FRP INTERNATIONAL

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Editor's Note

2012 brings a busy year for IIFC with the *Third Asia-Pacific Conference on FRP in Structures* (APFIS 2012) conference in February followed by the *Sixth International Conference on FRP Composites in Civil Engineering* (CICE 2012) in June. A number of new initiatives accompany these meetings including the first IIFC Poster Competition (APFIS) and the second IIFC Photo Competition. It is my hope that with this busy year will come an even busier and more robust *FRP International*.

This issue has two feature articles: the first, *Full-Scale Testing of a Bridge with FRP Decking at Bristol University* is developed from work presented at the recent *Advanced Composites in Construction* (ACIC; see back page) meeting in Warwick, UK by Dr. Wendel Sebastian. The second takes a more educational focus, reporting the recent development of a structural engineering and computational mechanics laboratory at Rose Hulman Institute of Technology, USA. To enhance the expertise required for the success of this lab, a unique undergraduate and faculty exchange research program focusing on FRP materials was carried out over the past three years.

This issue also has a brief report from the IIFC Executive Committee and Council reporting their many activities from 2011. Finally, on behalf of the entire IIFC Executive Committee, I would like to wish all readers the very best wishes for 2012; we look forward to seeing you in Sapporo and Rome.

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Become an *FRP International Author…*

As IIFC grows, we also hope to expand the utility and reach of *FRP International*. The newsletter will continue to report the activities of IIFC and focus on IIFC-sponsored conferences and meetings. Nevertheless, we are also soliciting short articles of all kinds: research or research-in-progress reports and letters, case studies, field applications, or anything that might interest the IIFC membership. Articles will generally run about 1000 words and be well-illustrated. Submissions may be sent directly to the editor. Additionally, please utilize *FRP International* as a forum to announce items of interest to the membership. Announcements of upcoming conferences and abstracts from newly-published PhD dissertations are particularly encouraged. *FRP International* is yours, the IIFC membership's forum. The newsletter will only be as useful and interesting as you help to make it. So, again, *please become an* FRP International *author*.

Report from the IIFC Executive Committee

Since CICE 2010 in Beijing there has been much activity within the IIFC Executive Committee under the new leadership of IIFC President Prof. Larry Bank. Some of it is related to the modernization of the visual identity of the Institute; most notable the website (www.iifc-hq.org) thanks to the efforts of Dr. Scott Smith and Dr. Jian-Guo Dai, and the quarterly newsletter under the leadership of the new editor-in-chief Dr. Kent Harries, which is now being broadly distributed electronically.

Other activity is taking place behind the scenes, such as the restructuring and automation of the membership database led by Prof. Chuck Bakis which will soon be linked with a secure log-in feature to the website that will allow members to update information and pay membership fees online.

An IIFC Poster Competition developed by Prof. Amir Fam is being been introduced at the upcoming APFIS 2012 conference in Hokkaido, Japan; this will become a new feature of IIFC organized conferences.

The second IIFC Photo Competition opens in January 2012 and the announcement of the winners will coincide with CICE 2012 in Rome, Italy.

The IIFC Executive and Advisory Committees met at the FRPRCS10 meeting in Tampa, USA, in April where it was announced that the next APFIS conference will be held in Melbourne, Australia, in 2013.

Effort is being made to improve outreach to industry, in part by providing publicity materials and presentations given by IIFC members at trade organization meetings such as Dr. Rudi Seracino at ACMA in the USA, Dr. Emmanuel Ferrier at JEC in Paris, and most recently Dr. Renata Kotynia at the Composites Trade Fair in Poland.

The IIFC is also providing non-financial sponsorship of related international conferences such as the Performance-based and Life-cycle Structural Engineering Conference in Hong Kong (PLSE 2012), and the Smart Monitoring, Assessment and Rehabilitation of Civil Structures Conference in Istanbul (SMAR 2013), which is co-sponsored by ISHMII.

As the next CICE conference fast approaches (Rome, 13-15 June 2012), which is the 6th conference in this series, activity again begins to ramp up in preparation for the various IIFC meetings and elections that will be held during the conference. In particular, Dr. Jian-Fei Chen will soon announce the call for proposals to host CICE 2016 so that the final selection may be made in Rome. Proposals from all interested groups are highly encouraged and welcome. In recent years, interest and competition to host this international conference series has been very high.

Finally, please be reminded that this Institute is run entirely by volunteers. At CICE 2012 in Rome elections will be held for membership in the IIFC Council and Executive Committee. If you are interested in participating in the administration of the Institute, please make sure your nomination is submitted when the calls are released and as always, recommendations and suggestions for improving the institute are always welcome and encouraged.

Dr. Rudi Seracino
Secretary of the IIFC Executive Committee

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The Third Asia-Pacific Conference on FRP in Structures (the Official Asia-Pacific Regional Conference of the IIFC) will be held at Hokkaido University, Sapporo on 2-4 February 2012.

Presently 72 papers representing 14 countries are scheduled for presentation. A special keynote lecture by Prof. Maruyama on the Great East Japan Earthquake including some topics related to FRP will also be presented. A laboratory and campus tour of Hokkaido University is also planned.

Sapporo has not been affected by the recent earthquake or nuclear power plant incident. Travel to and from Japan and to Hokkaido remains safe. What concerns all Japanese is an economic slowdown due to people's perception, both domestically and internationally. A successful APFIS2012 will both directly and indirectly positively affect the restoration of the affected areas and all of Japan.

IIFC Announces...

