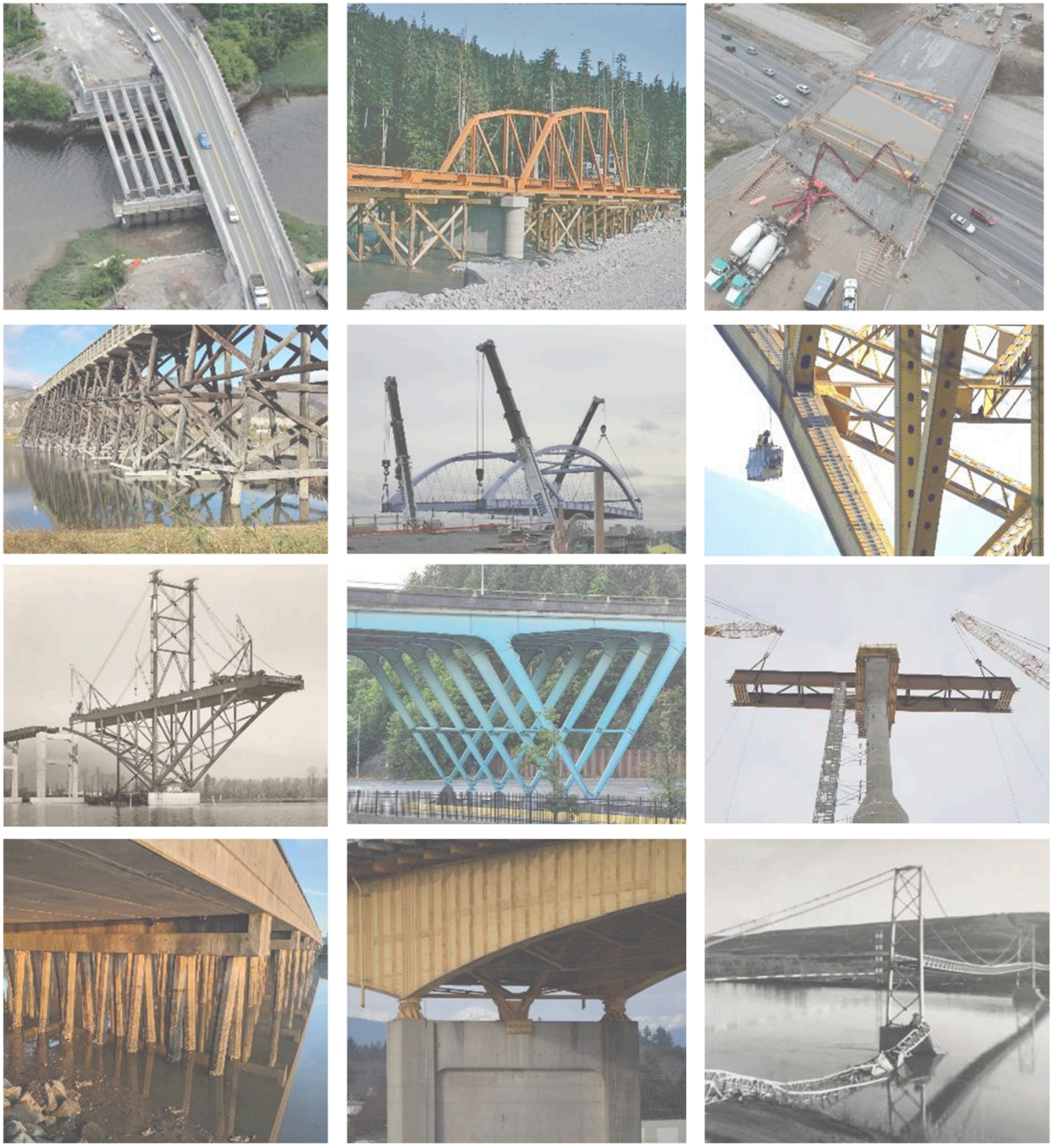
Structural Engineers Association of BC | Certificate in Structural Engineering Program

