ISIS INNOVATOR
NEWSLETTER OF ISIS CANADA RESEARCH NETWORK February 2005
The Canadian Network of Centres of Excellence on Intelligent Sensing for Innovative Structures

PWGSC DEMONSTRATES ISIS TECHNOLOGIES

Restoration of Cemetery Grave Markers

Dr. Aftab Mufti, University of Manitoba; Dr. Maria Onofrei, University of Manitoba

Brookside Cemetery, Winnipeg, MB

For the past two years ISIS Canada has been conducting research on behalf of Veterans Affairs Canada and Heritage Conservation Services, a department of Public Works and Government Services Canada (PWGSC), to provide a durable and economical solution to the rapid deterioration of heritage reinforced concrete structures across Canada. The research consisted of determining the suitability of innovative design procedures for using fibre reinforced polymers (FRPs) as reinforcement in the support beams and as pinning rods to anchor the grave markers to the support beams. After investigation, ISIS Canada recommended that glass FRPs be used to reinforce the concrete ground beams and as a method of attaching the markers used at the graves of Canadian veterans. Veterans Affairs Canada accepted the recommendation and the new methodology is being used to restore the grave markers at Brookside Cemetery in Winnipeg, Manitoba, and will be useful for other sites across Canada in the future.

Rehabilitation of Largest Parking Garage in Canada

Dr. Brahim Benmokrane, Université de Sherbrooke

Laurier-Taché Parking Garage SHM system, Hull, QC

The Laurier-Taché garage in Hull, Québec is subjected to the same environmental conditions as most parking facilities across the country, necessitating premature reconstruction of the concrete travel surface. Endeavoring to minimize deterioration caused by corroding steel reinforcements, and thereby reducing maintenance costs, PWGSC teamed up with ISIS Canada to evaluate the long term benefits of alternative design options. Using the expertise of Dr. Benmokrane, the interior structural slabs of the Laurier-Taché parking garage were reconstructed using FRP-composite bar technology. To better assess the long-term performance of FRPs in a concrete structure subjected to harsh environmental and loading conditions, a Structural Health Monitoring (SHM) system was installed as an integral part of the reconstruction process. The long term results of this test section have the potential of benefiting the design and reconstruction of other parking facilities across the nation.

Utilization of FRPs on New Trout River Bridge

Dr. Aftab Mufti, University of Manitoba; Dr. Roger Cheng, University of Alberta;
Dr. Gamil Tadros, SPECO Engineering Ltd.

Trout River Bridge, Alaska Highway, BC

Upon examination of the results of the extensive research and demonstration projects conducted by ISIS Canada over the past several years, PWGSC decided to utilize the new technology for the replacement of the Trout River bridge. The new river crossing structure has a concrete deck reinforced with glass fibre reinforced polymers (GFRPs) and steel. Successful performance of this demonstration project is likely to lead to several more structures on the Alaska Highway being rehabilitated or replaced using FRPs for strengthening.

COMPETITIONS

Visit the ISIS website for details on all student competitions and the four scholarships offered.

Scholarships
Posters
Essays
Presentations

www.isiscanada.com/competitions/studentc.htm

ISIS Canada 10th Annual Conference

May 4th - 6th, 2005 Public Forum Day May 4th, 2005

Plan to participate in this exciting presentation of smart, alternative **solutions for replacement and maintenance of civil infrastructure.** You will learn about the latest advances in research and application of **fibre reinforced polymers** and **structural health monitoring**. These innovative, cutting-edge solutions will be discussed by ISIS Canada researchers as well as guest speakers who are putting these technologies to work right now.

Keynote Speaker: Ms. Cécile Cléroux, P. Eng.
Assistant Deputy Minister, Program Operations Infrastructure Canada

Ms. Cléroux is a civil engineer specializing in project management and a seasoned manager who has a range of experience with service organizations, in both the public and private sectors. She is currently Assistant Deputy Minister, Program Operations, for Infrastructure Canada, a new federal department created in August 2002, whose mandate is to work with various orders of government, the private sector, and other partners to strengthen collective infrastructure management in Canada. A key member of the Infrastructure Canada executive team, Ms. Cléroux is actively involved in defining new approaches to managing public infrastructure assets.