2012 FRP-in-Construction Photo Competition

Competition Categories:

Category 1 – FRP in an engineering project (under construction or completed)

Category 2 – FRP in a research study

Winning Entries:

The winner in each category will receive an award at the 6th International Conference on FRP Composites in Civil Engineering (CICE 2012), Rome, June 13-15, 2012, along with a $200US prize. Also, one of the two winning photographs, selected by the panel of judges, will appear on the cover of the *Journal of Composites for Construction* published by the American Society of Civil Engineers (ASCE) http://ascelibrary.aip.org/cco/.

Runners-up:

The winner and five runners up, in each category, will have their photographs made into posters and displayed (with due acknowledgement) at the CICE 2012 Conference, Rome, June 13-15, 2012.

Competition Rules:

1. Only digital photographs will be accepted. Photographs must be in JPEG format of at least 1205 x 945 pixels, but not larger than 1600 x 1200 pixels. *For initial submissions*, photographs must be submitted in PDF format. Short listed photographs will be required to be submitted in the high resolution JPEG format at a later stage. Both color and black and white photographs are eligible.
2. The procedure of submitting is as follows:
   i. Go to IIFC web page: www.iifc-hq.org/
   ii. Select "IIFC Photo Competition" from the left column
   iii. Go to the following website "EasyChair Login Page for IIFC PC2012" by selecting the following link: www.easychair.org/account/signin.cgi?conf=iifcpc2012
   iv. Select "sign up for an account"
   v. After receiving account details, return to the same website to sign in: https://www.easychair.org/account/signin.cgi?conf=iifcpc2012.
   vi. Select "New Submission" from top bar
   vii. Enter the photographer's name and details in the "Author 1" box.
   viii. Enter the title of the photograph and the month and year it was taken in the "Title (*)" box.
   ix. Enter a maximum of 25 words description of what the photograph shows in the "Abstract" box.
   x. Enter the category: (1) for FRP application in an engineering project, or (2) for FRP in a research study, in the "Keywords" box.
   xi. Upload your photograph ***in PDF format*** by selecting "Browse" in the "Paper" box.
   xii. Click "Submit".
3. Only two (2) photographs per category per entrant may be submitted. Each entry must be submitted separately.
4. Only photographs taken during or after January 2006 can be entered in this competition.
5. By submitting the photograph to the competition the entrant: (i) Attests that he/she is the person who took the photograph, (ii) Transfers copyright to the IIFC for the photograph, (iii) Gives permission (with due acknowledgement) to the IIFC to use the photograph in publications, literature, and web sites.
6. **The competition entry period is from January 1, 2012 to March 31, 2012.**
7. The winning photographs will be selected by a panel of judges that will be co-chaired by Professors A. Fam and P. Labossiere, and will include a professional photographer.
8. Top awards winners may be required to submit their photographs in alternative formats as mandated by ASCE for use as the Journal cover photograph. Additional copyright releases may be required by ASCE. IIFC will release permission to ASCE to use the photographs for this purpose.
9. Members of the panel of judges are ineligible to enter the competition.

For any questions, contact Amir Fam at: fam@civil.queensu.ca

Winners of the 2005 IIFC Photo Competition...

Applications: Doug Gremel
Laying out an FRP deck in Amarillo, Texas, USA

Research: Steve Preston
FRP bars waiting to be tested

This article is a technical submission to FRP International. It describes an experimental program aimed at assessing in situ *behaviour of the ASSET FRP deck.*

Full-Scale Testing of a Bridge with FRP Decking at Bristol University

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In structural engineering research, it was previously the case that testing – backed up by predictive computer modelling – was the main method of progressing our understanding of the complex load responses of structures. However, given current levels of sophistication of computer modelling tools, there is frequently the perception that this situation is reversed and so it is now held that predictive modelling backed up by tests is the way forward.

However, there are some areas where predictive modelling and comprehensive testing both assume great significance in advancing our insight into structural action. The uses of FRPs for strengthening existing structures and for new-build constitute one such area. Testing is important to permit observation and understanding of otherwise unanticipated complexities in load response which can arise from the short-term and long-term constitutive behaviours unique to FRP materials, from the novel joints which must by necessity be detailed to hold the different components together in structures made wholly or partly of FRPs, and from the subtle changes in mechanical properties which can arise from changing fibre layouts / amounts in the FRP components.

For traffic bridges incorporating FRPs, the ultimate limit state – where extreme external loading causes failure in a single application – is one important consideration, but also the serviceability limit state of fatigue – where damage accumulates potentially up to a critical stage due to passage of millions of heavy vehicles over many years – can be another important consideration. Thus the fatigue resilience of the different components making up the structure must be understood and, if possible, enhanced. In performing their crucially beneficial role of load sharing internally, complex stress states can also exist within the joints and so the fatigue resilience of the joints requires careful consideration too. If FRP decking is used in the bridge, many joints may be required between individual deck units and the localised responses of the deck-to-deck joints to tire loading on the surfacing can generate significant stresses relative to those from global bending action of the bridge.

To date, in construction of new beam-and-deck bridges, FRPs have been used for the decks and/or the main beams. The well-known advantages of FRPs include low unit weight, high tensile stiffnesses and strengths, corrosion-resistance and ease of manufacture into modular components. These translate into a variety of benefits in bridge construction including a requirement for only light lifting equipment, enhanced site safety (owing to the repetitive nature of the task of assembling the deck units), accelerated construction schedules (giving consequent benefits of reduced lane rentals and generally lower traffic management costs during construction), less extensive (and expensive) foundations, long-term durability and more cost-effective maintenance. Either some or all of these benefits will typically be exploited in practical bridge applications.

