Achieving Innovation Through the CPCI Infrastructure for LIFE Program
Concrete Canada: December 4, 2013

Robert Burak, P.Eng.
President

Brian Hall, MBA
Managing Director

CANADIAN PRECAST/PRESTRESSED CONCRETE INSTITUTE
INSTITUT CANADIEN DU BÉTON PRÉFABRIQUÉ ET PRÉCONTRAINT
CPCI Infrastructure for LIFE Program

Precast Concrete Your Perfect Partner

“Infrastructure for Life”

- Long-Lasting
- Innovative
- Fast construction
- Efficient and safe

....Needs, Wants and Demands
Client Needs

• Need: To provide technically and economically feasible infrastructure components and systems for timely rehabilitation and construction of new infrastructure projects.
Clients Wants

- **Wants:** Components and systems must provide *equal to or better performance* than traditional rehabilitation or construction
Public Demands

• The public demands a shorter installation process time period than traditional methods; while maintaining high quality, longer-lasting highways, bridges and structures. In order to address this problem, public and private authorities need to adopt a new philosophy of "Get in Get out - Stay out"
Need to Address traditional methods of Infrastructure Construction

...Existing Infrastructure is aging - Much of the highway and water and sewage systems were built in the 1950s and 1960s, and is subsequently in need of rehabilitation and replacement
2012 National Infrastructure Report Card
Highlights of the 2012 National Infrastructure Report Card

• Municipal Roads and Water Systems


• Decades of Declining Public Investment
Fair to Very Poor

Roads
- 52.6%
- Replacement $91.1 Billion
- $7,325/Household

Wastewater
- 40.3% (plants)
- 30.1% (pipes)
- Replacement $39 Billion
- $3,136/Household
Fair to Very Poor

**Drinking Water**
- 15.4% (pipes)
- Replacement $25.9 Billion
- $2,082/Household

**Storm water**
- 23.4% (storm water pipes)
- Replacement $15.8 Billion
- $1,270/Household
Roots of National Municipal Infrastructure Deficit

• Fair to Poor represents $171.8 Billion Total Dollar Replacement
• Total Deficit $123 Billion
• ‘Structural Imbalance in growing list of Responsibilities’
• Lack of adequate Asset Management Programs
• Short term/ad hoc thinking
• “Local governments, prohibited by law from running budget deficits, were forced to raise property taxes, cut core services, and, most often, put off building and repairing core infrastructure such as roads and bridges, public transit, and drinking-water systems”
“Climate Change Adaptation and Canadian Infrastructure”

- This report summarizes current literature dealing with the challenge of adapting to climate change in Canada, with a particular focus on the country’s infrastructure. The report explores climate impacts and risks to key infrastructure by region and by type. It also introduces a number of key policy, regulatory and financial tools for consideration.
Disaster Resilience

Resilience: “Ability of a System and its counterparts to anticipate, absorb, accommodate or recover from the effects of a hazardous event in a timely and efficient manner”

Source: IPCC (2012)