C55 Practical Topics in Bridge Engineering

***Core Bridge Topics***

# COURSE DESCRIPTION

REVISION B (OCTOBER 31, 2021)



## REVISION HISTORY

**FIRST DRAFT**

| **Date:** 2021-Sep-27 | **Revision:** A | |
|---|---|---|
| **Prepared by** | **Assembled and Reviewed by** | |
| Instructor content prepared by corresponding instructor | Keith Holmes, M.Eng., P.Eng.<br>Manager, Bridges (BC & Yukon)<br>WSP Canada Inc. | |

**ISSUED FOR STUDENT REGISTRATION**

| **Date:** 2021-Oct-31 | **Revision:** B | |
|---|---|---|
| **Prepared by** | **Assembled and Reviewed by** | **Reviewed by** |
| Instructor content prepared by corresponding instructor | Keith Holmes, M.Eng., P.Eng.<br>Manager, Bridges (BC & Yukon)<br>WSP Canada Inc. | Darrel Gagnon, M.Sc., P.Eng.<br>Vice-President and Technical Director<br>COWI Bridge |

# TABLE OF CONTENTS

# C55 Practical Topics in Bridge Engineering

## *Core Bridge Topics*

# INTRODUCTION

## OVERVIEW

### 1. Program Background

The Structural Engineers Association of British Columbia (SEABC) is an association that promotes the interests of structural engineers in British Columbia. A key offering of the SEABC is the Certificate in Structural Engineering Program (CSEP). The goal of the CSEP program is to "*provide additional knowledge and skills in structural engineering to permit the candidate to be more effective in an engineering firm.*" Please see www.seabc.ca for more details.

### 2. Course Context

The CSEP program already covers several major bridge topics including loading (C50), analysis (C51), conceptual design (C52), and seismic (C54). A gap was identified for smaller bridge topics (i.e. joints, bearings, etc.), none of which were suited to a course on their own but useful when combined. An industry survey was completed in January 2021 to gauge interest in potential topics. From this survey, two courses "Practical Topics in Bridge Engineering" were developed:

I. Core Bridge Topics (C55)

II. Asset Management & Supplemental Topics (C56)

While the two courses were developed together, this Course Description covers **C55 "Core Bridge Topics"**. Also, please note that one course is not a prerequisite for the other.

### 3. Course Objective

The objective is to enhance the knowledge base of BC bridge engineers on relevant bridge topics not typically covered by university programs or other full-length SEABC courses.

### 4. Intended Audience

The intended course audience are BC bridge engineers with 1-5 years working experience. However, many aspects of the course will be relevant to bridge engineers of different experience levels and from across Canada.

### 5. Timing

Each course is 13 weeks long (total of 26 weeks) and includes one 2-hour class per week. The first offering of Course C55 is expected to run Jan-March 2022. The first offering of Course C56 is expected to run April-June 2022.

### 6. Instructors

Each class is led by a different instructor, a local specialist on that class topic.

### 7. Delivery

Each class will be delivered both in-person and webcast. In-person classes will be held at UBC Robson, Room C485 - 800 Robson Street, Vancouver, BC. A site-visit to the Oak Street Bridge is planned as part of Class II.7.

### 8. Communication

Notices to students and questions outside of class will be handled strictly through Classbit and e-mail.

### 9. Evaluation

Evaluation is a requirement of the CSEP program. Students mush achieve an overall grade of 68% to pass the course. Evaluation will vary from week to week but will typically include a weekly assignment or quiz. There will be no final exam or major course project.

## ROLES

**Course Coordinators**

- Keith Holmes, M.Eng., P.Eng.
  WSP Canada
  keith.holmes@wsp.com
  604-812-4183
- Darrel Gagnon, M.Sc., P.Eng.
  COWI Bridge
  dpg@cowi.com
  604-961-7339

**Instructors:** See following pages

**Markers:** Daniel Robertson & Thien Tong

**CSEP Board of Directors**

- John Pao, M.Eng., P.Eng. Struct.Eng.
  CSEP Chair
  cse-chair@seabc.ca
- Shannon Remillong
  CSEP Coordinator
  courses@seabc.ca

*(see https://www.seabc.ca/certificate-program/overview/ for full list)*

## MATERIALS AND COPYRIGHT

Students will be provided with a PDF copy of the class materials (typically a PowerPoint presentation). Instructors will identify but not provide reference materials for their respective topics. Students are expected to have access to key course materials including CSA S6:19 Canadian Highway Bridge Design Code through their own means.

