FRP
Fiber Reinforced Plastics
International
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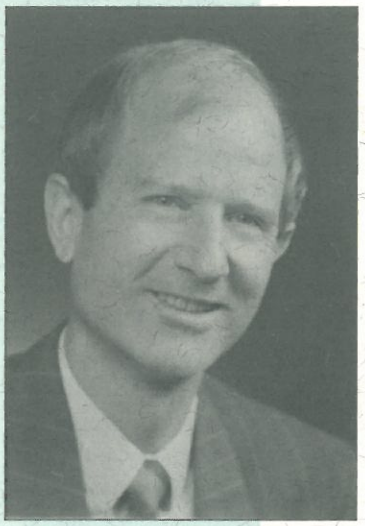
Guest Author Dr. Urs Meier

Restoration of a Historic Wooden Bridge with CFRP



Dr. Urs Meier
Swiss Federal Laboratories for Materials Testing and Research
CH 8600, Dubendorf
Zurich, Switzerland

Dr. Meier has been an outstanding world recognized researcher in the field of advanced fibre reinforced plastic material for the last 20 years. One of his recent achievements was the use of carbon fibre reinforced plastics in restoration of a historic two span wood bridge, in Sins, Switzerland. Built in 1807 to cross the Reuss River, each span is 30.8 meters, as shown in Figure (1). The bridge span on the Cham side was blown up on November 10, 1847, during the civil war and rebuilt in 1852 with a modified structural system different from the Sins side, as shown in Figure (2). The bridge was originally dimensioned for horse-drawn vehicles; today, vehicles with a load of 20 tons are permitted.

In 1992, rehabilitation of the bridge consisted of replacing the old wooden pavement with 200 mm thick bonded wooden planks pretensioned transversely.

The cross girders were strengthened using carbon fibre reinforced epoxy resin sheets. Each of these cross girders was constructed of two solid oak beams placed on top of each other as shown in Figure (3). To increase the depth, wooden blocks were originally inserted between the two beams as shown in the same figure. The two different types of CFRP sheets used are given in Table 1.

Figure 1. Historic wooden bridge of Sins/Switzerland

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• Composite Institute • Japan Concrete Institute •

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The wood surfaces of the girder were planed before the installation and bonding of the CFRP sheet to the girder as shown in Figure (4). Use of these techniques provided an excellent solution since CFRP sheets are extremely thin, high in stiffness and strength, and do not alter the original design of the structure. The CFRP could also be covered by thin layers of original wood. This project introduced practical experience and confidence in the use of this technique to preserve historical wooden bridges and structures.

PROPERTIES OF CFRP SHEETS

Property	Type 1	Type 2
Fiber type	T 700	M 46 J
Fiber volume fraction (%)	66	70
Longitudinal strength (MPa)	2300	2600
Longitudinal Young's modulus (GPa)	152	305
Strain at failure (%)	1.51	0.85

Table 1

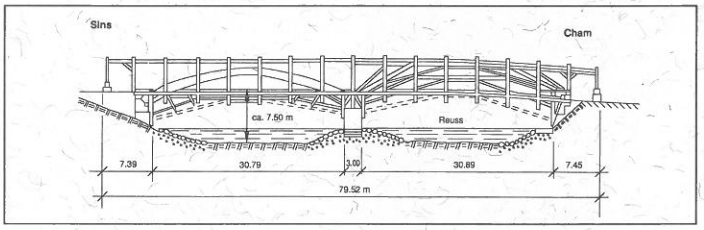

Figure 2. Longitudinal section of the bridge.

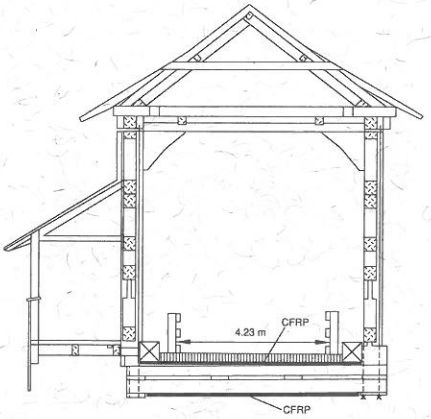

Figure 3. Cross section of the bridge.