CHALLENGING the STATUS QUO for DESIGN of CIVIL ENGINEERING Structures

Register on-line at www.isiscanada.com/conference/conference05.htm

The Crowne Plaza Hotel, Ottawa, Ontario
Reservations 1.800.567.3600 or email:crowneottawa@chiphospitality.com

Dr. Banthia Named Director of Theme 2

Dr. N. Banthia

The Board of Directors of ISIS Canada at its meeting on October 6, 2004 appointed Dr. Nemkumar Banthia of the University of British Columbia as Director of the Theme 2 research program, "Materials Science and Innovative Structures". Dr. Banthia has been an ISIS project leader for several years and has served on the Research Management Committee for the past four years. He is a materials specialist and developed the ISIS technology of using sprayed FRPs for rehabilitation and strengthening of civil engineering structures. This appointment is a reflection of the Board's desire to reduce the excessive workload of President Aftab Mufti (previous director of Theme 2) and to pave the way for increased emphasis on the durability of materials in the next phase of the ISIS mandate.

The following is a reproduction of what was said about Dr. Banthia in the May, 2004 B.C. Business magazine.
Dr. Nemy Banthia, 45, is acutely aware that, sooner rather than later, corrosion of reinforcing steel in bridges and parking garages, and rapidly deteriorating highways will cost Canadian cities alone $44 billion in repair and maintenance costs. That's why his discovery - which uses fibre-reinforced polymers to seal bridges and roads - is such an important breakthrough for civil engineers around the world.

The cost-effective polymer solution can also be sprayed on facilities such as hospitals, government buildings, and embassies and consulates to make them earthquake - or terrorist-resistant. Proven in the lab and on the Safe Bridge near Duncan, B.C., the spray technology is now being commercialized by UBC's Industry Liaison Department. The world markets are there, says the Canadian Construction Association, which estimates that $900 billion must be spent world-wide to fix existing infrastructure deficiencies.

How does Dr. Banthia keep his own innovation muscles strong and flexible? "I take a page out of Gandhi's book. He advocated that one must never be narrow in life. I love working in the lab with my hands and having lots of dialogue with students. I seek out people and knowledge outside my field and I travel extensively to places such as India, China and Singapore that stimulate my imagination and world view." Along the way, Dr. Banthia and his team have won several awards, including the "Solutions Through Research Award" from the Innovation and Science Council of British Columbia.

International Society for Structural Health Monitoring of Intelligent Infrastructures (ISHMII) Meeting a Global Need

As the design and construction of civil structures continue to evolve, it is becoming imperative that these structures be monitored for their health. In order to meet this need, the discipline of Structural Health Monitoring (SHM) has emerged. It involves application of electronics to civil structures and aims to assist engineers in realizing the full benefits of structural health monitoring. Against this background, a new international organization for promoting SHM, the International Society for Structural Health Monitoring of Intelligent Infrastructures (ISHMII) has been established. The aim of the Society is to advance the understanding and the application of Structural Health Monitoring (SHM) in civil engineering infrastructure, in the service of the engineering profession and society.

As the President of this new society, I look forward to the mutual sharing of information for the benefit of all our members, as well as building this important society together. With global assistance, I believe ISHMII will define the future of civil engineering.

- Dr. Aftab Mufti

International SHM Workshop

The Second International Workshop on Structural Health Monitoring of Innovative Civil Engineering Structures was held in Winnipeg, Canada on September 22-23, 2004. Over 100 delegates from 14 countries, 24 universities, 18 industries and one government agency participated. There were 44 presentations plus 8 keynote addresses. The welcoming remarks were given by the Honourable Tim Sale, Minister of Science, Industry and Technology, Province of Manitoba.

The goal of the SHM workshop was to provide a state-of-the-art report on recent research activities, technological utilization and commercialization activities in structural health monitoring technologies that will strongly support the introduction of innovations in civil structural engineering. The proceedings from the workshop are available for $100 CDN.

To place an order for a copy of the proceedings, please email Charleen Choboter at choboter@ms.umanitoba.ca

International Workshop on Innovative Bridge Deck Technologies, Winnipeg, April 15-16, 2005

Dr. Nemkumar Banthia is organizing an International Workshop on Innovative Bridge Deck Technologies, to be held in Winnipeg on April 14-15, 2005. The workshop is by invitation only, and among its objectives is to identify and discuss emerging and innovative bridge deck technologies, and to adopt a clear and unambiguous position on the use of FRPs in bridge decks. The list of international participants includes:
Dr. P. Balaguru, Dr. V.S. Gopalaratnam, Dr. V. Karbhari, and Dr. W. Klaiber from the United States; Dr. S. Matsui from Japan; Prof. U. Meier from Switzerland; Prof. M. Tandon from India, and over a dozen representatives from across Canada including Dr. A. Mufti, President of ISIS Canada.