Note that any shared class materials will abide by the requirements of its publishers. For this course, SEABC has obtained authorization from CSA to share only limited excerpts of S6:19, embedded within the presentation materials.

## WEEK I.1 | INTRODUCTION & BRIDGE LOADING

### OBJECTIVES

*By the end of the class, students will understand:*

1. General layout and goals of C55 & C56 courses on Practical Topics in Bridge Engineering
2. Background philosophy and key components of CHBDC S6-19 Section 3 – Loads

### KEY TOPICS

1. Introduction to courses C55 & C56
2. Life safety philosophy basis for CHBDC
3. Basic derivation of limit states design to achieve target life safety
4. Design load factors and load combinations
5. Permanent Loads
6. Live Loads
7. Other Loads

### REFERENCES & EVALUATIONS

| | |
|---|---|
| Key References: | • CSA S6:19 CHBDC Section 3<br>• BC MoTI Supplement to CHBDC |
| Eval. Format: | Take home assignment – short answer questions |

### LEAD INSTRUCTOR

**DARREL GAGNON, M.Sc., P.Eng.**
**Vice-President and Technical Director**

Darrel Gagnon is a Vice President and Technical Director for COWI North America Ltd. with over 34-years of experience on small to major bridge projects throughout North America and overseas. Darrel has served keys role on many of western Canada's largest bridge projects including Golden Ears, Lions' Gate, Port Mann, Pattullo, and Walterdale Bridge.

Since 2010 he's led the management, inspection, evaluation, rehabilitation design and new design of Parks Canada's western inventory of 200+ bridges. Darrel is an ongoing member of S6 (CHBDC) Technical Committee and multiple Sub-Committees including Section 3 – Loads (Chairman), Section 14 – Evaluation (Chairman) and Section 15 – Rehabilitation. In addition, he's been a key member of CSA's recent Climate Change Study for Bridges.

Darrel has served on the SEABC educational board for over seven years and is the instructor for SEABC course C50 – Bridge Loadings and Load Ratings.

### SUPPORTING INSTRUCTOR

**KEITH HOLMES, M.Eng., P.Eng.**
**Manager, Bridges (BC & Yukon)**

Keith Holmes is the Bridge Group Manager for WSP in British Columbia and Yukon with over 20-years of experience on major infrastructure works in BC and overseas. Keith has served a key role on many of BC's largest projects including Sea-to-Sky Highway, Port Mann / Highway 1, and Kicking Horse Canyon Phase 4.

Keith authored the 2010 TAC Guide to Bridge Traffic and Combination Barriers and led full-day workshops to support the TAC Guide in major cities across Canada. Keith presently serves on the Section 12 Sub-Committee for the Canadian Highway Bridge Design Code (CHBDC) and has provided barrier related updates to the BC MoTI's 2016 and 2021 Supplement to the CHBDC.

## WEEK I.2 | SELECT GEOTECHNICAL TOPICS

### OBJECTIVES

*By the end of the class, students will understand:*

1. How to communicate with geotechnical engineers on a project
2. Geotechnical site characterization
3. Seismic hazard and liquefaction potential

### KEY TOPICS

1. Subsurface characteristics
   a. Soil properties and classification
   b. Influence of pore water pressure
   c. Bedrock properties
2. Geotechnical challenges (settlement, stability, liquefaction, etc)
3. Site investigation
   a. Drilling
   b. In-site testing
   c. Geophysics
   d. Laboratory testing
4. Seismic Hazard
   a. 2015 vs 2020 Hazard Model
   b. Site Class vs Vs30
   c. Amplification Effects
   d. Site Response Analysis (linear and non-linear)
5. Liquefaction potential
   a. Behaviour
      – Sand-like, Clay-like
   b. Triggering
      – Simplified, Complex
   c. Consequences
      – Reduced Strength/Stiffness
      – Settlement
      – Lateral Displacement
      – Kinematic loads on piles

