INNOVATOR
NEWSLETTER OF ISIS CANADA February 2002
The Canadian Network of Centres of Excellence on Intelligent Sensing for Innovative Structures

Golden Example of How Partnerships are Generated
ISIS Examines Golden Boy

The Rehabilitation Challenge:
a remote and awkward location
(1,650 kilos tiptoed atop a dome)
and
preserving historically significant elements

CP Picture Archive (Adrian Wyld)

The first step in studying options was to mark the statue with reflective tape that was used to record coordinates for 3-D modelling.

Partnerships are the lifeblood of technology utilization and they clearly play an important role in ISIS Canada's diverse range of demonstration projects. Less clear is the process of becoming a partner. For example, how does a plan to regild the gold leaf on Manitoba's Golden Boy lead to an ISIS proposal to outfit the 1,650 kilogram icon with fibre optic sensors for remote monitoring.

The original plan was simply to get the Boy looking gold. However, when the province's engineering consultant, Dillon Consulting, noted major corrosion on the support post, the project turned into a structural issue. The remote location of the 5.25-metre Golden Boy atop the Manitoba Legislative Building and the issue of corrosion made it seem a possible candidate for rehabilitation using fibre reinforced polymers (FRPs).

Dillon's engineers, Mr. Bob Wiebe and Mr. Sital Rihal were aware of ISIS Canada's expertise in using FRPs for rehabilitation in civil engineering structures. However, it was the Minister of Transportation and Government Services, Mr. Steve Ashton, who early in the process suggested contacting ISIS Canada.

Since 1919 the Golden Boy has been held in place by a central 5" diameter steel rod from the waist down through the leg and ankle, to the ball of the foot and further into a cast iron clamp assembly below the sculpture. Endoscopic examination of the interior reveals corrosion is taking place at varying degrees. Dillon Consulting is looking for the least invasive solution possible that will prevent further ingress of water and moisture while providing strength. The repair materials must be inert, stable and able to stand up to brutal freeze thaw cycles and high winds.

ISIS Canada's expertise in innovative applications of glass and carbon fibre reinforced polymers seemed a promising place to start. FRPs have been used throughout Canada to restore timber bridges, concrete structures, and a growing variety of structural components. The engineers were considering the polymer's resistance to corrosion, its strength and the portable nature of its light weight when they sought the creative expertise of ISIS Canada's technical consultants, Dr. Gamil Tadros and Mr. Walter Saltzberg.

(L to R) Standing on scaffolding at eye level with the Golden Boy's torch, Ameen Deraj, Gamil Tadros, Bob Wiebe, Walter Saltzberg and Aftab Mufti.

"I have worked with ISIS on several other Dillon projects in the past. I preferred to work with ISIS because of the relationship and the ties we have developed over the years. In addition, the personal expertise of Dr. Mufti and Dr. Tadros in the area of wind analysis was particularly useful for the peer review," said Mr. Rihal.

As well, ISIS is at the forefront of structural health monitoring technologies involving fibre optic sensors that collect data on how a structure is handling daily stresses such as high altitude winds and inhospitable temperatures. Structures like the Golden Boy that are difficult and costly to monitor visually can be monitored via fibre optic sensors.

A structural analysis and wind tunnel testing of a 1:20 scale model of the sculpture at the University of Western Ontario has determined that the Golden Boy must come down from his perch. Final decisions on the conservation of the Golden Boy are pending. In the meantime, this unique project has become a research topic for Bogdan Bogdanovic's Master's Thesis titled, "Finite Element Analysis for Conservation". Working under the guidance of Dr. Mufti at the University of Manitoba, Mr. Bogdanovic will examine the shaft supporting the Golden Boy and its reaction to stress caused by wind and gravity loads, and propose repair techniques using FRPs.

Civil Infrastructure Systems

are generally the most expensive assets in any country (an estimated $2 trillion in Canada), and these systems are deteriorating at an alarming rate. As well, the introduction of intelligent materials and innovative design approaches in these systems is painfully slow due to heavy reliance on traditional construction and maintenance practices and the conservative nature of design codes. Feedback on "state of the health" of constructed systems is practically non-existent. Technologies for monitoring civil engineering structures are evolving to fill this gap.