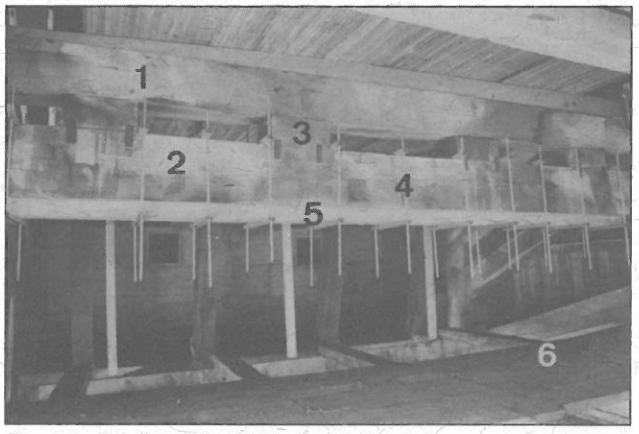

Figure 4. Bonding of the CFRP sheet to the girder
**1 upper oak beam (30 cm x 30 cm)*
**2 lower oak beam (37 cm x 30 cm)*
**3 spacer block*
**4 tension rod*
**5 wooden plank to press the CFRP sheet to the girder*
**6 platform for workers*

Canadian Network

The first meeting of the Canadian Network for Advanced Composite Materials in Bridges and Structures Network (ACMBSN) was held in Toronto, February 6, 1993, under the chairmanship of Dr. A.A. Mufti. The objectives of the ACMBSN are to:

i. identify products needed for the use of advanced composite materials in bridges and structures;
ii. assist in forming industrial alliances to develop these products where they do not already exist;
iii. provide Research and Development advice and consulting services to the alliance members; and
iv. assist in organizing conferences, newsletters and other information exchanges.

The ACMBSN is partially supported through the Advanced Industrial Materials Networks component of the Technology Outreach Program (TOP-AIM) which is administered by Industry, Science and Technology Canada. TOP-AIM is designed to support non-profit, private sector national networks of university scientists, engineers and industrialists. Such networks are intended to foster a new approach to developing technologies.

For information, contact Dr. A.A. Mufti, N.S. CAD/CAM Centre, Technical University of Nova Scotia, P.O.Box 1000, Halifax, Nova Scotia, Canada B3J 2X4, Tel: (902) 420-7763 FAX: (902) 422-8380.

Editor's Message

On behalf of the editors of FRP International, I would like to express my appreciation for the overwhelming number of letters of support and the encouragement received in response to the first issue of FRP International. We are also delighted and very proud to announce that the Composites Institute (CI) of the Society of the Plastics Industry Inc., (SPI) has joined us for the technical and financial responsibility of FRP International. CI is the world's largest organization devoted to reinforced plastics/composites with nearly 500 member organizations and sponsorships. CI has recently focused its effort on the development of new markets for composites in Civil Engineering structural applications, specifically in the areas of marine/waterfront/offshore structures and use of composites for reinforced concrete construction. We are delighted to have them on board.

- Sami Rizkalla

Conferences and Meetings

International Symposium on FRP

The International Symposium on FRP Reinforcement for Concrete Structures was held in conjunction with the ACI Spring Convention in Vancouver, Canada, March 29-31, 1993. The symposium addressed all aspects related to the use of FRP for concrete structures. Six sessions were presented and covered materials, reinforced concrete, prestressed concrete, analysis/design, Japan's National Project, and field applications. The 40 papers presented, in addition to the 16 papers accepted, will be published by the ACI in a proceedings volume tentatively scheduled for release in the summer of 1993. For more information, contact ACI. Tel: (313) 532-2600 FAX: (313) 533-4747.

