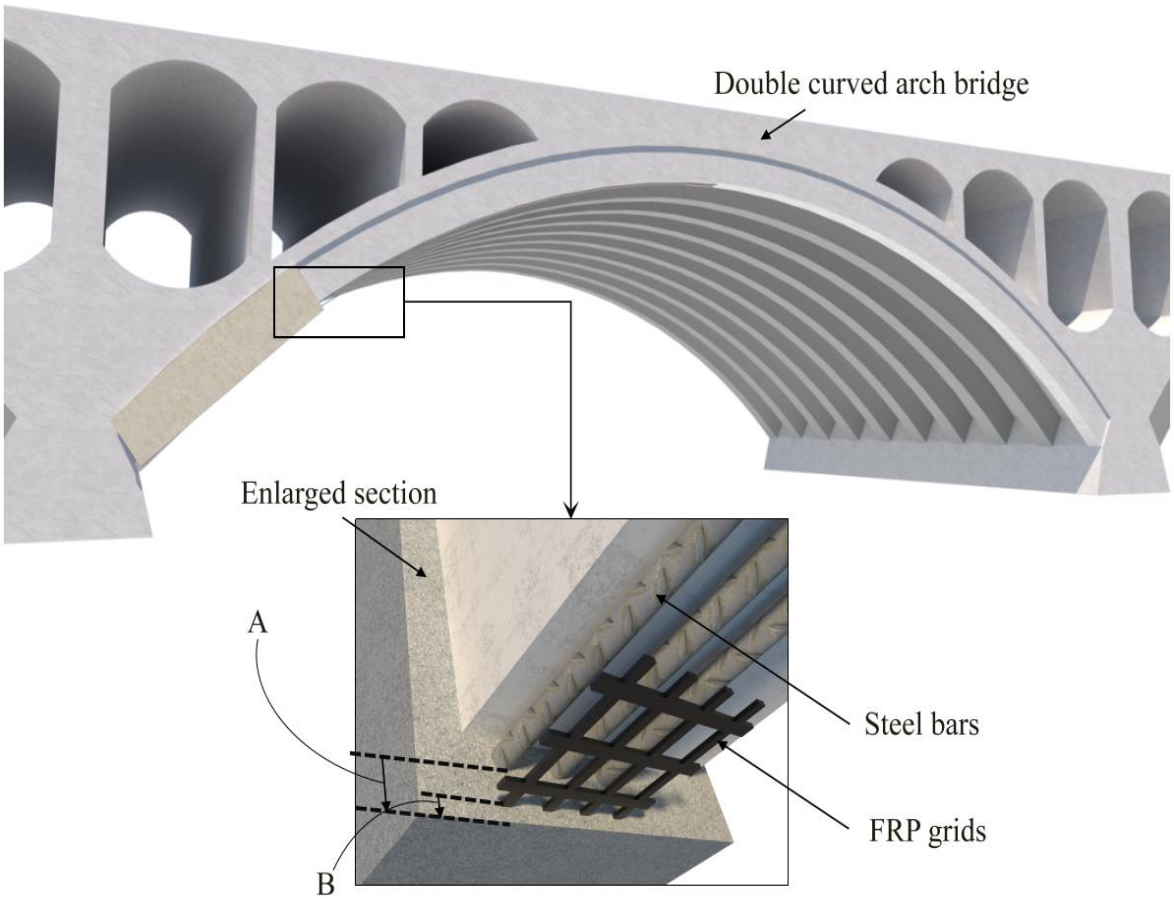


Fig. 3. Strengthening of structures with hybrid FRP grids and steel bars

As a structural material with better tensile strength and durability, FRP grids can also be used to strengthen RC members alone, as shown in Fig. 4. Wu et al. [2-6] divided the strengthening methods of the FRP grids into two types, namely, thin bonding and section enlargement. Regarding the section enlargement method, the polymer cement mortar with excellent durability is selected as the bonding material, and the value of B is greater than 10+t mm, where t is the thickness of the FRP grids. This strengthening method is commonly used in previous investigations as well as practical applications. In the case of the thin bonding method, epoxy putty or geopolymer mortar is selected as the bonding material. Owing to the higher bond strength of the epoxy putty and geopolymer mortar in comparison with polymer cement mortar, the value of B can be significantly reduced. Usually, the value of B is equal to zero when the thin bonding method is adopted.