1st International Workshop on
Structural Health Monitoring of Innovative Structures

September 19-20, 2002

Structural Health Monitoring (SHM) is an evolving technology for monitoring and defining the health of innovative civil engineering structures. The Workshop's goal is to provide a state-of-the-art report on recent activities in research, utilization and commercialization, all of which play a role in advancing innovative civil engineering.

KEYNOTE SPEAKERS

Dr. Emin Aktan, Drexel Unversity, USA
Dr. Farhad Ansari, University of Illinois at Chicago, USA
Dr. Fu Kuo Chang, Stanford University, USA
Prof. Urs Meier, EMPA, Switzerland
Dr. Moe Cheung, Public Works, Canada
Dr. Sami Rizkalla, North Carolina State University, USA
Dr. Roderick Tennyson, University of Toronto, Canada
Dr. Yozo Fujino, University of Tokyo, Japan

With short courses September 18, 2002:

Installation, Use and Repair of Fibre Optic Sensors

Dr. Roderick Tennyson, University of Toronto

An overview of basic FOS concepts combined with specific applications in composite laminates, concrete repair and new structures.

Guidelines for Structural Health Monitoring

Dr. J.J. Roger Cheng, University of Alberta

A primary focus on bridge applications, although the concepts are applicable to all civil engineering structures.

Online registration at:
www.isiscanada.com/Conference/SHM_Conference/SHM_conference.htm

Accommodation at the Hotel Fort Garry
for both the ISIS Annual Conference and Structural Health Monitoring Workshop
Reservations 1.800.665.8088

Workshop September 2002 - Winnipeg

COMPETITIONS

Check the ISIS web site for details on expanded student competitions.

Scholarships
Essays
Posters
Presentations

www.isiscanada.com/competitions.htm

ISIS Canada 7th Annual Conference

May 1-3, 2002

Find out what is being accomplished in leading edge research and applications of FRPs and structural health monitoring technologies.

Guest Speaker: Professor Urs Meier, Director, EMPA

(Swiss Federal Laboratories for Materials Testing and Research)

For online details:
www.isiscanada.com/conference/conference.htm

ISIS Monitors New San Francisco Bridge

ISIS Canada researchers are joining in a project with California Department of Transportation (Caltrans) to extensively monitor the health and performance of the new Benecia-Martinez Bridge in San Francisco by installing two different monitoring systems. Caltrans will install strain sensing instrumentation on one span of the structure utilizing a 64-channel data acquisition (DA) system. ISIS Canada's companion system will use Fox-Tek's FTI 4000 Fibre Optic Strain Sensors with two readout units using a 16-channel system to complement and verify the Caltrans Monitoring Program.

The fibre optic sensors will be located in close proximity to the Caltrans strain sensors providing the best possible data comparison from both technologies. The system is designed to monitor strains from various load sources such as dead load, vehicle loads and thermal loads. The data will be analyzed to determine creep, shrinkage and deflection.

In total 32 FTI Sensors will be placed on Piers 7 and 8 with two DA systems installed on each pier during the cantilever construction. After the two cantilevers are connected and the FOS are installed, one DA System will be disconnected while the other will continue to be used by ISIS Canada over the two year monitoring program.

ISIS Canada and Caltrans will equally share the data collected from both systems. ISIS Canada will analyze both data sets and compare the results of both technologies to determine whether fibre optic sensing technology can provide additional information about the structure.

Project Leaders: *Dr. Aftab Mufti, P.Eng., University of Manitoba*
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Dr. Gamil Tadros, P.Eng., SPECO Engineering
E-mail: tadrosg@cadvision.com

ISIS Holds Competition for FRP Bridge Design

In collaboration with the Université de Sherbrooke's Faculty of Engineering, ISIS Canada announces its first design competition for ISIS students. Students are invited to design an FRP covered pedestrian bridge with the winning design to be built in the summer of 2002 to provide new access to the Faculty of Engineering building. The pedestrian bridge will also be outfitted with fibre optic sensors for structural health monitoring.

The winning entry will be announced at ISIS Canada's annual May conference in Winnipeg, after which a member of the Ordre des ingénieurs du Québec will prepare the final design in collaboration with the winner or a representative of the winning team. Actual construction at the Université de Sherbrooke will begin in the summer of 2002. By the fall, sensors will be installed and the bridge officially opened.