ACI Committee 440 - FRP Reinforcement

ACI Committee 440 met on Monday, March 29, 1993, in the Balmoral Room of the Hyatt Regency, Vancouver, Canada. The Committee is currently preparing a state-of-the-art report on the use of FRP in Concrete Structures. Technical information may be forwarded to Prof. Mohammad Ehsani. Tel: (602) 621-6589 FAX: (602) 621-2550 E-mail: EHSANI@CCIT.ARIZONA.EDU

CI Constructions Sessions

The Composites Institute (CI) sponsored construction sessions in conjunction with the 48th Annual Conference and Expo '93, held in Cincinnati, Ohio, February 1993. On Wednesday, February 10, CI sponsored a session on "Opportunities for Composites in Reinforced Concrete Construction", which featured a panel of experts offering information about composite products in reinforced concrete construction. The need for team work, industry initiatives, knowledge of total structural behaviour and industrial standards were emphasized as the important factors and will influence the use of composites in Civil Engineering construction. The work by the U.S. Army Corps of Engineers on carbon fibre/epoxy and glass fibre/epoxy tendons for prestressing concrete columns and beams was presented.

On Thursday, February 11, CI sponsored the session on "Understanding and Doing Business in the Construction Industry". The session included discussion on the potential of composition in the construction, and the obstacles and resources associated with successful market development. The U.S. Army Corps of Engineers presented their five-step program to support construction technology. Further discussion included commercial issues such as working with specifiers and contractors, and the importance of long-term commitment to the industry.

Other construction-related sessions at the conference featured the following presentations:

- Opportunities in the U.S. Marine/Water-Front/Inland Waterway/Offshore Market
- Ultimate strength characteristics of an FRP/Kevlar cable structural system
- Test results of Fasteners for structural Fibreglass composites
- Construction of an Advanced Composite Bridge in the USA
- Performance of Pultruded PFRP Frame connections under static and dynamic loads
- Pultruded FRP Grating as a Reinforcement for Concrete
- Pultruded cable in the channel tunnel and other enclosed situations
- A Universal Design Equation for FRP Columns
- Fatigue behaviour of glass fibre vinyl ester beams
- Fabrication and compressive properties of Braided CFRP truss joint

Copies of CI's 48th Annual conference proceedings book are available from SPI literature sales, Tel: (202) 371-5200. Ask for Catalog #AF-195.

FIP Symposium in Japan

The Fédération Internationale de la Précontrainte, FIP, symposium on "Modern Prestressing Techniques and Their Applications" will be held October 17-20, 1993, at Kyoto International Conference Hall, Kyoto, Japan. The technical program will consist of keynote lectures and eight topics. A total of 7 presentations, 16 papers and posters will be devoted to the topic of "Utilization of New Materials and New Systems in Prestressed Concrete". For further information about the symposium, please contact The Secretariat, 1993 Symposium, Japan Prestressed Concrete Engineering Association, Tsukudo-cho 4-6, Shinjuku-ku, Tokyo, 162 Japan, FAX: (03)3235-3370.

Application of FRP in Structural Engineering

An International Symposium on "The Application of Fibre Reinforced Plastics (FRP) in Civil Structural Engineering" will be held in Bologna, Italy, on October 22, 1993. The program, organized by *Istituto Scienza delle Costruzioni*, University Bologna, will cover the following topics:

- State of the Art Report on FRP
- Concrete reinforcement with FRP and industrial perspective
- Performance of structural elements reinforced with advanced composites
- Reinforcement of concrete structures with composite plates
- Reinforcement of concrete structures with FRP bars and cables

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The invited speakers are Urs Meier (EMPA), T. Uomoto (Japan), R.N. Swamy (Sheffield), A. Credali (Milano), A. Nanni (USA), and A. Ditommaso (Bologna). Abstracts of 400 words are due immediately. Authors will be notified of acceptance by May 30, 1993. Final manuscripts will be required by September 1, 1993. For correspondence please contact: Dr. Marco ARDUINI, Istituto Scienza delle Costruzioni - University Bologna Via Ie Risorgimento, 2., 40136 BOLOGNA, ITALY. FAX: (3951) 644-3495

First International Conference on Composites Engineering

The First International Conference on Composites Engineering (ICCE/1) will be held on August 29-September 1, 1994, in New Orleans. The goals of the conference are:

1. To bridge the gap between mechanics and materials science aspects of composites;
2. To encourage interactions between basic and applied research groups in composites;
3. To assess the state of the art in the modelling and analysis of modern composite structures.