<table>
<thead>
<tr>
<th>CLIMATE HAZARDS</th>
<th>REGION</th>
<th>ESTIMATED COSTS (CAD)</th>
<th>INFRASTRUCTURE DAMAGED</th>
</tr>
</thead>
<tbody>
<tr>
<td>Toronto Flood, August 19, 2005</td>
<td>Ontario</td>
<td>&gt;$500 million</td>
<td>• Collapse of Finch avenue (a major arterial street)</td>
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<td>• Damage to two high-pressure gas mains, and a portable water main</td>
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<td>• Damage to telephone, hydro and cable service lines</td>
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<tr>
<td>Southern Alberta floods, 2005</td>
<td>Prairies</td>
<td>&gt;$400 million</td>
<td>• Sewer backup</td>
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<td></td>
<td></td>
<td></td>
<td>• Roads, parks, sewers, bridges, buildings, agriculture</td>
</tr>
<tr>
<td>Peterborough Flood, July 15, 2004</td>
<td>Ontario</td>
<td>$200 million</td>
<td>• 500 homes were flooded</td>
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<td></td>
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<td>• 1,000 homes had gas lines disconnected</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>• Sewer systems and roads were inundated</td>
</tr>
<tr>
<td>B.C. Wildfires, 2003</td>
<td>British Columbia</td>
<td>$700 million</td>
<td>• Destroyed 334 homes and many businesses</td>
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<tr>
<td>Hurricane Juan, 2003</td>
<td>Atlantic</td>
<td>$200 million</td>
<td>• Homes, businesses, energy systems, roads, pipelines</td>
</tr>
<tr>
<td>Ice storm, 1998</td>
<td>Ontario, Quebec, Atlantic Canada</td>
<td>$5.4 billion</td>
<td>• Power lines causing loss of electricity for more than 4 million people</td>
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<tr>
<td></td>
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<td>• 1,000 steel electrical pylons, and 35,000 wooden utility poles were crushed by the weight of the ice</td>
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<td></td>
<td>• Approximately $790 million damage to homes, cars and other property</td>
</tr>
<tr>
<td>Saguenay flood, 1996</td>
<td>Quebec</td>
<td>$1.7 billion</td>
<td>• Roads, bridges, railways, aqueduct and sewage networks needed complete restoration</td>
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<td></td>
<td>• Pumping stations were completely wiped out</td>
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<td></td>
<td></td>
<td></td>
<td>• 20 businesses destroyed and another 25 damaged</td>
</tr>
<tr>
<td>Calgary hailstorm, 1991</td>
<td>Prairies</td>
<td>$884 million</td>
<td>• Roof and building damage</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Aircraft and automobile damage</td>
</tr>
</tbody>
</table>

Sources: Government of British Columbia (2003); Environment Canada (2005); Public Safety Canada (2005)
• Climate change has the potential to substantially affect the lifespan and effectiveness of Canada’s infrastructure, particularly our transportation, buildings, marine and water management infrastructure.

• Measures can be taken to limit costs and strengthen the resiliency of infrastructure - the paper documents a number of key policy, regulatory, and financial tools for consideration.
International Institute for Sustainable Development (IISD) - Four General Conclusions

• While there has been a significant amount of research and planning done, most supporting policies and regulatory changes remain nascent and investments have not yet fundamentally shifted.

• Recent climate events in Canada and abroad have galvanized calls for action at the local, regional and national levels, providing a key opportunity for industry actors to get engaged in the resiliency conversation now.
The Purpose of Infrastructure for LIFE Program

- The purpose of the Infrastructure for LIFE program is to advance longer-lasting infrastructure using innovative technologies and practices to accomplish fast construction of efficient and safe infrastructure concrete solutions... **PRECAST systems**
The Purpose of Infrastructure for LIFE Program

- The Infrastructure for LIFE Program can provide the financial incentives to clients while demonstrating state-of-the-art technologies... PRECAST systems

- Elevated performance standards, and new business practices in the construction process that results in improved safety, faster construction, reduced congestion from construction, and improved quality and user satisfaction... PRECAST systems
The Purpose of Infrastructure for LIFE Program

- Regulatory authorities are realizing that precast concrete components can be used to minimize interference to the public during municipal construction projects. Traffic holdups also have an adverse impact on the environment ... PRECAST systems
Balancing the Needs, Wants and Demands

Performance

Impact

Cost

Environmental
Social
Economic

Sustainable Precast Plant Program

Designing with Precast Concrete

Certified Plant

Design Manual
The Precast Concrete Partnership

- Optimization includes, but is not limited to, identifying opportunities for mutual collaboration on exchange of technical information, codes and standards development, industry education and training, publications, and legislative or advocacy initiatives.
The Precast Concrete Partnership

Today’s Infrastructure includes all of this...
# Typical Program for an IFL Seminar