Thus far, although FRPs have not enjoyed widespread application in new bridge construction, the number of bridges with a significant proportion of load-bearing FRP components is increasing. In the bridges to date, different combinations of FRPs and traditional construction materials having been pursued, as follows:

- *A concrete deck slab acting with open section carbon and glass FRP longitudinal beams including horizontal FRP flanges*. For single-span simply supported bridges this approach has the benefit of using the materials to their true strengths, namely the concrete in compression and the FRP in tension.
- *FRP decking combined with steel I-section main beams*. This form benefits from the reduced weights of the decking and the steel beams, along with the ductility of steel.
- *FRP decking in unison with pre-tensioned concrete (PTC) main beams*. This combination is advantageous where the corrosion resistance of the decking against winter de-icing salts is a key consideration. The natural corrosion resistance of the PTC beams is an added benefit. Further, the high stiffnesses and low construction depths of PTC beams are beneficial, the latter characteristic is especially useful where the reduced structural depth enables minimisation of the soil volumes required to construct lead-up ramp roads to the bridge.

- *FRP decking and FRP main beams*. A key advantage of low self-weight of the superstructure is the result. To satisfy global stiffness requirements, carbon fibres would probably be used within the components to a significant extent. This provides an excellent opportunity to alter fibre layouts throughout the bridge to arrive at a truly optimised structure.

There has also been variety in the forms of the connections used between the decking and the main beams. These connections fall into two broad categories, namely mechanical and chemical. Mechanical connections have been popular in part because there is familiarity with such connections from more traditional forms of construction. Where FRP decking is used, holes must be cut or formed into the base of the deck units to allow protrusion into the modular deck units of the connectors from the main beams. Holes must typically also be cut into the decking from above, to enable pouring of grout into the deck voids around the connectors. With the chemical (i.e. adhesively bonded) joints, a key challenge is adequate surface preparation to ensure good adhesion.

Whichever of these component and joint options are pursued, development of a suitable method to assess the fatigue resilience of the structure is important. For convenience, tests are commonly conducted to determine the fatigue responses of individual components and connections. In such cases, representation of the boundary conditions (commonly the connection to the remaining structure) is important if a reliable assessment of fatigue resilience is to be the result. Such representation of the boundary conditions is not always straightforward. Consequently, the alternative of constructing and testing a full-scale specimen of the bridge, where the actual boundary conditions for the critical components and joints are automatically present, is highly desirable. It is propitious to conduct such tests in the laboratory environment, as the inputs (loads, etc) to and the outputs (strains, deflections, etc) from the specimen can all be reliably measured. These ideas have come together in a project at Bristol University in the UK to build and test under fatigue loading a full-scale FRP deck – PTC beam bridge specimen with only bonded connections. In what follows, key features of this project are discussed.

Description of the Project

The bridge specimen under test in the BLADE (Bristol Laboratory for Advanced Dynamics Engineering) facility at the Faculty of Engineering, Bristol University, uses the pultruded, modular ASSET decking system of which three units are shown in Fig. 1. This glass FRP cellular deck system, which emerged from a European-funded research programme, is of parallelogram section with thick flanges and thinner webs, including a diagonal web which gives the impression of two equilateral triangles with slightly truncated corners. Short lengths of ASSET units are shown in Fig. 1 for clarity, but the units are pultrudable to any lengths in practice; limited only by the capabilities of the transporters used to take the units from factory to site.

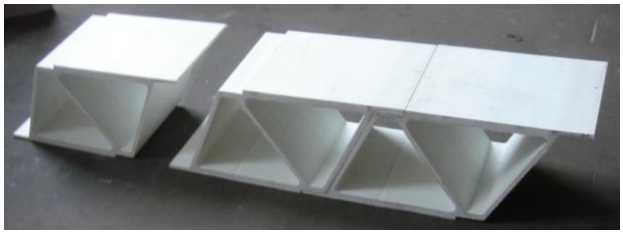

Fig. 1 Short lengths of ASSET glass FRP deck units.

Fig. 2 shows the bridge specimen in an *ad hoc* test frame made of steel. The ASSET deck units span across and are bonded to three PTC beams spaced at 1.45m centres. This moderate deck span across the PTC beams lies between a threshold economical minimum of 1m (below which the high number of PTC beams leads to excessive costs) and a maximum of 2.3m corresponding to limits on deck deflection under tire loads. Each PTC beam is 8m long and the width of the specimen (the length of each deck unit) is 3.65m.

Only adhesive joints are used in the structure, both for the deck-to-deck connections and for the deck-to-beam connections.

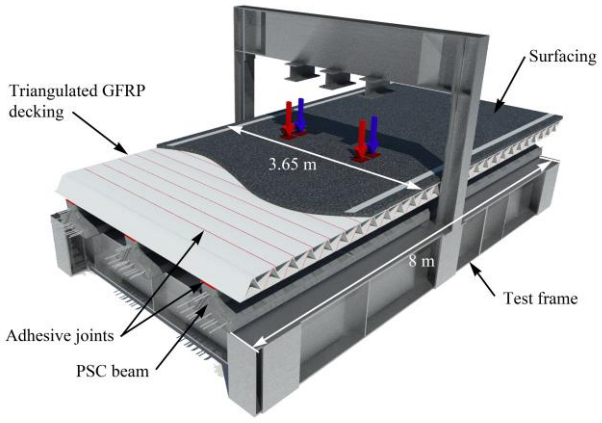

Fig. 2 Test specimen in Fatigue Testing Frame.

While Fig. 2 shows surfacing applied to the decking, tests are first conducted on the specimen without

surfacing. The tests are subsequently repeated after application of the surfacing. The specimen is simply supported on the test frame, with pin supports under the PTC beams at one end and roller supports under the beams at the opposite end.