The following sessions related to Civil Engineering will be highlighted in the ICCE/1 conference:

- buckling, vibration, damping of composite materials structures
- civil and marine engineering applications
- design and analysis of composite structures
- finite element or numerical analysis, 3-D FEM, boundary element method
- fracture, fatigue strength and damage of composites
- mechanics of composite materials plates and shells
- smart structures and smart materials made of composites
- static and dynamic material characterization
- thick composites, failure criteria, constitutive modelling

If you are interested, please submit immediately a two-page abstract and a very brief vitae (c.v.) to the ICCE/1 conference to: Professor David Hui, University of New Orleans, Department of Mechanical Engineering, New Orleans, LA 70148. Tel: (504) 286-6192 FAX: (504) 286-7413, E-mail: DXHME@UNC.EDU. If you are interested in organizing a session, please contact Dr. D. Hui.

New Products

New LeadLine Line-up

Mitsubishi Kasei Corporation has developed two types of new LEADLINE, Carbon Fiber Reinforced Plastic Rod, 8 mm and 12 mm diameter, and LEADLINE Bars and Stirrups, as shown in Figure (10). The bars will be used for reinforced and prestressed concrete structures. The company also produces LEADLINE I-Beam, structural members to be used for buildings and structures, as shown in Figure (11). This wide range of LEADLINE products meets the various needs of architectural and civil engineering applications. For further information, contact Mr. Tokitaro Hoshijima, CF & ACM Division, Mitsubishi Kasei Corp. 5-2, Marunouchi 2-chome, Chiyoda-ku, Tokyo 100, JAPAN Tel: (03) 3283-6838 FAX: (03) 3283-6825

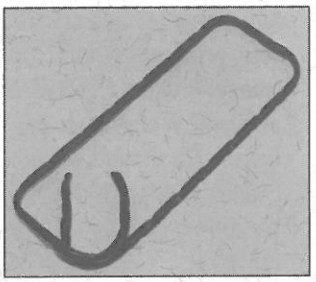

Figure 10. LeadLine Stirrups by Mitsubishi Kasei

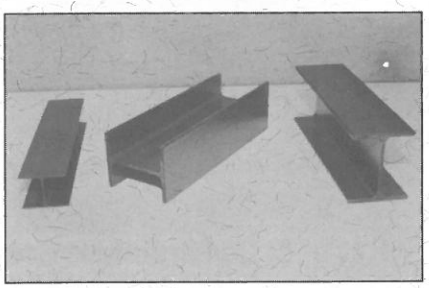

Figure 11. LeadLine Structural members by Mitsubishi Kasei

Codes and Design Criteria

New JSCE Committee on FRP

The Japanese Society of Civil Engineers established a new committee of FRP in December 1992. The objectives of the committee are to establish design and construction codes and the appropriate testing methods for concrete members using Continuous Fiber Reinforced Materials (CFRM). The planned working period of the committee is three years.

FRP Research

Full Scale Test Using FRP for Retrofit of PC Beams

Sho-Bond Corporation and Fuji P.S. Corporation, supervised by Dr. K. Maruyama of Nagaoka Technical University and Dr. H. Mutsuyoshi of Saitama University, carried out full scale tests on damaged Prestressed Concrete beams strengthened by external cables, as shown in Figure (5). The cables used are heavy-duty, anti-corrosion prestressing steel, CFCC, and FiBRA Parafil rope. It was confirmed that external FRP cables can be applied to retrofit old RC and PC bridges. For further information, please contact Sho-Bond Corporation, FAX: (03)3292-8154.