**Day 1 – Bridges and Buildings**

<table>
<thead>
<tr>
<th>Time</th>
<th>Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>7:30 AM</td>
<td>Registration and Welcome Reception (coffee and light breakfast)</td>
</tr>
<tr>
<td>8:00 AM</td>
<td>Welcome</td>
</tr>
<tr>
<td></td>
<td>Robert Burak, P.Eng. - Canadian Precast/Prestressed Concrete Institute</td>
</tr>
<tr>
<td>8:45 AM</td>
<td>Precast Concrete Fundamentals</td>
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<td></td>
<td>Brent Bechar, P. Eng. - CPCI Ontario Chapter Chair</td>
</tr>
<tr>
<td>9:15 AM</td>
<td>The Work of Dr. Khaled Soudki, PhD, P. Eng.</td>
</tr>
<tr>
<td></td>
<td>Dr. Nordin Webb – University of Toronto</td>
</tr>
<tr>
<td>9:45 AM</td>
<td>Seismic Response of Columns Internally Reinforced with GFRP Bars and Spirals</td>
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<tr>
<td></td>
<td>Professor Shamin A. Sheikh – University of Toronto</td>
</tr>
<tr>
<td>10:15 AM</td>
<td>BREAK</td>
</tr>
<tr>
<td>10:30 AM</td>
<td>Precast Concrete for Quality and Durability and how it has evolved in MTO’s Northwest Region</td>
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<tr>
<td></td>
<td>Roy Kousinas – Ministry of Transportation – Ontario</td>
</tr>
<tr>
<td>11:15 AM</td>
<td>Precast Concrete and Prefabrication for Accelerated Bridge Construction (ABC)</td>
</tr>
<tr>
<td></td>
<td>Waela Young – Ministry of Transportation – Ontario</td>
</tr>
<tr>
<td>12:00 PM</td>
<td>LUNCH</td>
</tr>
<tr>
<td>1:00 PM</td>
<td>Glass Fiber Reinforced Polymer applications in Accelerated Bridge Construction</td>
</tr>
<tr>
<td></td>
<td>Dr. Khaled Sannah, Ph.D., P.Eng., FCSCE – Ryerson University</td>
</tr>
<tr>
<td>2:15 PM</td>
<td>BREAK</td>
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<tr>
<td>2:30 PM</td>
<td>Evaluation of an Impact-Damaged Prestressed Concrete Bridge Girder Repaired by Externally Bonded CFRP Sheets</td>
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<tr>
<td></td>
<td>Dr. Khaled Sannah, Ph.D., P.Eng., FCSCE – Ryerson University</td>
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<tr>
<td>3:00 PM</td>
<td>Case Study – Precast Concrete Building</td>
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<tr>
<td>4:00 PM</td>
<td>CPCI Ontario Scholarship Award and Closing remarks</td>
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<tr>
<td>5:15 PM</td>
<td>Cocktail Reception</td>
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</tbody>
</table>
Typical Program for an IFL Seminar