First ISIS Steel Free Bridge Deck Concept Constructed Outside Canada

Another example of the technology transfer impact of ISIS Canada is the July, 2004 construction of the ISIS design concept for a steel free bridge deck in Ames, Iowa by the Iowa Department of Highways. Dr. Wayne Klaiber, of Iowa State University, liaised with ISIS Canada prior to embarking on this non-conventional approach to supporting a bridge deck. Dr. Aftab Mufti, President of ISIS Canada was the principal developer of this design concept and has supervised the construction of six such operating bridges across Canada.

"This truly shows the effectiveness of ISIS not just in research and development for Canada, but also for rapid deployment globally. This should be a clear example for other centres worldwide for technology transfer," said Dr. Vistasp Karbhari, of the University of California, San Diego.

Civionics Manual Now Available

ISIS has completed a new Manual #6, Civionics Specifications, to assist practicing engineers, suppliers and contractors to apply SHM techniques to new and existing structures being rehabilitated, including the selection and installation of sensors. This is a hands on, practical document that is available for purchase on the ISIS website. The manual includes a video that demonstrates the installation technique.
To facilitate the transfer of this new technology, Manual #6 can be obtained free of charge by students in Canadian Universities and technical colleges at the request of their instructor. A series of cross-country workshops is being planned for the fall of 2005 to provide training in the use of this advanced technology.

Dr. A. Mufti

Dr. M. Onofrei

This project is lead by Dr. A. Mufti, and coordinated by Dr. M. Onofrei. Dr. N. Banthia, Dr. B. Benmokrane, Dr. M. Boulfiza, Dr. J. Newhook, Dr. G. Tadros, Dr. B. Bakht and Mr. Peter Brett round out the team. This project team has extensive expertise in materials science and structural engineering.

Performance of Glass Fibre Reinforced Polymers in Concrete Structures

by Dr. M. Onofrei

This project addresses concerns related to the durability of glass fibre reinforced polymers (GFRP) as reinforcement in civil engineering structures.

To predict the long-term behaviour of GFRP reinforcement with any confidence, the laboratory data and the estimates from models ought to be verified (validated) and calibrated against actual 5 to 8-year GFRP performance data, which currently is lacking. The objective of this study is to provide data on the performance of GFRP materials exposed to a concrete environment in real-life engineering structures.

Core specimens of GFRP reinforcement have been collected from five field demonstration projects across Canada: (1) Hall's Harbour Wharf, Nova Scotia; (2) Joffre Bridge, Quebec; (3) Chatham Bridge, Ontario; (4) Crowchild Trail Bridge, Alberta; and (5) Waterloo Creek Bridge, British Columbia. Appropriate analyses are performed on core specimens by research teams at four Canadian universities, which are members of the ISIS Canada Research Network: University of British Columbia, University of Manitoba, University of Saskatchewan and University of Sherbrooke.

After establishing the protocol for assessment of GFRP durability, each research team independently performed testing. Results to date indicate that no deterioration of GFRP reinforcement took place in any of the field demonstration projects included in this study. Microscopic examinations indicate that no chemical degradation processes occurred within the GFRP reinforcement due to alkalinity of concrete.

This study will generate data on the performance of GFRP reinforcement in concrete in a range of environmental conditions and 5 to 8 years of service life of engineered structures. The overall goal of this study is to provide a set of data that can easily be used by the construction community. Data from laboratory testing (i.e., accelerated testing in simulated alkaline environments) could be calibrated against data obtained in this study from cores of GFRP reinforcement actually in service. In addition, the safety factors used in most design codes that are overly conservative could be realistically adjusted with some degree of confidence.