The winner of the competition will receive $2000 in addition to having the satisfaction of seeing the concept accepted and constructed. For more details, visit the web site at:

www.isisicanada.com/DesignCompetition/Announcement.htm

Capilano Expressway Rehabilitation

Edmonton's ageing Capilano Expressway requires a new concrete bridge deck slab and in an effort to reduce the project's capital cost, The City is considering an innovative Canadian design that actually reduces the amount of reinforcing steel without jeopardizing strength. The innovative design has its foundation in an arching-action theory.

Conventional concrete bridge decks are reinforced according to assumptions on flexural bending and failure. This is the flexural design method. It is a method that results in excessive steel reinforcing which is susceptible to corrosion and results in deterioration of the concrete structure. ISIS Canada's research indicates that the failure mode of a reinforced concrete bridge deck is not actually flexural bending but punching which results in deck slabs failing at much higher concentrated loads than those predicted by the flexural theory.

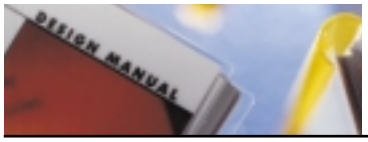
This theory has been proven for simply supported deck spans. Recent tests conducted by ISIS at the University of Manitoba demonstrate this theory is also valid for cantilever bridge deck slabs like the Capilano Expressway.

A full-scale cantilever section of the bridge deck, measuring approximately 10 meters in length and 5 meters in width, was constructed and tested. The model consists of three different spans of 3 meters to test the different options that have been proposed for the replacement of the deck. Six tests were carried out in which a simulated truck tire print was applied for 5 cycles before testing the deck to failure. All tests revealed an ultimate load approximately three times the design load. A punching mode of failure was consistent, thus proving that internal arching forces are being developed within the concrete deck.

Based on these tests results, Mr. Peter Fairbridge, P.Eng. of ISL Infrastructure Systems, the consulting engineering firm for the project, will design an innovative concrete bridge deck that costs less and is less vulnerable to the life shortening effects of corrosion.

ISIS Project Leaders: *Dr. Aftab Mufti, P.Eng., University of Manitoba* *E-mail:muftia@cc.umanitoba.ca* *Dr. Gamil Tadros, SPECO Engineering* *E-mail: tadrosg@cadvision.com*

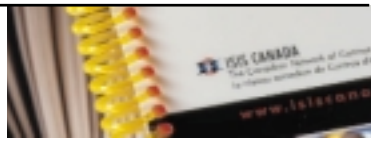
Manuals Published



Order online at: www.isiscanada.com

1 Installation, Use and Repair of Fibre Optic Sensors
2 Guidelines for Structural Health Monitoring
3 Reinforcing Concrete Structures with Fibre Reinforced Polymers (FRPs)
4 Strengthening Reinforced Concrete Structures with Externally-Bonded Fibre Reinforced Polymers (FRPs)

Short courses based on design manuals numbers 3 and 4 are planned to take place in major centres across Canada later this year.



Workshops Planned

NEW BOARD MEMBERS

Sherif Barakat, Ph.D., National Research Council of Canada

As Director General of the Institute for Research in Construction, Dr. Barakat is responsible for the leadership and management of Canada's centre for construction technology. The Institute employs over 220 skilled staff with an annual budget of approximately $22 million. During the past 22 years, Dr. Barakat has successfully led and completed NRC and industry collaborative research projects in many areas of building performance including ventilation and air movement, energy performance, dynamic thermal response of buildings, performance of improved glazing systems, and heat transfer in buildings.


Sherif Barakat

Edwin Bourget, Ph.D, Vice President of Research, Université de Sherbrooke

The Multidisciplinary Committee of the Canada Foundation for Innovation is just one of the many committees Dr. Bourget currently sits on. His scientific expertise is in the field of oceanic research. Dr. Bourget's doctoral thesis from the University of Wales was a study of structure and formation of barnacle shells. His professional associations include Association canadienne-francaise pour l'avancement des sciences; American Society for Engineering Education; Eco-Ethics International Union; and International Society of Chemical Ecology.


Edwin Bourget

Gary Jolly President and CEO, Fibre Optic Systems Technology Inc.

Founded and arranged financing for this ISIS Canada spin off company that utilizes fibre optics to measure stress and strain on large infrastructure projects such as bridges, dams and pipelines. Prior to joining Fibre Optic Systems Technology Inc. (FOX-TEK Inc.) Mr. Jolly was President and CEO of Safegate International. Developed and grew this small, regional, Swedish company into a world leader in the field of Airport Surface Movement, Guidance and Docking Systems. Achieved a market growth from three million to over twenty million annually while competing with major players such as Siemens, Honeywell, Deutsche Aerospace and Crouse-Hinds.