Day 2 – Underground and Concrete Technologies

**DAY 2**  
NOVEMBER 14TH, 2013

<table>
<thead>
<tr>
<th>Time</th>
<th>Session</th>
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<tbody>
<tr>
<td>7:45 AM</td>
<td>Welcome Reception (coffee and light breakfast)</td>
</tr>
<tr>
<td>8:30 AM</td>
<td>CPCi Certification, Life Cycle Assessment, Sustainability</td>
</tr>
<tr>
<td></td>
<td>Robert Burak, P.Eng. - Canadian Precast/Prestressed Concrete Institute</td>
</tr>
<tr>
<td>9:00 AM</td>
<td>Innovation in underground infrastructure/precast culverts</td>
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<tr>
<td></td>
<td>Jason Spenser – Con Cast Pipe</td>
</tr>
<tr>
<td>10:00 AM</td>
<td>BREAK</td>
</tr>
<tr>
<td>10:15 AM</td>
<td>Case Study – Use of Precast Concrete Tunnel Liner Segments</td>
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<td></td>
<td>Brian Garrod, P.Eng. – Hatch Mott MacDonald</td>
</tr>
<tr>
<td>10:45 AM</td>
<td>Prestressing of carbon fiber reinforced polymer tendons in girders. Glass fiber reinforced polymer tubes with concrete for use in piles and utility poles</td>
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<tr>
<td></td>
<td>Dr. Amir Fam – Queens University</td>
</tr>
<tr>
<td>12:00 PM</td>
<td>LUNCH</td>
</tr>
<tr>
<td>1:00 PM</td>
<td>Lafarge, Building Better Cities, Solution Providers and Applications of Ductal – Lafarge Canada</td>
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<tr>
<td>1:30 PM</td>
<td>Bacteria, concrete, and you – from biogenic sulfide corrosion to self-healing concrete</td>
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<tr>
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<td>Dr. Karl Peterson, University of Toronto</td>
</tr>
<tr>
<td>2:30 PM</td>
<td>BREAK</td>
</tr>
<tr>
<td>2:45 PM</td>
<td>Early Field Performance of Low-Shrinkage High-Performance Concrete Deck</td>
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<tr>
<td></td>
<td>Daniel Cusson, PhD. P.Eng. – National Research Council of Canada</td>
</tr>
<tr>
<td>3:45 PM</td>
<td>Professional Engineers Ontario – Denis Dixon, Past President, PEO</td>
</tr>
<tr>
<td>4:15 PM</td>
<td>Available CPCi resources</td>
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<tr>
<td></td>
<td>Joët Rochefort – Canadian Precast/Prestressed Concrete Institute</td>
</tr>
<tr>
<td>4:30 PM</td>
<td>Closing Remarks</td>
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</tbody>
</table>
Case Examples: Hospitals, Institutions, Education Facilities, Office Buildings

• Qualico Head Office, Winnipeg MB

• William Osler Hospital, Brampton ON

• Mundy’s Bay Elementary School, Midland ON

• Toronto South Detention Center, Mimico ON
Qualico Head Office, Winnipeg MB
TOTAL PRECAST EXAMPLE - QUALICO
HEAD OFFICE Winnipeg, MB

• Precast Components
  – 9,200 lin. feet of precast piles.
  – 55,500 ft\(^2\) of 8-inch (200 mm) prestressed hollowcore.
  – 6,700 ft\(^2\) of 12-inch (300 mm) hollowcore.
  – 52 - Precast columns.
  – 72 - Inverted tee beams.
  – 55 – Prestressed spandrel beams
  – 30 - Wall panels.
• Details
TOTAL PRECAST – ACCELERATED SCHEDULE

• Precast Schedule:
  – Piles were produced & driven in March, 2008.
  – Hollowcore was produced in June & July, 2008.
  – Precast production started mid-May, 2008 and ran until the end of July, 2008.
QUALICO HEAD OFFICE

- **Spandrel Beams:**
  - L-shaped beams.
  - **Support hollowcore** on one side.
  - Weld plates cast in for brick support angles.
  - Prestressed to minimize cracking & allow narrow web.
QUALICO HEAD OFFICE
QUALICO HEAD OFFICE

- **Owner/General Contractor:** StreetSide Development Corporation, A QUALICO Company
- **Architects:** Prairie Architects
- **Structural Engineers:** Tower Engineering
- **Precast Concrete:** Lafarge Construction
- **Materials – Precast Division:**
THE SOLUTION
Architectural Insulated Precast Concrete Wall
Resilient Infrastructure
Mundy’s Bay Elementary School
• LEED Gold-Certified elementary school located in Midland, Ontario, that utilizes a radiant air conditioning system
• ‘Top of the Class’ in Enerlife’s survey of Best Performing Schools in North America and sets a new standard in environmentally-conscious school construction

Exterior
Classroom
Mechanical options:
- RAIC + EXHAUST AIR RECOVERY + DEMAND CONTROL VENTILATION + VARIABLE SPEED DRIVES

Approximately 30% of the energy delivered to buildings is dissipated in the departing ventilation and exfiltration air streams.