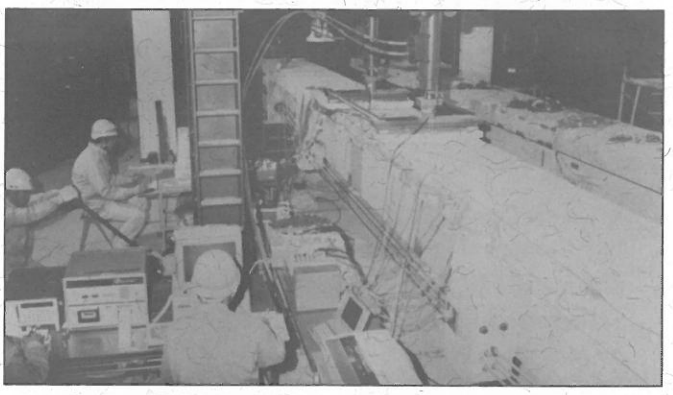

Figure 5. Full scale test using external prestressing

Canadian Research on NEFMAC and ISOROD

The Institute for Research in Construction at the National Research Council and Public Works Canada are jointly conducting tests on fiber reinforced concrete and FRP reinforcements. With financial support from Shimizu Corporation of Japan, Autocon Equipment Incorporated of Ontario, and the Industrial Research Assistance Program of Canada, one type of FRP reinforcement under evaluation in the study is the proprietary FRP grid, NEFMAC (Shimizu Corporation, 1991). NEFMAC can be used to reinforce highway bridge decks, barrier walls, and parking garage slabs. Tensile strength and stiffness, endurance limits for a number of cyclic loading ranges, and creep under various levels of load sustained for 10,000 hours are being determined. Tests are also in progress to evaluate the effect of ambient temperature, cyclic and sustained loads, and exposure to salt and alkali, freeze-thaw cycles, and UV radiation on the grid's strength. Two types of glass FRP rods, one of which is ISOROD (Pultrall, 1992), are being tested to determine their fatigue strength and durability. For further information contact D.A. Taylor, Institute for Research in Construction, National Research Council of Canada, Ottawa, K1A 0R6.

Private Association for FRP in Japan

A private association for the use of FRP in reinforced concrete civil structures and building was founded in Japan. The "Association of Composite Materials Using Continuous Fiber for Concrete Reinforcement", known as "CCC Association" was founded in 1988 with an aim that continuous fiber reinforced plastics (FRP) reinforced concrete would soon be applied to civil structures and buildings.

CCC Association is actively working to achieve the following objectives:

1. Consignment research with other organizations;
2. Participation in related projects, and;
3. Collection and exchange of information on FRP, concrete structures reinforced with FRP.

The researchers of the CCC Association are working on the design methods and the performance of Continuous Fiber Reinforced Concrete (FRC). The committee reports to the Japan Society of Civil Engineers (JSCE) and the Architectural Institute of Japan (AIJ) in cooperation with Building Research Institute Ministry of Construction. The results of this research have been published world-wide.

For more information, please contact Sadao Kurihara, Secretariat of CCC Association, The Japan Reinforced Plastics Society, 3-15-15, Ginza, Chuo-ku, Tokyo, 104. Tel: (03) 3543-1531 , FAX: (03) 3543-1536.

Non-Metallic PC Beams

Dr. H. Mutsuyoshi at Saitama University and Hazama Corporation, Japan, have recently developed Prestressed Concrete beams reinforced entirely with FRP, as shown in Figure (6). The materials used are Parafil ropes as external cables and CFCC as shear and longitudinal reinforcements. Non-metallic PC beams show almost the same behaviour as those reinforced with ordinary steel and tendons. For further information, please contact Dr. H. Mutsuyoshi, Saitama University, Urawa Japan, FAX: (048) 855-9361, or Mr. T. Kita, Hazama Corporation, Technical Research Institute, Tsukuba, Ibaraki, Japan, FAX: (0298)58-8829.

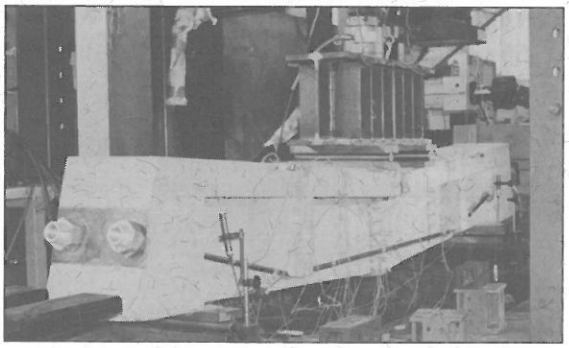

Figure 6. Non-Metallic PC Beam

New Publications

M.Sc. and Ph.D. Theses

FRP International intends to publish a list of completed M.Sc. and Ph.D. theses related to the use of advanced fiber reinforced plastic material for Civil Engineering applications. Please send information to the Editor or any of the Associate Editors. The following are some of the theses completed in 1992-93:

- Alrik L. Svenson, *Impact Characteristics of Glass Fiber Reinforced Composite Materials for Use in Roadside Safety Barriers*, MS Thesis, Department of Civil Engineering, The Catholic University of America, 1993.
- Rosner, C. N. *Single-bolted Connections for Orthotropic Fibre-Reinforced Composite Structural Members*, The University of Manitoba, Winnipeg, Manitoba, Canada R3T 2N2, 1992.
- Zuhan, Xi, *A Study of Full-Size Pultruded Grating Reinforced Concrete Bridge Deck Slabs*, MS Thesis, Department of Civil Engineering, The Catholic University of America, 1992.