Fabrication of the specimen within the test frame was a challenge. A key issue was the inevitable waviness of the top surface of each PTC beam, as well as the difference in heights between the three PTC beams at any given transverse section through the specimen. Both these points meant that the thickness of the deck-to-beam adhesive layer varied between 5mm and 25mm. Spacers were used as appropriate between the deck and the beams to help ensure that the deck units were as near horizontal as possible in the transverse direction of the specimen. All the preparatory grit-blasting, bonding and general assembling of the bridge specimen were done within the BLADE facility at Bristol. A side view of part of the completed specimen may be seen in Fig. 3, where the vertical actuators supported against the cross member of the test frame are evident.

Fig. 3 Side view of completed specimen.

More detail of the actuators loading the top of the deck via steel plates faced with elastomeric pads can be seen in the left image of Fig. 4. The right image of Fig. 4 shows how the loads within each red – blue pair are programmed to vary in time with respect to each other. The load associated with the red arrow changes (increases or decreases) in the opposite sense to that of the related the blue arrow, such that the total load remains constant. This scenario is meant to approximate movement of a tire load as the tire rolls along the deck. The two arrows of either colour may be considered to represent loads from two wheels on an axle.

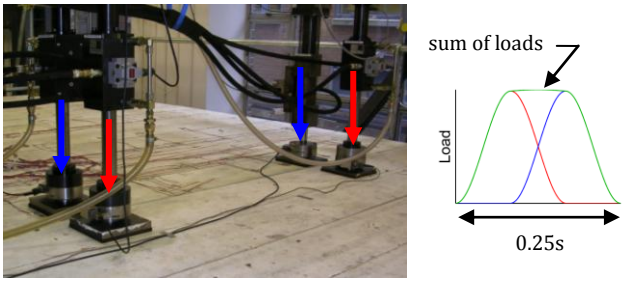

Fig. 4 Anti-phase loads from actuators on top of deck.

The elastomeric pads through which the deck is loaded are 200mm x 200mm square-in-plan. As Fig. 5 illustrates, each pad load has been positioned centrally within the local span of the relevant deck unit's top flange, so as to generate significant local bending effects within the deck, including within the deck-to-deck joints in the immediate vicinity of the load. Thus, the fatigue resilience of the deck-to-deck joints resulting from a combination of global effects in the structure and the more significant, highly localised effects under tire loads, may be assessed. In Fig. 4, the transverse lines representing the tops of the deck-to-deck joints are clearly evident; each red arrow – blue arrow pair of loads are located to either side of the same joint. This permits proper high-cycle fatiguing of the joints in question. The loading system is run continuously at 4 Hz, with a target of up to 10 million cycles.

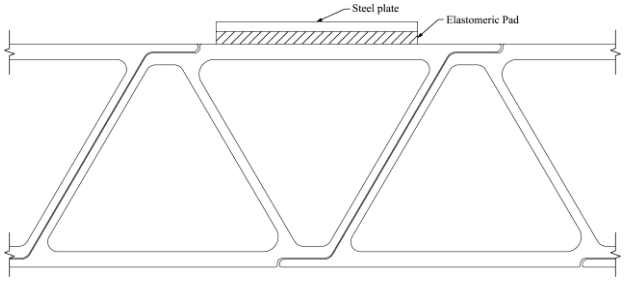

Fig. 5 Location of load to generate high local effects within deck.

The issues under investigation in this project include:

- *Understanding how results from the actuator - pad loading system translate into fatigue resilience under actual tire loads*. The frequency of fatigue loading possible from a tire test facility is low, so the time needed to assess fatigue resilience by applying sufficient tire passes (10 million cycles or above) and the associated costs can be prohibitive. There can also be the issue of fatigue breakdown of a tire loading rig. By contrast, actuators can reliably apply fatigue loads at significant cycling rates over tens of millions of cycles. Thus, particularly for local effects,

if a robust means can be found of converting actuator – based results into design-oriented data for fatigue resilience, then this time-efficient fatigue test method may be recommended in guidance documents. To provide results for comparison, a tire loading rig will soon be installed as an additional feature of the test facility at Bristol. Fig. 6 shows an initial plan for this facility, in which a horizontal actuator pushes and pulls the tire in a setup with roll stability, while lead weights in containers give the fatigue load.

- *Gaining insight into prying effects in the deck-to-beam joints*. Owing to the high torsional stiffness of PTC beams, prying stresses can arise in the bonded deck-to-beam joints when the tire loads on the deck are transversely offset from the lines of the beams. The prying stresses may not lead to immediate failure, but they may in the long term lead to cumulative damage in a fatigue context, which can for example influence the transmission of braking loads between the deck and the supports. Note that although steel I-beams are of low torsional stiffness, prying can also arise near the supports of FRP deck-steel beam bridges due to diaphragms which inhibit rotation of the beams there. Thus, generic results on prying from this project may apply to such bridges also.
- *Developing a framework of ideas on the failure behaviour of this bridge system*. Once all fatigue testing of the specimen is completed, loads will be applied to induce failure of the specimen. Observing the mode(s) of failure and establishing the extent to which computer analysis is able to predict the overall failure behaviour is important.
- *Feeding key outputs from this project into design guidance documentation*. An immediate outlet for these results is BD90, the UK Highways Agency's in-house design guide for bridges incorporating FRPs. Wider initiatives to develop such guidance will also be targeted to ensure use of the outputs by a broad spectrum of practitioners.