RAIC captures part of the daytime ventilation heat for nighttime flushing and with energy recovery, it can operate in 100% fresh air or demand-controlled ventilation mode in extreme heat.
Mundy’s Bay Elementary School - Sustainable Energy Solutions Using Precast Hollowcore - Radiant Ceilings

SUMMER COMBINED THERMAL MASS AND COLD CLIMATE NIGHT TIME FLUSHING
Based on a gross floor area of 4,792 m², the annualized energy intensity for the school is 138 ekWh/m² or 12.8 ekWh/sq.ft, which is approximately 40% lower than comparable educational buildings in Ontario.
Toronto South Detention Center
Total Precast Structure
Toronto South Detention Center – Total Precast Structure
Modular Construction
Case Studies: Parking Garages, Stadiums

- GTAA Parking Garage, Toronto Pearson Airport
- GO Transit, Oakville, ON
- Varsity Pavilion, University of Toronto
- Yankee Stadium, NYC
GTAA Parking Structure
GTAA Parking Structure

- **Owners:** Greater Toronto Airports Authority (GTAA)
- **Architect/Engineers:** NORR Limited, Architects Engineers Planners/Walker Parking Consultants
- **General Contractor:** Ellis Don Construction Company
- **Precast Concrete:** Pre-Con Inc./PSI Windsor
GTAA Parking Structure

• Two Phases
• Phase I
  – Main Lobby Tower and Pedestrian Bridge to Terminal
  – Started in 2003, completed in 2006
• Phase II
  – 6 level parking structure; Total: 165,000 sq. m.
  – Fabrication started in January 2008, last piece cast in January 2009 – 5500 total pieces fabricated
  – Last piece erected April 2009
GTAA Parking Structure
GTAA Parking Structure
GTAA Parking Structure
Double T’s provide Long Clear Spans
GTAA Parking Structure
Inverted Tee Beams
GTAA Parking Structure
L-Shaped Load-bearing Spandrel Panels
GTAA Parking Structure
Architectural Finishes
Includes the following Precast elements:

- 691 Double Tees
- 79 Beams
- 234 Spandrels
- 97 Columns
- 95 Column Walls
- 44 Shear Walls
Structural and Architectural Spandrel Panels
Architectural Finishes – Acid Etched Exposed Aggregate Finish
GO TRANSIT - OAKVILLE STATION
PARKING GARAGE
GO TRANSIT - OAKVILLE STATION PARKING GARAGE

6 LEVELS – Parking for 1394 CARS (including slab on grade)

OWNER: GO TRANSIT - GTAA
CONTRACTOR: ELLIS-DON
ARCHITECT: THE WALTER FEDY PARTNERSHIP
ENGINEER: MARSHALL MACKLIN MONAGHAN
Varsity Pavilion - University of Toronto
Varsity Pavilion – University of Toronto

- Completed Fall 2009
- New Building was built over an existing electrical substation and high voltage transformer
- Utilized advantage of prestressed hollowcore to span 16 m safely over the transformer
- Also provided 3 hour fire rating
- Winner – 2009 Ontario Concrete Awards for Structural Design Innovation
A unique two piece shallow beam was designed and fabricated. The beam was bolted together after being set in place.
The project utilized advantage of hollowcore to span 16 m safely over the transformer
Yankee Stadium

1450 Architectural Panels; 150 mm thick precast
50 mm thick Indiana Limestone cast into panels
Varsity Pavilion – University of Toronto

- **Contractor:** M. J. Dixon Construction Ltd.
- **Architect:** Diamond and Schmitt Architects INC.
- **Engineer:** Halcrow Yolles
- **Precast Supplier:** Coreslab Structures (ONT) Inc.