FRP Research in Japan

The following papers have been published in the Proceedings of Japan Concrete Institute, Vol. 14, 1992. Nos. 6, 14, 19, 21 and 22. A total of 22 papers are published in English in the Transactions of JCI, Vol. 14. Copies can be purchased through JCI, Room 708, Shuwa-Kioicho TBR Bldg. No. 7, Kojimachi 5-chome, Chiyoda-ku, Tokyo 102, Japan, FAX: (81) 3-3263-2115:

• Trial Manufacture of Large Diameter Carbon Fiber, Rough Mesh Net by Hiroaki TSURUTA, Yoshifumi SAKAMOTO, Tatsunori MAKIZUMI and Shinichiro OKADA

• Development of a Thin Permanent Form Reinforced by Aramid Fiber Mesh by Koichiro TANAKA, Sadatoshi OHNO, Masanao NISHIYAMA and Junichi IDA

• Behaviour of Beam-Interior Column Joint using Continuous Fiber Bars in Beam by Mamoru YAMADA, Kouzou KIMURA and Yoshirou KOBATAKE

• Bond Performance of concrete Members Reinforced with FRP Bars by Yasuhisa SONOBE, Masami FUJISAWA, Toshiyuki KANAKUBO and Keisuke YONEMARU

• Effect of the Stiffness of Reinforcement on Punching Shear Strength of FRP Reinforced Concrete Slabs by Yasuhiko SATO, Yoshihiro TAKAHASHI, Tamon UEDA and Yoshio KAKUTA

• Compressive Properties of Concrete members Reinforced with FRP as Transverse Reinforcement by Ryoji HOSOI, Hiroshi MUTSUYOSHI, Hirofumi TANIGUCHI and Tatsuo KITA

• Nonlinear Dynamic Analysis and Evaluation of Impact Resistance for FRP Reinforced Concrete Slabs by Ayaho MIYAMOTO, Michael W. KING, Teruhisa ISHIBASHI and Masafumi MITO

• Application of PPC Beams Reinforced with Braided Aramid Fiber Rods to a Base Isolated Housing by Tadashi OKAMOTO, Sumiyuki MATSUBARA Masaharu TANIGAKI and Koichi HASUO

• Absorbing Capacity of Proto-Type Cushion System using Concrete slab Reinforced with Braided AFRP Rods by Norimitsu KISHI, Osamu NAKANO, Hiroshi MIKAMI and Ken-ichi MATSUOKA

• Experimental Study on Impact Resistance of RC Slab Reinforced with Braided AFRP Rods by Hiroshi MIKAMI, Masatoshi KATO, Tomio TAMURA and Norimitsu KISHI

• Bending Fatigue Behaviours of Prestressed Concrete Beams using Aramid-Fiber Tendons by Kaoru IWAMOTO, Yasuo UCHITA, Nobuaki TAKAGI and Takayuki KOJIMA

• Flexural Capacity and Failure Type of PC Beam with FRP Tendon by Yukikazu TSUJI, Tomoko ISHIDA, Chikanori HASHIMOTO and Masanori MARUOKA

• Mechanical Properties of Composite Beams with FRP by Masazumi SIKAMORI, Osamu KIYOMIYA, Masao YAMADA and Eiji SUEOKA

• Experimental Study on Shear Failure of Concrete Slabs Reinforced with Grid-Shaped FRP Bars by Yoshihiro TAKAHASHI, Yoshio KAKUTA and Yasuhiko SATO

• An Experimental Study on Toughness of Concrete Beams Reinforced by Carbon FRP Bars by Sadatoshi OHNO, Tadahiro KAKIZAWA, Takashi IWASHIMIZU and Tadaki NAKAI