### REFERENCES & EVALUATIONS

| | |
|---|---|
| Key References: | • CDN Foundation Engineering Manual<br>• CSA S6:19 CHBDC<br>• BC MoTI Supplement to CHBDC |
| Eval. Format: | Google Quiz (take-home multiple choice, including simple calculations using geotechnical inputs) |

### LEAD INSTRUCTOR

**CHRIS WEECH, M.ASc. P.Eng.**
**Senior Geotechnical Engineer**

Chris Weech is a Senior Geotechnical Engineer with Thurber Engineering located in Victoria, BC. With 24 years of geotechnical engineering experience, he has a wide range of civil infrastructure projects in British Columbia, and at various Canadian and International locations. He has provided geotechnical design input for over 20 bridges and has particular expertise in soft soils engineering, deep foundations, and seismic design practice. Chris has been on technical review / advisory boards for several seismic retrofit programs, including the Legislative Assembly of BC and various schools on Vancouver Island, and is currently a contributor to the site response analysis procedures within the Seismic Retrofit Guidelines for Low-Rise Buildings in British Columbia. He is also a member of the Task Group on Seismicity and Site Amplification for the 2025 National Building Code of Canada.

## WEEK I.3 | SELECT FOUNDATION TOPICS

### OBJECTIVES

*By the end of the class, students will understand:*

1. How to communicate with geotechnical engineers on a project
2. Soil structure interaction
3. Earth pressures on abutments

### KEY TOPICS

1. Soil-structure interaction
   a. Foundation type
      – Shallow, Deep
   b. Static
      – Settlement
         o Pile down-drag
         o Differential settlement at abutment / approach fill interface
      – Lateral displacement (approach fill induced lateral displacement)
   c. Seismic
      – Inertial loading
      – Kinematic loading
      – Settlement
2. Soil Springs
   a. Footings
   b. Piles
      – Axial, Lateral
   c. Abutments
      – Lateral resistance, demand

### REFERENCES & EVALUATIONS

| | |
|---|---|
| Key References: | • CDN Foundation Engineering Manual<br>• CSA S6:19 CHBDC<br>• BC MoTI Supplement to CHBDC |
| Eval. Format: | Google Quiz (take-home multiple choice, including simple calculations using geotechnical inputs) |

### LEAD INSTRUCTOR

**JUAN CARLOS CARVAJAL, Ph.D., P.Eng.**
**Senior Geotechnical Engineer**

Juan-Carlos is a Senior Geotechnical Engineer with Thurber Engineering located in Vancouver, BC. He has over 20-years of combined professional and research experience in geotechnical, geo-structural and earthquake engineering, structural dynamics, ambient vibration testing of bridges, forensic engineering, and advanced finite element analysis. Highlights of his experience include selection and scaling of earthquake records, nonlinear site response analysis, liquefaction assessment, seismic soil-structure interaction analysis, seismic response of bridge embankments, and foundation design.

## WEEK I.4 | CONCRETE MATERIALS

### OBJECTIVES

*By the end of the class, students will understand:*

1. The importance of specifying concrete properties for bridge construction with respect to CSA and MoTI requirements
2. How to identify concrete issues related to mix design, constructability, durability corrective action before and during construction

### KEY TOPICS

1. Concrete specifications (CSA A23.1/2), BC MOTI SS and DBSS and BC Supplement to CHBDC S6-14
2. Concrete mix design submittals – one page doesn't cut it
3. Performance Requirements – Durability
4. Performance Requirements – Constructability
   a. Production
   b. Conveyance
   c. Placement
   d. Finishing
   e. Curing
   f. Protection
5. Mass concrete and thermal mitigation
6. Quality Control
   a. What is being done and what should be done
7. Challenges
   a. Environmental requirements
   b. Materials availability (e.g. fly ash)
   c. Concrete production in remote areas

### REFERENCES & EVALUATIONS

| | |
|---|---|
| Key References: | • CSA A23.1:19/CSA A23.2:19<br>• BC MoTI Requirements |
| Eval. Format: | Take home assignment - mix design review and what to look for in the standard documents |

### LEAD INSTRUCTOR

**OLIVER GEPRAEGS, M.ASc., P.Eng.**
**Senior Materials Engineer**

Oliver Gepraegs is a Senior Materials Engineer located in Victoria, BC. He is an expert in concrete materials engineering, quality management and the assessment rehabilitation of structures. He has extensive experience in service life assessment, durability design and thermal mitigation for mass concrete.