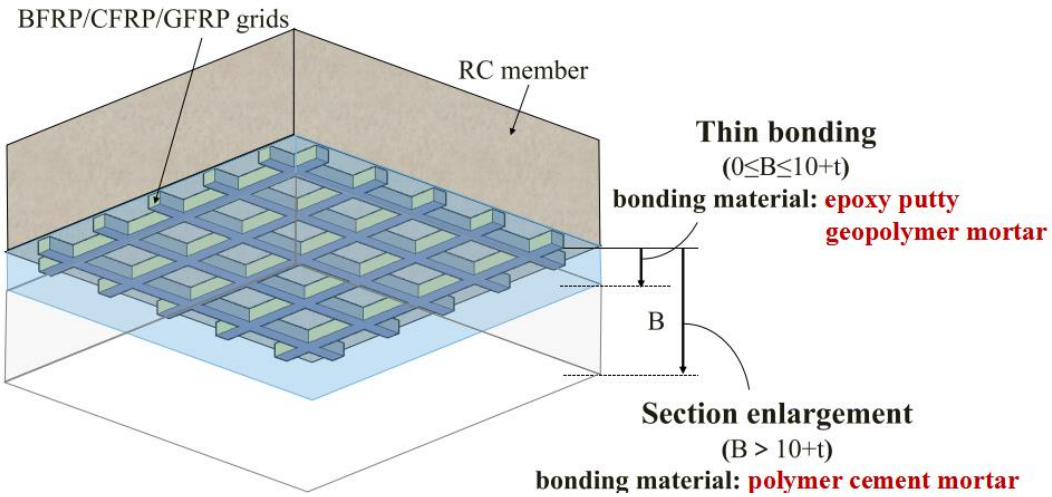


Fig. 4. Strengthening method with FRP grids from thin bonding to section enlargement

According to an investigation of the double curved arch bridge, the stiffness and load capacity of the arch ribs were insufficient. Therefore, the modified increasing section strengthening method with the hybrid configuration of the FRP grids and steel bars was adopted to improve the performance of the arch ribs, as shown in Fig. 5(a). The steel bars with the diameter of 20 mm were arranged close to the existing arch ribs, and a layer of basalt fiber-reinforced polymer (BFRP) grids was installed outside the steel bars. The BFRP grids were produced with the automatic continuous compression moulding technology, and they were characterized by square mesh with nominal dimensions of 50 × 50 mm. Moreover, the width and thickness of each bar of the BFRP grids were 10 mm and 2 mm, respectively. In this strengthening project, the the values of A and B were 50 and 15 mm, respectively. This strengthening project started from January 2018 and lasted for about 6 months.

The demonstration, design and construction guidance of the strengthening method used in this project were completed by the team of Professor Wu Zhishen from Southeast University, China. Theoretical analysis showed that the modified increasing section strengthening method can effectively improve the stiffness, load capacity and durability of the arch ribs, and prolong the service life of the arch ribs by at least 50 years. Meanwhile, in this strengthening project, the relationship between "structural strengthening under the requirements of practical functions" and "repair of cultural relics according to the law of cultural relics conservation" was considered. Not only some traditional construction methods and techniques were inherited and used in the conservation, but also some innovative

strengthening methods which were more suitable for the conservation of cultural relics were developed in the process of the project. This strengthening project can provide a reference for similar conservation projects.

(a) install BFRP grids (b) after strengthening

Fig. 5. Strengthening of arch ribs

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Recent Highlighted Publications

Design, modeling, optimization, manufacturing and testing of v ariable-angle filament-wound cylinders

Highlight word: Variable-angle, Variable stiffness, Buckling, Filament winding

Author: José Humberto S. Almeida Jr; Luc St-Pierre Zhihua Wang; Marcelo L. Ribeiro; Volnei Tita; Sandro C.Amico; Saullo G.P.Castro.