• Property of RC Structure Reinforced with Sheet type Carbon Fibre by Kimitaka UJI, Kazunao YOKOTA and Shoji IKEDA

• Shear Behaviour of Concrete Beam Reinforced by CFRP Rods by Toshihiko KOBAYASHI, Kyuichi MARUYAMA, Keiji SHIMUZU and Shouzou KANEKURA

• Flexural Crack Behaviour of Concrete Beams Reinforced by Multi-Layered CFRP Rods by Yasuyuki YAMAMOTO, Kyuichi Maruyama, Keiji SHIMIZU and Masahiko OHTAKA

• Applicability of Shear Strength Aquation of RC Beam for Reinforced Concrete Beams with FRP Rods by Katsunori YOKOI, Hiroshi SHIMA, and Hiroyuki MIZUGUCHI

• Shear Behaviour of Spiral Deformed FRP Rods as Web Reinforcement in Concrete Beams by Tetsuya HIRONAKA, Seiichi TSUJI, Fumio SHIRAISHI and Hajime HAMADA

• Influences of Short Cut Glass Fiber Usage on Tensile Behaviour of Mortar Plates Reinforced with Continuous

(continuned on page 8)

Completed Composite Structures

Longest Fiberglass Bridge in the USA

Devil's Pool in Fairmount Park, Philadelphia, PA, is the site of North America's longest fibreglass pedestrian bridge. The 50 ft. span bridge, shown in Figure (7), is a replacement for a wooden structure that was damaged by a summer storm. The FRP beams were manufactured by Creative Pultrusions Inc. and designed by E. T. Techtronics. The project design provided an innovative blend of structural engineering and environmental design which resulted in significant cost savings. The cost of the project, including foundation work, was approximately $25,000 US, and the total weight of the bridge is estimated at 2500 pounds. Estimates for other conventional steel and concrete designs ranged up to $100,000 US. The design also minimized the impact on the environment during the construction and provided low maintenance and a natural look for the park. For more information, contact CP Inc., Pleasantville Industrial Park, P.O. Box 6, Alum Bank, PA 15521 USA. Contact person: Ms. K. Bakale Tel: (814) 839-4186.

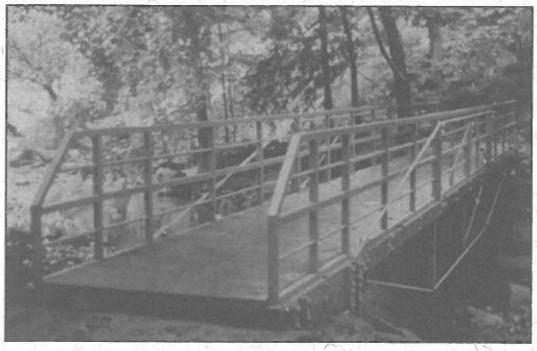

Figure 7. 50 ft. fiberglass pedestrian bridge in Philadelphia

CFCC for Prestressed Concrete Bridges in Japan

Three prestressed concrete bicycle bridges were constructed in the Noto peninsula, Ishikawa prefecture in Japan, using carbon-fiber composite cables (CFCC). Prestressed concrete bridges in this region are typically exposed to severe damage due to the surrounding sea wind environment. CFCC were used as tendons and stirrups of the three pre-tensioned prestressed concrete bridges, due to their high resistance to corrosion.

The three bridges were constructed by P.S. Corporation; their structural system and geometrical dimensions are given in the Table below. One of the bridges, the 15th bridge, is shown in Figure (8).

Name	Type	Span (m)	Effective Width (m)	Completion
15th Bridge	hollow slab	10.000	3.500	Mar. 1991
Kanta-Bashi Bridge	slab	7.000	3.500	Mar. 1992
Hishinegawa-Bashi Bridge	slab	10.000	3.500	Nov. 1992

Figure 8. 15th bicycle bridge in Japan

ISOROD for Highway Bridge in Canada

In Montréal, Québec, the Ministry of Transportation of Québec has reinforced a 100 m length of barrier wall (New Jersey type) on a highway bridge with glass FRP reinforcement. The bridge is part of Highway 15, crossing the Prairies River (Rivière des Prairies). The reinforcements were produced by Pultrall Incorporated in Thedford Mines, Québec. The long-term durability of the structure is being monitored, and the results will determine the future uses of FRP by the Ministry.