- **Precast Products**
  - 2670 SF of 14” thick hollow core
  - 2650 SF of 12” thick solid precast slabs (26 pcs)
  - 52’ Precast beam (2 pcs)
Yankee Stadium

- Prestressed Bleacher Seats
- Triple Bleachers sections
- 1,960 Seats
Yankee Stadium
Yankee Stadium
INSIDE FINISH
Yankee Stadium

Owner: NY Yankees (MLB)
Architect: HOK Sports Facilities (Populous)
Engineer: Thornton-Tomassetti
Contractor: Turner Construction Company
Precaster: BPDL
Kingston Regional Sports and Entertainment Centre

- Completed 2008
- 5,700 seats
- LEED Certified
- two depths of structural slabs, parabolic bleachers, and cantilevered suite tubs.
- Precaster: PSI Windsor
K-Rock Centre

- 455 single bleachers, 22 tub bleachers, 500 sq. m of 300 mm prestressed hollowcore and 315 sq. m of 250 mm hollowcore.
K-Rock Centre
Case Studies: Bridges

- Whiteman’s Bridge, Brantford
- Port Mann Bridge, Vancouver
- Highways A25 & A30, Montreal
- Hodder Street Bridge, Thunder Bay
Whitemans Creek Bridge, Brantford
Whitemans Creek Bridge, Brantford

A synthesis of accelerated bridge construction, ultrahigh performance concrete and fibre-reinforced polymer reinforcement.

The existing three-span concrete bridge was replaced with a single, 45-metre-span bridge, during a seven-week highway closure.
Wing Wall and Abutment Installation
Deck Slab Installation

UHPC For Shear Pockets
RAPID CONSTRUCTION
Port Mann Highway One and Port Mann Bridge (2010-2012)
Port Mann Highway One and Port Mann Bridge

- This is a rebuild of Highway #1 from 216th Street in Langley, BC to the Cassiar Tunnel in Vancouver.
- The new 10 lane bridge is currently the widest bridge in the world and the 2nd longest cable stayed bridge in the world.
- $2.5B project
- CPCI Members; Surespan, Armtec, APS
Port Mann Highway and Bridge Project

PRECAST CONCRETE ELEMENTS USED

- Precast Prestressed I girders for Highway crossings...typically 1727mm deep
- Precast Box girders for Main Bridge
- Precast prestressed stay in place forming deck panels, 90mm thick
- 250mm full depth deck panels for the main bridge.
Port Mann Highway and Bridge Project

**PRECAST CONCRETE ELEMENTS USED**

- EPS (Expanded Polystyrene) *wall panels*
- RECO *wall panels*
- *Sidewalk panels* for the main bridge
- *Cover panels* for the anchorages in the tower
- *Highway Pedestrian overpasses* with flanged box girders
- *U beams* for pier caps.
Port Mann Box girders
Cantilevered Construction
Typical Box Girder Reinforcing Fabrication at Plant
(Note: These are Alberta LRT)
Box Girder Engineered Formwork
Box Girder “Match Casting”
Port Mann
Main Cable Towers
Port Mann Deck Panels – 1164 in Total
Deck Slabs Shipped by Barge
• **OWNER**: Transportation Investment Corporation - part of B.C. Ministry of Transportation and Infrastructure

**CONSTRUCTION MANAGER**: Kiewit Flatiron General Partnership

**PROJECT DESCRIPTION**: 850 meter long, 65 meter wide cable-supported bridge

**PROJECT ENGINEER**: - a consortium of Hatch Mott MacDonald and MMM Group

**BRIDGE DESIGN ENGINEER**: T.Y. Lin International

**PRECAST SUPPLIER**: Surespan Structures Ltd. & Armtec Infrastructure Inc.
Hwys. A-25 and A-30 Montreal
Hwys. A-25 and A-30 Montreal

- Prestressed Deck Slabs
- Precaster: BPDL, Alma QC
Hwys. A-25 and A-30 Montreal
Hwys. A-25 and A-30 Montreal
Hodder Avenue Bridge
Hodder Avenue Bridge
• Owner: Ministry of Transportation of Ontario, Northwestern Region, Thunder Bay, ON, Canada
• Engineer of Record: Hatch Mott MacDonald, Mississauga, ON, Canada
• Precaster and UHPC Supplier: LaFarge Canada Inc., Winnipeg, MB, Canada
• Contractor: Teranorth Construction & Engineering Ltd., Sudbury, ON, Canada
• Total Cost: $9 million
• Bridge Length: 279 ft (85 m)
THANK YOU

www.cpci.ca