Gary Jolly

APPOINTMENT

External Assessment Panel:
Strategic Development in Advanced Buildings Technology in a Dense Urban Environment

In January 2002, Dr. Aftab Mufti participated as a panel member for an external assessment of the Hong Kong Polytechnic University Department of Civil and Structural Engineering. It is an important development in the University's quality assurance program. Departmental assessment is a process whereby the academic and management standards and procedures of a department are reviewed by peers against high international standards. "One of the main benefits of participating was the opportunity to learn more about the use of FRPs in buildings in Hong Kong. This new knowledge provides a more clearly defined picture of the state-of- the art from an international perspective," said Dr. Mufti.

NEW ON STAFF

ISIS Canada's Administrative Centre welcomes Pat Paige and Dana Bebak to the fold.

Dana joins us in the newly created position of Financial Clerk. With over 15 years of accounting experience in various capacities and sectors, she is well-qualified to assist in the financial operations of ISIS. Dana will also take on some new challenges, such as keeping the ISIS Canada web site current.

Pat Paige is taking on the role of Public Affairs Officer. She offers a wealth of media and marketing knowledge with experience in healthcare, government and telecommunications. She is replacing Jennifer Redston whose creativity and talent will be missed. Thank you Jennifer for a job well done and welcome aboard Pat and Dana.

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John Newhook, Ph.D., P.Eng.
Dalhousie University

Dr. John Newhook has been appointed Assistant Professor at Dalhousie University in the Department of Civil Engineering. He was previously at the University of Calgary. Dr. Newhook continues to work on ISIS projects including a new focus on: developing a centralized monitoring and management program for ISIS field projects and developing a pre-stressed concrete bridge girder with FRP webs. ISIS is pleased to have a representative in the Maritimes.

E-mail: john.newhook@dal.ca

Walter Saltzberg, P.Eng.
University of Manitoba
Faculty of Engineering
Design Engineering Group

Mr. Walter Saltzberg, an ISIS Canada Consultant, has been appointed Engineer-in-Residence at the University of Manitoba. This new position is an innovative program and the first of its kind in North America. Its purpose is to provide practicing engineering experience to both students and staff.

E-mail: saltzber@cc.umanitoba.ca

Hong Kong

A select group of international leaders in code development (including ISIS Canada) recently participated in a forum on codes and guidelines for the use of FRP composites in civil engineering. The forum was hosted by the Research Centre for Advanced Technology in Structural Engineering at the Hong Kong Polytechnic University and sponsored by the Hong Kong Institution of Engineers and Hong Kong Society of Theoretical and Applied Mathematics. It provided an opportunity for ample discussion among representatives of countries actively developing codes and guidelines for FRP applications. The Forum was held in conjunction with the International Conference on FRP Composites in Civil Engineering at which ISIS researchers made a number of presentations, as follows:

Keynote Lecture, Aftab A. Mufti, University of Manitoba
FRPs and FOSs lead to innovation in Canadian civil engineering structures

S.G. Masoud and K. Soudki, University of Waterloo
Rehabilitation of corrosion-damaged reinforced concrete beams with FRP sheets

C. Gheorghiu, P. Labossiere, A. Raiche, Université de Sherbrooke
Effect of exposure conditions on the strength of RC beams externally reinforced with CFRP

Korea

The Korean Highway Corporation (KHC) hosted ISIS Canada representatives in January 2002 to exchange information on FRP products and learn more about steel-free deck technology developed by Dr. Aftab Mufti and his colleagues. Korean participants included the Korea Institute of Construction Technology and members of the KHC Composite Structures and Materials Committee.

Awards

Earth Science Systems Research Award Best Paper
ASCE Ninth International Conference on Structural Faults and Repairs
A.J. Boyd & N. Banthia, University of British Columbia

Best Applied Research Paper for 2000
CI/ASCE Journal of Composites for Construction
Baidar Bakht, George Al-Bazi, Nemy Banthia, Moe Cheung, Marie-Anne Erki, Martin Faoro, Atsuhiko Machida, Aftab Mufti, Kenneth Neale, Gamil Tadros