Oliver has been involved with transportation and infrastructure projects across Canada and internationally, including the Sea-to-Sky Highway, Port Mann Highway 1 Project, Highway 29 re-alignment, and Kicking Horse upgrades. He is a Professional Engineer registered in the Provinces of Alberta and British Columbia, and is a member of the American Concrete Institute (ACI), serving actively on several technical committees. He has given presentations and taught courses on bridge condition assessment, service life, rehabilitation and reinforcing steel corrosion.

## WEEK I.5 | REINFORCED CONCRETE

### OBJECTIVES

*By the end of the class, students will understand:*

1. Deck design and reinforcing bar types
2. Force flow in reinforced concrete members

### KEY TOPICS

1. Deck Design
   a. Empirical method
   b. Cantilever design/barrier anchorage considerations
   c. Link slabs
   d. Crack control
   e. Partial-/Full-depth precast panels
2. Force Flow and Strut-and-tie Modelling
   a. Basics
   b. Example: Beam (transition from B to D regions, explain STM vs MCFT, "Flt", reinforcing detailing)

### REFERENCES & EVALUATIONS

| | |
|---|---|
| Key References: | • CSA S6:19 CHBDC Section 8<br>• Collins & Mitchell<br>• MacGregor textbook<br>• Muttoni stress-field book (not mandatory) |
| Eval. Format: | Take-home assignment - numerical strut -and-tie modelling problem |

### LEAD INSTRUCTORS

**KATRIN HABEL, Dr.sc.techn., P.Eng.**
**Manager, Transportation Structures**

Katrin Habel is the Manager for Transportation Structures for Associated Engineering located in Vancouver, BC. Her experience includes new design, rehabilitation and strengthening, assessments, and load ratings of bridges, retaining walls, culverts and related structures, and project management with a focus on reinforced concrete, ultra-high performance concrete (UHPC) and rehabilitation.

For the Canadian Highway Bridge Design Code, Katrin is a member of several committees and subcommittees, notably Vice-Chair of the Technical Subcommittee 15 – Rehabilitation, Member of Technical Subcommittee 8 – Concrete, and Chair of the task force on fibre reinforced concrete. Katrin is also an active member of several committees of the American Concrete Institute, including the committees on strut-and-tie modeling and UHPC.

**CRAIG SCHAPER, P.E., C.Eng., P.Eng.**
**Senior Bridge Specialist**

Craig is a bridge specialist with 30 years of experience on projects in Canada, America, Europe, Taiwan and South Africa. Craig has had key roles on several significant bridges in Western Canada, including the Pitt River Bridge, the Vancouver Convention Center Expansion Project Overpass, and the McTavish Interchange Overpass, besides other road and pedestrian bridges across Canada. As an advisor on operations, maintenance and repair contracts such as for the 3.4 km Champlain Bridge in Montreal, he encourages best-practice detailing in design to enhance the durability of structures. He has authored several scientific/technical papers.

Craig has a wide variety of bridge design experience in reinforced concrete and deck design. This allows him to discuss design aspects on bridges with authority and bring his experience into the course.