This project benefits from a steering group comprising representatives from the UK's Institution of Civil Engineers (ICE) and from bridge owners (the Highways Agency and Network Rail), materials suppliers (Fiberline, Weber, Tarmac), structural design consultants (Mouchel, Tony Gee) and a contractor (Concrete Repairs). The generous supplies of advice, finance and materials to the project from the partners is gratefully acknowledged.

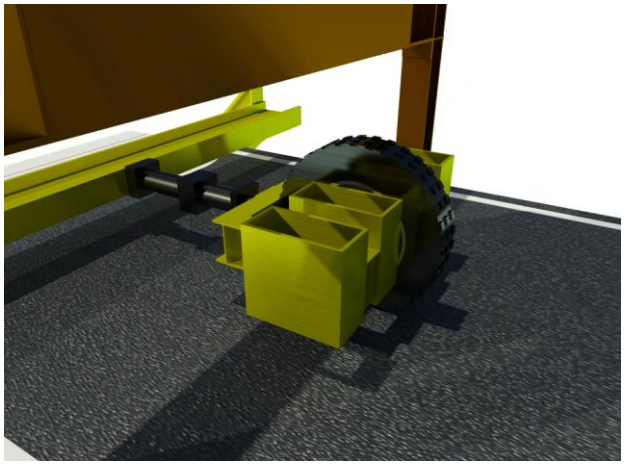

Fig. 6 Proposed Tire Loading Rig.

CICE 2012 Keynote Lectures Announced

The CICE2012 Local Organising Committee is pleased to announce the six keynote lectures planned for CICE 2012 in Rome. In addition to the IIFC Medal winner and the IIFC Distinguished Young Researcher Award winner which were selected by the IIFC Honours Committee, the Local Organising Committee invited four keynote speakers:

Prof. Larry Bank (U.S.A.) (IIFC Medal winner, the IIFC Distinguished Lecture)
Progressive Failure of FRP Composites for Construction

Dr. Laura De Lorenzis (Italy) (IIFC Distinguished Young Researcher Award winner)
Modeling of interfacial debonding in FRP-strengthened structures

Prof. Oral Buyukozturk (U.S.A.)
Durability and long-term performance of FRP-concrete systems

Mr. Carlo Paulotto (Spain)
FRP girder bridges: lessons learned in Spain during the last decade

Prof. Bjorn Taljsten (Sweden)
FRP strengthening of Structures -20 years of experience- bridging academic resarch and industrial needs

Prof. Zhishen Wu (Japan)
Advancement of Structural Safety and Sustainability with Basalt Fiber Reinforced Polymers

www.cice2012.it

This article describes the collaborative development of a new teaching and research facility which will focus on the use and application of FRP materials.

Providing Rose Students with Undergraduate Research Opportunities - Establishing the Structures and Computational Mechanics Laboratory at Rose-Hulman

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In 2009 through a 'Faculty Success Grant' the Civil Engineering (CE) Department of Rose-Hulman Institute of Technology (RHIT) established the Structures and Computational Mechanics (SCM) Lab that worked collaboratively with the Structural Engineering and Mechanics Group (SEM) at the University of Pittsburgh (PITT) for two years. The collaboration efforts focused on the use of FRP in civil infrastructure. External collaboration with PITT helped develop the expertise to ensure the success of the SCM. The SEM Group at PITT is engaged in a wide variety of experimental, analytical and theoretical research. A primary theme of their research is rehabilitation and retrofit of deteriorating bridge and building structures. The PITT collaboration was directed by Dr. Kent A. Harries.


2009: RHIT students Troy Evasage and William Bro working in the Watkins Haggart Laboratory at PITT.


2010: RHIT students Josh Sizemore and Christine Adams working in the Watkins Haggart Laboratory at PITT.


2011: Students Jacob Slifer and Chris Oshlund working in the new SCM Laboratory at RHIT.

The Structures and Computational Mechanics Lab is headed by Dr. John Aidoo who has extensive structural engineering laboratory experience working with FRP composites. Furthermore, to develop a clearer understanding of the FRP-to-concrete interface, an analytical component, using finite element analysis (FEA) tools was used to model the experimental investigation and parametric studies based on the critical bond parameters investigated. This component of the research studies was undertaken by the Mechanical Engineering (ME) department of RHIT and integrated into the SCM. In the ME department, the research was directed by Dr. Richard Onyancha whose research interests include developing predictive models for material property and process characterization using commercially available FEA software for the micro and macro length scales.

The goals of this collaboration were to:

- Create undergraduate research opportunities for RHIT students
- Enhance the SCM laboratory capabilities to undertake undergraduate research projects with industry or government institutions over the long-term
- Establish a long-term funded research collaboration between RHIT and PITT

Summer Research Program at the University of Pittsburgh

In the summers of 2009 and 2010 RHIT undergraduate admitted students worked closely with RHIT and PITT faculty members in the Watkins Haggart Structural Engineering Laboratory at PITT. During this period, the students participated in research projects, trained in the use of structural testing equipment and acquired the knowledge and skills in instrumentation and data acquisition. Additionally, the faculty members involved, as well as their student collaborators, used this opportunity to identify practical ways to set up the SCM lab at RHIT.

In the summer 2009, two research projects were undertaken: 1) Pull-off Test to Assess Bond Quality; and 2) Development of a Test Method to Assess Bond Degradation for Beams Bonded with Fiber Reinforced Polymers (FRP). In the summer 2010, three research projects were undertaken: 1) Experimental Assessment of Bonded FRP-to-Steel Interfaces; 2) The Effect of

Substrate Preparation on Bond Performance; and 3) Investigation of Bonded FRP-to-Steel Interfaces using Finite Element Modeling.