DOI: 10.1016/j.compositesb.2021.109224

Journal: COMPOSITES PART B: ENGINEERING

Abstract: This work demonstrates the potential of manufacturing variable-angle composite cylinders via filament winding (FW), called VAFW. The proposed design strategy allows different filament angles along the axial direction by dividing the cylinder into regions of constant angle called frames. Designs using two, four, or eight frames are herein investigated. A genetic algorithm is applied to optimize each design for maximum axial buckling load. A design with minimum manufacturable filament angle is included in the study. All structures are manufactured and tested under axial compression, with displacements and strains measured by digital image correlation (DIC). The thickness and mid-surface imperfections of the different designs are measured through DIC and used to explain the observed buckling mechanisms. These imperfections are incorporated into a nonlinear numerical model along with a progressive damage analysis. Additionally, a scaling factor is applied on the measured imperfections to enable an imperfection sensitivity study on the proposed designs. The VAFW design shows buckling strength, stiffness, and absorbed energy substantially higher than the constant-angle configuration, attributed to tailored thickness buildup and optimized tow steered angles at particular regions of the cylinder. The experimental and numerical results indicate that VAFW designs can be tailored to postpone buckling so that the material strength can be better exploited.

The effects of aging in seawater and SWSSC and strain rate on the tensile performance of GFRP/BFRP composites: A critical review

Highlight word: Durability performance, Seawater, SWSSC environment, Dynamic tensile properties

Author: Sheng Li; Shuaicheng Guo; Yiming Yao; Zuquan Jin; Caijun Shi; Deju Zhu.

DOI: 10.1016/j.conbuildmat.2021.122534

Journal: CONSTRUCTION AND BUILDING MATERIALS

Abstract: Replacing metallic materials (typically carbon steel bars) with fiber reinforced polymer (FRP) composites to reinforce marine concrete structures can effectively resolve the corrosion issue of carbon steel due to external chloride ions and moisture. However, the corrosion-free nature of FRP material cannot guarantee its desirable durability in the marine structures. In order to better understand the durability performance of FRP composites, this paper summarizes the quasi-static tensile properties of FRP composites after exposure in simulated seawater and seawater sea sand concrete (SWSSC) environments, and the dynamic performance of the FRP materials. It is found the degradation degree of FRP composites increases with the exposure time, temperature, stress level and alkalinity/salinity of the immersion solution. Currently, the investigations on the dynamic tensile properties of FRP composites after long-term exposure tests are quite limited. Hence this study identifies the possible research needs by summarizing the investigations on the degradation of FRP's dynamic performance after seawater exposure and the strain rate sensitivity of glass/basalt fiber reinforced polymer (GFRP/BFRP) composites under dynamic loading. The impact strength, Young's modulus and fatigue life will all be diminished due to exposure in seawater. And both the mechanical performance and failure mode of the FRP composites are obviously influenced by the applied strain rate. This study identifies the current knowledge gap and can serve as a valuable reference for further investigation on the long-term performance, especially the long-term dynamic tensile properties of FRP composites in seawater and SWSSC environments.

Additive fabrication of large-scale customizable formwork using robotic fiber-reinforced polymer winding

Highlight word: additive manufacture, robotic fabrication, dynamic winding, topological optimization

Author: Ya Ou; Dingwen Bao; Guanqi Zhu; Dan Luo.

DOI: 10.1089/3dp.2020.0358

Journal: 3D PRINTING AND ADDITIVE MANUFACTURING

Abstract: Based on the established system of concrete-filled fiber-reinforced polymer (FRP) tube (CFFT) in civil engineering and construction industry, this research presents a novel fabrication method for freeform FRP formwork through an additive process of winding FRPfabric with industrial robots. Different from the filament winding or fused deposition modeling process in additive manufacture, large-scale formwork is fabricated with layered winding of FRP fabric and simultaneously applying fast cure epoxy resin in the proposed methods. It increases the fabrication speed and material efficiency compared with the typical fabrication process of FRPformworks, and achieved the geometry flexibility from the numerically controlled additive process. The fabrication methods are developed through a series of preliminary tests, exploring the appropriate fabrication parameters, such as the overlapping height of each layer, winding speed, and epoxy resin type. Two additional prototypes addressing geometrical flexibility are also fabricated. Based on the feasibility studies, the article discussed the potential application of this system on a double-skin tubular arch (DSTA) bridge and a tree-like topological optimized column as the future outlook of this method. As developed based on the established construction systems such as CFFTs and DSTAs, not only the proposed system is compatible with current structure and construction system, but it also benefits from combining an off-shelf material with a flexible and accurate programmable roboticprocess. This research contributes to the scope of additive manufacturing system by targeting the fabrication of nonuniform optimized large-scale structures.