For further information, contact Mr. Gilles Giasson, Services des ouvrages d'art de la Direction des structures, Ministère des Transports, 200 Dorchester Sud, Québec, QC G1K 5Z1, Tel: (418) 644-3218.

Repair of Concrete Parking Structure

Public Works Canada is conducting field investigations in Hull, Québec, where a parking garage structure underwent repair work using fiber reinforced concrete and FRP bars in four soffit repair areas. The repaired areas were instrumented, and a data-logger is being used to monitor the behaviour under service loads and loads induced by the test load. The objective is to collect data on the performance of the conventional repair versus the FRP bars, and a comparison of the load sharing characteristics of the existing reinforcements with the replacement reinforcements.

Glass fiber reinforced plastic bars, ISOROD, produced in Canada, were used in this project. The electric resistance stain gauges used to instrument the steel and the ISOROD reinforcements are shown in Figure (9). For further information contact M.S. Cheung, Manager, Research Development & Demonstration, Architectural and Engineering Services, Public Works Canada, Ottawa, Ontario, K1A 0M2.

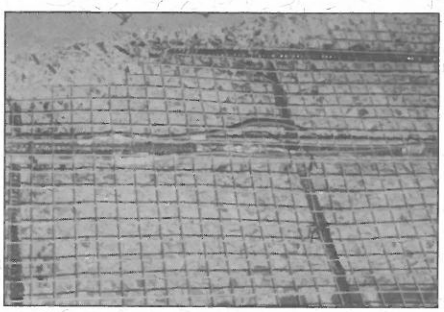

Figure 9. Repair of Parking Structure in Canada

Workshops

Canada-Japan Workshop

With support from the Japan Science and Technology Fund (JSTF) the Nova Scotia CAD/CAM Centre in Halifax is organizing a Canada-Japan Workshop, July 28-30, 1993, in Ottawa, Canada. The objectives of the workshop are to define research and business areas for enhanced science and technology in the use of advanced composite materials in bridges and structures,and to foster cooperation between Canadian and Japanese universities, public and industrial organizations, and practicing engineers. The JSTF, initiated in 1989, is a five year $25 million Cdn. fund to promote joint scientific and technological research and development, and to help create strategic partnerships in sectors of Canadian priority. It is managed jointly by External Affairs and International Trade Canada, Industry, Science and Technology Canada, and the Natural Sciences and Engineering Research Council of Canada. The JSFT funds research visits, research exchanges, bilateral research and development projects.

For information about the JSTF, contact External Affairs and International Trade Canada, North Asia Relations Division (PNR), JSTF, 125 Sussex Drive, Ottawa, Ontario, Canada K1A 0G2, Tel: (613) 996-0980 , FAX: (613) 943-8167.

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Fibers by K. FUKUZAWA, H. NOZAKI, K. TANAKA, and K. HORIGUCHI

- Improving Shear Capacity of Existing Reinforced Concrete Members by Applying Carbon Fiber Sheets by K. UJI

"Research and Applications of Fiber-Reinforced Plastic Reinforcement in Concrete"

The Corps of Engineers held a workshop on "Research and Applications of Fiber-Reinforced Plastic Reinforcement in Concrete" at the Bevel Centre of the Huntsville Division of the Corps in Huntsville, AL, on March 2-3, 1993.

The Corps of Engineers, along with the Department of Transportation (DOT), the Department of Energy, and the Environmental Protection Agency (EPA) have been tasked with overseeing the development of a high-speed magnetically levitated and propelled transportation system (MAGLEV). Within this system, the Corps and the DOT will be supervising development of the guideway for the MAGLEV system. Part of this work involves research on fiber-reinforced plastic (FRP) in areas of the guideway where magnetic forces are high. As such, the Corps will soon be initiating a research program on the use of FRP in the guideways of the MAGLEV system.

The purpose of the workshop was to bring together the people who are conducting research on FRP with the Corps/DOT MAGLEV community to evaluate the potential use of FRP in the MAGLEV program. It will also be used as means to formulate the Corps research program so as to involve private sector participation.

Faculty of Engineering
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To:_____