With two years of external collaboration with PITT, the Rose-Hulman faculty members had acquired the expertise to undertake summer research activities at the Structures and Computational Mechanics (SCM) Lab at Rose-Hulman. Additionally, we were able to leverage the external collaboration with PITT to successfully write a National Science Foundation Major Research Instrumentation (MRI) proposal requesting funds to purchase closed-loop structural testing equipment for SCM lab and digital imaging correlation equipment for 3D strain measurement.

In summer 2011, two research projects were undertaken at the SCM Lab: 1) Experimental Assessment of Bonded FRP-to-Timber Interfaces; and 2) Investigation of bonded FRP-to-Timber Interfaces using Finite Element Modeling. The students have presented their summer research at the 8th Annual Interdisciplinary Research Collaborative (IRC) Undergraduate Student Research Symposium at Rose-Hulman.

Impact of Research Activities

Successful implementation of the research activities has benefited RHIT, the CE and ME departments, and the students and faculty members involved. The impacts of the external collaboration with PITT include: 1) Recruitment of RHIT students to graduate school; 2) enhanced quality/marketability of RHIT students for the job market; 3) curricula development; 4) faculty development; and (e) enhanced laboratory capabilities enhancing RHIT's research competitiveness.

Educational Component

Some of the skills developed as part of the 2011 summer project have proved useful in other courses notably ME421 Mechanical Engineering Laboratory. This is an undergraduate senior level course in which the students conceive, design, implement, test and refine a project of their choosing. ME421 is a lab based course where students work in teams of three or four, on independent projects involving design of experiment techniques. Because ME421 is a team based course, peer teaching resulted in skill transfer to the other team members.

As part of the added educational benefit, a graduate student used the empirical data from the 2009 and 2010 summer sessions to create and validate finite element analysis models to investigate the FRP-concrete and FRP-steel bonds in a master's thesis.

In the Civil Engineering department, the skills acquired in the summer projects have been incorporated into some courses: Concrete Design I & II. Additionally, plans are underway to incorporate the summer 2011 project as part of the EM 203-Mechanics of Materials course.

Publications from RHIT-PITT Collaboration

Sizemore, J., Aidoo, J., Harries, K.A. and Monnell, J. (2011). Use of Silane Adhesion Promoter to Enhance FRP-to-Steel Bond Performance, *4th International Conference on Durability & Sustainability of FRP Composites for Construction (CDCC 2011)* Quebec City, July 2011.

Eveslage, T., Aidoo, J., Harries, K.A., and Bro, W. (2010) Effect of Variations in Practice of ASTM D7522 Standard Pull-Off Test for FRP-Concrete Interfaces, *ASTM Journal of Testing and Evaluation* Vol. 38, No. 4. pp 424-430.

Eveslage, T., Aidoo, J., Harries, K.A., and Bro, W. (2010). Towards a Standard Test Method for Assessing FRP-to-Concrete Bond Characteristics, *5th International Conference on FRP Composites in Civil Engineering (CICE 2010)* Beijing, September 2010.

and earlier…

Harries, K.A., Zorn, A. ,Aidoo, J. and Quattlebaum, J., (2006). Deterioration of FRP-to-Concrete Bond Under Fatigue Loading. *Advances in Structural Engineering - Special Issue on Bond Behaviour of FRP in Structures* Vol. 9, No. 6, pp 779-789.

Harries, K.A. and Aidoo, J., 2005. Deterioration of FRP-to-Concrete Bond Under Fatigue Loading. *International Symposium on Bond Behavior of FRP in Structures (BBFS 2005)*, December 2005. pp 561-566.

Harries, K.A. and Aidoo, J. 2006. Debonding- and Fatigue-Related Strain Limits for Externally Bonded FRP, *ASCE Journal of Composites in Construction*, Vol. 9 No. 1 pp 87-90.

Aidoo, J., Harries, K.A. and Petrou, M.F., 2004. Fatigue Behavior of CFRP Strengthened Reinforced Concrete Bridge Girders, *ASCE Journal of Composites in Construction*, Vol. 7 No. 6 pp. 501-518.

Polish Group of IIFC Conference

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The Polish Group of the International Institute for FRP in Construction (PGIIFC) was established in March 2007 at the Faculty of Engineering, Architecture and Environmental Engineering at the Technical University of Lodz , which, since 1998, is the national leader in research on strengthening reinforced concrete structures with composite materials.

PGIIFC official patronage is the Committee of Civil Engineering of the Polish Academy of Sciences. PGIIFC is currently the youngest organization operating under the auspices of KILiW Sciences, created to integrate the scientific and engineering applications in the field of composite materials in infrastructure construction.

The PGIIFC conference was held in Lodz, Poland on October 18, 2011. The objective of the special PGIIFC meeting was to provide a national forum for all concerned with the application of FRP composites in civil engineering and to exchange advances in both research and practice.

Prof. Lawrence Bank (left) and Dr. Renata Kotynia (right) at the PGIIFC Conference.

The PGIIFC was honored by Prof. Lawrence Bank and Dr. Jian-Fei Chen who as invited keynotes lecturers provided two very impressive presentations opening the two main sessions.

The meeting represented a unique opportunity for participants from academia (including Universities of Lodz, Warsaw, Silesian, Wroclaw, Cracow, Gdansk, Lublin, Bialystok), engineers, FRP manufacturers, structure owners, commercial companies (including Sika, S & P Reinforcement, MC-Bauchemie, BBR) and delegates from the national public and industrial institutions to present and exchange views on present and future research.

The PGIIFC conference focused on research and field applications of FRP for construction and rehabilitation of structures. Many examples of interesting building structures and bridges post-tensioned with FRPs were presented.