For more information contact: Dr. Maria Onofrei, University of Manitoba.
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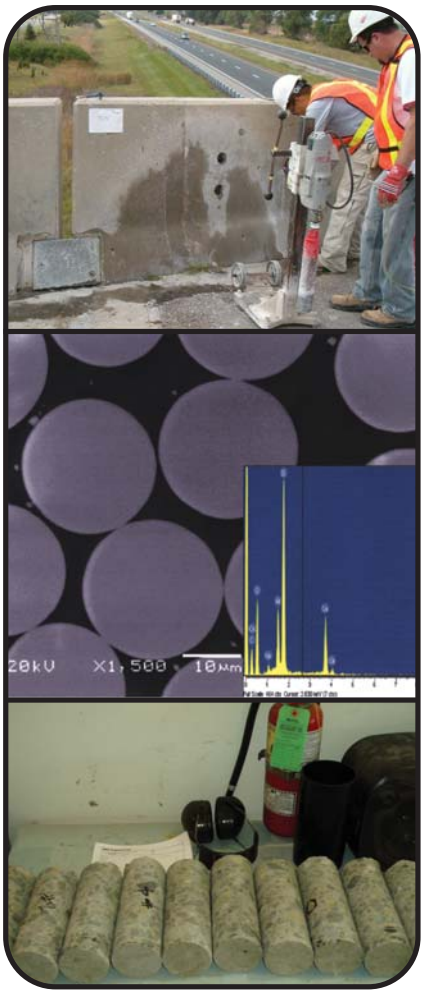


Province of Manitoba Funds ISIS Research

The University of Manitoba and ISIS Canada Research Network have received a $600,000 grant from Manitoba Transportation and Government Services.

"Manitoba is delighted to extend this very productive partnership with ISIS and support groundbreaking research that is changing the way we design, build and repair bridges," said Transportation and Government Services Minister Ron Lemieux. "The previous research and demonstration projects by ISIS Canada have proven there are alternative and cost-effective measures we can use in bridge repair and construction.

Dr. Aftab Mufti, President of ISIS Canada, says the grant is primarily to fund research into the use of innovative technologies and structural health monitoring for new construction and rehabilitation of existing structures in Manitoba.

The agreement is for $120,000 annually over a 5-year term to a maximum of $600,000. During this time, ISIS will research and evaluate long-term durability performance of composite timber stringers using glass fibre reinforced polymer (GFRP) reinforcement in various structures.

One aspect of the research will be done in partnership with the Province of Manitoba, Wardrop Engineering and LaFarge Canada, which will assist in the design, fabrication and testing of ductal GFRP reinforced overhead sign structures. In addition, an automated on-site computer system capable of interpreting the large volumes of data generated from structural health monitoring will be developed.

Dr. Mufti explains: "As concrete structures deteriorate rapidly in our climate, the ISIS Canada Research Network will continue research into the use of innovative materials and technologies to address these problems and extend service life. This will include a life-cycle engineering cost analysis to demonstrate the economics of using ISIS technologies."

Rehabilitation of Timber Bridges using FRPs

by Dr. D. Svecova

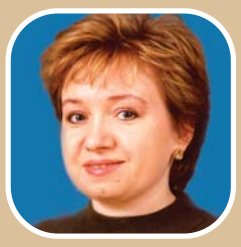
Timber Bridge Rehabilitation

Timber bridges constitute nearly one third of all structures in Manitoba. Most of these bridges were built decades ago and will require strengthening or replacement in the near future. For the past 6 years, one of the ISIS research projects at the University of Manitoba, conducted in collaboration with Manitoba and Government Services, focused on innovative strengthening schemes for timber. Dr. Dagmar Svecova from the Department of Civil Engineering and her colleagues used glass fibre reinforced polymer (GFRP) bars to increase the shear and flexural capacity of timber. One of the advantages of this strengthening system is that it can be performed with very little interruption to traffic.

Recently, GFRP sheets were also used to strengthen creosoted timber beams. One or more plies of sheets were applied to the tension face of the beams for flexural strengthening. While it is possible to use only flexural strengthening, better results were obtained from beams strengthened for both flexure and shear. In this case, diagonal GFRP sheets were applied in the shear span of the beams. This work was carried out in collaboration with Dr. Baidar Bakht.

The long term performance of these reinforcing systems is also being studied. Timber stringers strengthened with GFRP sheets are subjected to the combined effects of temperature and humidity to simulate the effects of long term exposure to environmental conditions. The research is being conducted in the new environmental chambers at the University of Manitoba which were acquired through a Canada Foundation for Innovation grant.

For more information contact: Dr. Dagmar Svecova, University of Manitoba. email: svecovad@cc.umanitoba.ca



Dr. D. Svecova

Dr. B. Bakht

Using Life Cycle Engineering and Costing to Predict Extra Benefits Using FRPs

To a considerable extent, the benefits of using FRPs for strengthening civil engineering structures are tied to the increased useful life span of these new reinforcement materials. The longer the materials last, the greater the benefit. How long will they last? This is still being quantified.