Experimental, analytical and numerical investigation of pultruded GFRP composite beams

infilled with hybrid FRP reinforced concrete

Highlight word: Pultruded GFRP composite beams, EBR method, Flexural strengthening, Mechanical property

Author: Gemi Lokman; Madenci Emrah; Ozkilic Yasin Onuralp.

DOI: 10.1016/j.engstruct.2021.112790

Journal: ENGINEERING STRUCTURES

Abstract: This paper presents the experimental, analytical and numerical analyses on the behavior of the pultruded GFRP composite beams infilled with hybrid fiber reinforced concrete under four-point loading. The examined experimental variables included: (1) effect of pultruded GFRP box profile, (2) effect of conventional steel bars, GFRP bars and hybrid bars, (3) effect of externally GFRP wrapping. Pursuant to this goal, a total of 9 medium-sized beam specimens were constructed. The experimental tests were simulated using finite element models with ABAQUS program. A novel analytical method for analyzing the flexure behavior of beams has been presented. Applying the first order shear deformation beam theory and introducing auxiliary functions, the equation of motion is derived using the Hamiltonian approach. Initial stiffness, ductility, energy dissipation capacity were compared based on the load-displacement relationship. The pultruded profile significantly enhanced the behavior of traditional reinforced concrete beam and GFRP composite wrapping also considerably improved the behavior of the pultruded profile infilled with reinforced concrete beam. More importantly is that hybrid reinforcements are recommended for all cases. Moreover, detailed damage analyses are provided.

Effect of cryogenic environments on failure of carbon fiber reinforced composites

Highlight word: Cryogenic environments, Failure Envelopes, Mechanical property, Tomography and fractography

Author: Jörg Hohe; Michael Schober; Sascha Fliegener; Klaus-Peter Weiss; Simon Appel.

DOI: https://doi.org/10.1016/j.compscitech.2021.108850

Journal: COMPOSITES SCIENCE AND TECHNOLOGY

Abstract: The present study is concerned with damage and failure of CFRP composites under isothermal mechanical loads in the ambient and cryogenic thermal regimes. In an experimental study, the mechanical failure behavior of unidirectionally carbon fiber reinforced materials is investigated at ambient temperature and in a liquid Helium environment at 4.2 K under a variety of loading conditions. The effect of thermally induced damage is investigated on specimens exposed to cryogenic temperature without external mechanical load and subsequent testing till failure at ambient temperature. Three different materials including high modulus and intermediate modulus high strength fibers as well as epoxy and thermoplastic (PEEK) matrix systems are considered. The results are employed to investigate the applicability of different standard composite failure criteria in the cryogenic regime.

Structural analysis of a wind turbine blade repurposed as an electrical transmission pole

Highlight word: Wind turbine blade, Electrical transmission pole, Repurpose, Thoeritical analysis

Author: Ammar A. Alshannaq; Lawrence C. Bank; David W. Scott; T. Russell Gentry.

DOI: https://doi.org/10.1061/(ASCE)CC.1943-5614.0001136

Journal: JOURNAL OF COMPOSITES FOR CONSTRUCTION

Abstract: This paper focuses on the conceptual use of a fiber-reinforced polymer (FRP) wind turbine blade that is repurposed for a second life as an electrical transmission pole. Thousands of tons of fiber-reinforced polymer composite wind turbine blades are currently coming out of service globally and are being landfilled or incinerated. These are not environmentally preferable disposal methods. This paper presents a detailed structural analysis of a Clipper C96, 46.7-m-long turbine blade used as an electrical pole. The analytical procedure needed to characterize the wind turbine blade for repurposing includes determining the external and internal geometry of the blade, identifying the types of materials and laminates used throughout the blade, and calculating effective moduli and section properties for structural analysis. Code-specified load combinations are then used to analyze the transmission line BladePole to determine internal forces and deformations and stresses. Maximum stresses were compared to those obtained from theoretical models. The results indicate that wind turbine blades can safely be used as electrical transmission poles.

ASCE Journal of Composites for Construction

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http://ascelibrary.org/cco/

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http://www.editorialmanager.com/jrncceng/

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