The conference was divided into two main sessions: I) research and development and II) field applications. A final session was organized in the Laboratory of the Department of Concrete Structures that provided an opportunity for very fruitful discussions among meeting participants in the laboratory hall among the tested RC structures and specimens.

KOMPOZYT-EXPO 2011

The second KOMPOZYT-EXPO trade fair was held in Krakow November 24-25, 2011. The fair gathered almost 130 exhibitors, representing among others the UK, Croatia, China, Germany, Switzerland, Italy and the USA. Krakow's KOMPOZYT-EXPO 2011 was an opportunity to establish contacts, and exchange information and experience from the European FRP markets. In two days, the event was visited by almost 2000 professionals, including many guests from abroad.

Many new products and innovatory solutions were presented at the fair. The best were awarded with original statuettes. The competition committee comprised distinguished scientists, composites specialists and representatives of the media awarded distinctions in a number of different categories:

Machines and equipment for the processing of composite materials:

Phoenix Equipment Polska for the applicator for gelcoats for universal applications and ecological solutions.

Materials and raw materials for the production of composites:

Milar Ltd., the producer SAERTEX, an original solution for the core in sandwich-structured composites.

Krosglass S.A., for the pioneering preparation of glass mats with a fibre of 9 micrometer in diameter.

Baltazar Kompozyty Ltd. for PALAPREG ECO P-55-01, an eco-friendly resin with biocomponents and lower styrene emissions.

Composite materials products:

Technische Universität Dresden Institut Für Leichtbau Und Kunststofftechnik for eTRUST, the comprehensive use of composite materials and the construction of a racing car and the unique technologies used in its construction.

ASCE *Journal of Composites for Construction* Abstracts

The American Society of Civil Engineers (ASCE) Journal of Composites for Construction (JCC) is published with the support of IIFC. As a service to IIFC members and through an agreement with ASCE, *FRP International* will begin indexing ASCE JCC. The ASCE JCC may be found at the following website:

http://ascelibrary.org/cco/

ASCE JCC subscribers and those with institutional access are able to obtain full text versions of all papers. Preview articles are also available at this site. The doi (digital object identifier) number is a unique string assigned to each paper that may be used to search and find the paper online. Papers may be submitted to ASCE JCC through the following link:

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

ASCE Journal of Composites for Construction, Volume 15, No. 5, pp 663-874. September/October 2011.

Flexural Performance of Carbon Fiber-Reinforced Polymer Prestressed Concrete Side-by-Side Box Beam Bridge

Nabil F. Grace, Elin A. Jensen, and Delali K. Noamesi

doi:10.1061/(ASCE)CC.1943-5614.0000207 (9 pages)

Effect of Transverse Reinforcement on the Flexural Behavior of Continuous Concrete Beams Reinforced with FRP

Mostafa El-Mogy, Amr El-Ragaby, and Ehab El-Salakawy

doi:10.1061/(ASCE)CC.1943-5614.0000215 (10 pages)

Evaluation of Flexural Behavior and Serviceability Performance of Concrete Beams Reinforced with FRP Bars

Chakib Kassem, Ahmed Sabry Farghaly, and Brahim Benmokrane

doi:10.1061/(ASCE)CC.1943-5614.0000216 (14 pages)

Seismic Behavior of Concrete Columns Reinforced by Steel-FRP Composite Bars

Ze-Yang Sun, Gang Wu, Zhi-Shen Wu, and Min Zhang

doi:10.1061/(ASCE)CC.1943-5614.0000199 (11 pages)

Flexural Strengthening of RC Beams with Cement-Based Composites

Angelo D'Ambrisi and Francesco Focacci

doi:10.1061/(ASCE)CC.1943-5614.0000218 (14 pages)

Seismic Repair and Strengthening of Lap Splices in RC Columns: Carbon Fiber–Reinforced Polymer versus Steel Confinement

Amer M. ElSouri and Mohamed H. Harajli

doi:10.1061/(ASCE)CC.1943-5614.0000213 (11 pages)

Shear Strengthening of RC Beams with Externally Bonded FRP Composites: Effect of Strip-Width-to-Strip-Spacing Ratio

Amir Mofidi and Omar Chaallal

doi:10.1061/(ASCE)CC.1943-5614.0000219 (11 pages)

Conceptual Model for Prediction of FRP-Concrete Bond Strength under Moisture Cycles

C. Tuakta and O. Büyüköztürk

doi:10.1061/(ASCE)CC.1943-5614.0000210 (14 pages)

Bond Efficiency of EBR and NSM FRP Systems for Strengthening Concrete Members

A. Bilotta, F. Ceroni, M. Di Ludovico, E. Nigro, M. Pecce, and G. Manfredi

doi:10.1061/(ASCE)CC.1943-5614.0000204 (16 pages)

Carbon Fiber Shear Retrofit of Forty-Two-Year-Old AASHTO I-Shaped Girders

David A. Petty, Paul J. Barr, G. Parry Osborn, Marvin W. Halling, and Travis R. Brackus

doi:10.1061/(ASCE)CC.1943-5614.0000208 (9 pages)

Residual Strength of Impact-Damaged CFRP Used to Strengthen Concrete Structures

Joseph E. Kirby and Sarah L. Orton

doi:10.1061/(ASCE)CC.1943-5614.0000205 (8 pages)

Fiber-Reinforced-Cementitious-Composites Plate for Anchoring FRP Sheet on Concrete Member

Qingxu Jin and Christopher K. Y. Leung

doi:10.1061/(ASCE)CC.1943-5614.0000211 (9 pages)

Predicting the Response of FRP-Strengthened Reinforced-Concrete Flexural Members with Nonlinear Evolutive Analysis Models