As a service to the user sector, ISIS continues to employ field demonstration case studies to determine the life cycle engineering cost benefits of the new technologies. Results thus far have been encouraging. There is overwhelming evidence that rehabilitation of existing structures with FRPs is an economical means for strengthening and repair. Capital costs are lower and long-term maintenance will be less. Data is also emerging that makes it easier to quantify the long-term benefits of using FRPs in new structures. This is especially the case for concrete bridge decks that employ the hybrid design concepts developed by ISIS. Quantification of the benefits will facilitate increased use of the advanced designs, for the economic well-being of Canadians.

Workshops for practicing engineers are being planned for the fall of 2005.

For more information contact: Dr. Gordon Sparks, University of Saskatchewan. email: gordon.sparks@vemax.com

Dr. G. Sparks

ISIS Takes Structural Health Monitoring to New Depths

Application of SHM to Harbour Dredging

The Halifax Port Authority is increasing the berthing depth at the Fairview Cove container terminal in Halifax Harbour, Nova Scotia. Sheet piles are being driven beneath existing concrete caissons to stabilize the soil foundations during and after dredging. Anchor bolts to secure the sheet piles will be installed at depths of at least 14 metres below the mean water level. The Port Authority requires monitoring any movement of the cribs, sheet piling, and the anchor bolts, that may occur due to the proposed dredging operation.

To address the challenge of monitoring at such depths, ISIS Canada (via Dalhousie University) in collaboration with the Port Authority, the MacDonnell Group and fibre optic sensor suppliers RocTest Inc. and LxSix Inc. are installing a series of Fabry-Perot and Bragg grating sensors. The sensors will be monitored periodically during dredging operations and for a one-year period after completion of construction. While fibre optic sensors have been used in other marine environments, this project represents the first truly sub-marine application. It is also typical of a growing number of field projects in which Structural Health Monitoring technology is being employed to better understand behaviour during construction rather than long-term serviceability.

For more information contact: Dr. John Newhook, Dalhousie University. email: John.Newhook@dal.ca

Dr. J. Newhook

APPOINTMENTS & HONOURS

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Mr. Dennis Sargent, P. Eng.

The Technology Transfer and Commercialization Committee welcomes its newest member, Dennis Sargent. Mr. Sargent is President of Sargent and Associates Engineering Ltd. in Victoria, British Columbia. ISIS is looking forward to having Mr. Sargent's input and gaining experience from his utilization of the technologies in this increasingly important field of engineering.

Ms. Rania Al Hammoud

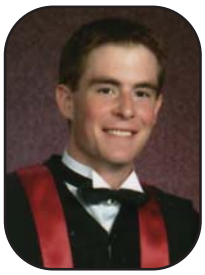
Rania Al Hammoud, University of Waterloo, has been elected by her fellow research students to serve as President of the ISIS Canada Student Committee for 2004-2005. Ms. Al Hammoud received her Bachelor degree in Civil Engineering from the American University of Beirut, Lebanon. Her research interests include the behaviour of corroded and FRP repaired reinforced concrete structures under static and fatigue loading.

Dr. Amir Fam

Dr. Amir Fam, ISIS Project Leader, is one of the 2004 recipients of the Queen's University Chancellor's Research Awards. Dr. Fam's research focuses on structural applications using fibre-reinforced polymers. He is currently working with concrete-filled fibre composite tubes. Durable in corrosive environments, these structures may be used in bridge columns, hydro poles, light poles and highway traffic signs.

Mr. Walter Saltzberg, P. Eng.

ISIS Canada is pleased to announce the appointment of Walter Saltzberg as International Liaison Officer. Mr. Saltzberg is the former head of the bridge design office for Manitoba Transportation and will continue to serve ISIS Canada as a technical advisor. In his new capacity, he will take on the additional responsibility to liaise with foreign colleagues regarding technology transfer and to assist Canadians to export products created through the ISIS research program. This appointment reflects the increasing global outreach of ISIS headquarters and the effort being made to facilitate the export of Canadian technology.



Mr. Marc Bourassa

ISIS Canada is pleased to announce that Marc Bourassa is the recipient of the $5,000 Urs Meier Scholarship for Engineering Excellence for 2005. Marc will enter the Civil Engineering Masters program at the University of Saskatchewan in September 2005, under the supervision of ISIS Project Leader, Dr. Leon Wegner. In addition to his academic excellence, Mr. Bourassa is involved in numerous extracurricular activities and has proven leadership abilities, all of which confirm him to be a deserving recipient of this prestigious award.