Antonio R. Marí, Eva Oller, and Jesús M. Bairán

doi:10.1061/(ASCE)CC.1943-5614.0000214 (11 pages)

Diagonal Compression Testing of FRP-Retrofitted Unreinforced Clay Brick Masonry Wallettes

Hamid Mahmood and Jason M. Ingham

doi:10.1061/(ASCE)CC.1943-5614.0000209 (11 pages)

Nonlinear Behavior of a Masonry Subassemblage Before and After Strengthening with Inorganic Matrix-Grid Composites

F. Parisi, G. P. Lignola, N. Augenti, A. Prota, and G. Manfredi

doi:10.1061/(ASCE)CC.1943-5614.0000203 (12 pages)

Contribution to Shear Wrinkling of GFRP Webs in Cell-Core Sandwiches

Behzad D. Manshadi, Anastasios P. Vassilopoulos, Julia de Castro, and Thomas Keller

doi:10.1061/(ASCE)CC.1943-5614.0000212 (8 pages)

Combined Shear and Flexural Behavior of Hybrid FRP-Concrete Beams Previously Subjected to Cyclic Loading

Yilei Shi, Bin Li, and Amir Mirmiran

doi:10.1061/(ASCE)CC.1943-5614.0000202 (9 pages)

FRP-Confined Circular Concrete-Filled Thin Steel Tubes under Axial Compression

Y. M. Hu, T. Yu, and J. G. Teng

doi:10.1061/(ASCE)CC.1943-5614.0000217 (11 pages)

Performance of Glued-Laminated Timbers with FRP Shear and Flexural Reinforcement

T. Russell Gentry

doi:10.1061/(ASCE)CC.1943-5614.0000206 (10 pages)

Analytical Model for CFRP-Strengthened Prestressed Concrete Girders Subject to Cyclic Loading

Ronaldson J. de F. M. Carneiro and Guilherme S. S. de A. Melo

doi:10.1061/(ASCE)CC.1943-5614.0000201 (4 pages)

Did You Know?

IIFC Members receive the ASCE member's subscription rate for the *ASCE Journal of Composites for Construction*. Internationally, *JCC* is available in print ($178/yr), online ($135), or both ($198). Print rates are $30 less in the United States. To subscribe: www.asce.org.

Upcoming Conferences and Meetings

APFIS 2012 ***Third Asia-Pacific Conference on FRP in Structures,*** February 2-5, 2012, Sapporo, Japan. www.eng.hokudai.ac.jp/labo/maintenance/APFIS2012

JEC Europe Composites Show and Conference, March 27-29, 2012, Paris. www.jeccomposites.com/events/jec-europe-2012

IIFC Photo Competition, January 1 - March 31, 2012, see announcement in this newsletter. www.iifc-hq.org.

Photos must be submitted by March 31, 2012

ACMBS-VI ***Advanced Composite Materials in Bridges and Structures***, May 22-25, 2012, Kingston, Canada. www.acmbs2012.ca.

CICE 2012 ***6th International Conference on FRP Composites in Civil Engineering***, June 13-15, 2012, Rome, Italy. www.cice2012.it

Early Registration Before: January 31, 2012

JEC Asia Composites Show and Conference, June 26-28, 2012, Singapore. www.jeccomposites.com/events/jec-asia-2012

4th International Symposium on Bond in Concrete 2012, June 17-20, 2012, Brescia, Italy. www.bondinconcrete2012.org

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JEC Americas Composites Show and Conference, November 7-9, 2012, Boston. www.jeccomposites.com/events/jec-americas-2012

Performance-based and Life-cycle Structural Engineering Conference in Hong Kong (PLSE 2012), December 5-7, 2012, Hong Kong, China. www.polyu.edu.hk/fce/PLSE2012.

Abstracts due: January 15, 2012

11th International Research Symposium on Fiber Reinforced Polymer for Reinforced Concrete Structures (FRPRCS-11), June 26-28, 2013, Guimarães City, Portugal. www.frprcs11.uminho.pt

Abstracts due: March 31, 2012

Second Conference on Smart Monitoring, Assessment and Rehabilitation of Civil Structures, September 9-11, 2013, Istanbul, Turkey. www.smar-2013.org

Abstracts due: June 30, 2012

APFIS 2013 ***Fourth Asia-Pacific Conference on FRP in Structures,*** December 2013, Melbourne Australia.

CICE 2014 ***7th International Conference on FRP Composites in Civil Engineering***, August 2014, Vancouver, Canada.

International Institute for FRP in Construction

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By submitting this application you agree to share your contact information with fellow IIFC members and any conference/organization associated with IIFC.

FRP INTERNATIONAL

the official newsletter of the International Institute for FRP in Construction

Advanced Composites in Construction 2011

The fifth Conference on Advanced Composites in Construction (ACIC 2011) was held at Warwick University, UK, on 6-8 September 2011. The ACIC conferences are attended by representatives from both academia and industry around the world and the papers focus on research and application of FRP composites to the built environment. The 80 delegates in attendance enjoyed high quality research presented from four keynote and 37 general session presentations. The conference also featured a Young Researchers' Competition which consisted of a Poster session as well as a five minute presentation per applicant. The ACIC 2011 proceedings are available from NetComposites at www.netcomposites.com/Default.asp, and the sixth installment of the ACIC series will be hosted by Queen's University Belfast in September 2013.

Jian Fei Chen (U. of Edinburgh), Wendel Sebastian (Bristol U.), Mina Dawood (U. of Houston), Toby Mottram (Warwick U. and chair of ACIC 2011), and Scott Smith (University of Hong Kong) at ACIC 2011.