## WEEK I.6 | PRESTRESSED CONCRETE

### OBJECTIVES

*By the end of the class, students will understand:*

1. Fundamentals of design of prestressed concrete
2. Practical experience for design and detailing of prestressed members

### KEY TOPICS

1. Partial prestressing and full prestressing
2. PT losses and secondary effects
3. Local design of webs of PT members
4. Camber estimates for prestressed concrete girder bridges
5. Stressing sequence of post tensioned members

### REFERENCES & EVALUATIONS

| | |
|---|---|
| Key References: | • CSA S6:19 CHBDC Section 8<br>• CPCI Precast Concrete Design Manual |
| Eval. Format: | Take home assignment – calculations of prestressing losses |

### LEAD INSTRUCTOR

COWI

**HISHAM IBRAHIM, Ph.D., P.Eng.**
**Vice President and Technical Director**

Hisham Ibrahim is a Vice President and Technical Director for COWI North America Ltd. with over 26 years of practical experience working on local and international large bridge projects. His project experience includes Tappan Zee Bridge in NYC, Arthur Ravenel Jr Bridge in Charleston, Rama 8 Bridge in Thailand, Stonecutters Bridge in Hong Kong, Chacao Bridge in Chile and Golden Ears Bridge in Vancouver. He has been also involved in the construction engineering and the erection analysis of many complex concrete bridge projects such as Sheikh Zayed Bridge in Abu-Dhabi and 6th Street bridge in LA.

Hisham is a concrete design expert who has received his Ph.D. degree from the University of Alberta in the area of High Strength Concrete. He has been a member of the technical subcommittee Chapter 8 (concrete structures) of the Canadian Bridge code since 2006.

## WEEK I.7 | BRIDGE SPECIFIC TOPICS IN STEEL

### OBJECTIVES

*By the end of the class, students will understand:*

1. The advantages of using steel for bridge design
2. Sizing member details for stiffeners, locating and sizing connections.
3. And be exposed fatigue, corrosion, and durability details.

### KEY TOPICS

1. Why Steel? When should you use steel
2. Getting started, span arrangement, articulation, and preliminary sizing
3. Girder Spacing, cross frames, lateral bracing, vertical/longitudinal stiffeners
4. Connection details, field vs shop, bolt connections
5. Deck considerations, panels, shear connectors, lateral floor beams
6. Fatigue
7. The little details, durability, inspection, drainage, jacking requirements

### REFERENCES & EVALUATIONS

| | |
|---|---|
| Key References: | • CSA S6:19 CHBDC Section 10<br>• BC MoTI Supplement to CHBDC |
| Eval. Format: | Take home assignment – sizing and spacing of steel girders for bridge crossings |

### LEAD INSTRUCTOR

**TONY MARTIN, M.ASc, P.Eng.**
**Vice President, Bridges & Structures**

Tony Martin is a Vice President and principal structural engineer with 38 years of experience in the analysis, design, and construction of highway, pedestrian, and rail bridges, as well as marine structures. Tony has had a variety of project roles, including project director, project manager, lead engineer, owner's engineer, and contractor's engineer. He has participated in project delivery that includes traditional design-bid-build, early contractor involvements, alliance, design-build, and public-private partnership projects. His responsibilities have included structural standards, design details, production quality, and final project reviews.

Tony's expertise includes detailed design and seismic analysis of new structures, as well as retrofit and rehabilitation of existing structures. Tony has been a lead designer in major DB projects in BC, such as the Port Mann/Highway 1 Improvement Project, Sea to Sky Highway project and a recent bid proposal for the Kicking Horse Canyon Phase 4 Project. Tony reviewed sections of the Ministry's supplement to the Canadian Highway Bridge Design Code, CAN/CSA-S6-19. Tony also served as reviewer for EGBC's Professional Practice Guidelines for Performance Based Seismic Design of Bridges in BC.

## WEEK I.8 | ECONOMICAL DESIGN OF STEEL BRIDGES

### OBJECTIVES

*By the end of the class, students will understand:*

1. How steel bridges are fabricated and some of the methods used for welding and inspection
2. How the choices made at the design stage affect the economics

### KEY TOPICS

1. Materials
2. Fabrication process
3. Welding inspection
4. Design of plate girders for economy
5. Design of box girders for economy
6. Bracing considerations
7. Analysis and fit condition
8. Girder transportation

### REFERENCES & EVALUATIONS

| | |
|---|---|
| Key References: | --- |
| Eval. Format: | Take home assignment |

### LEAD INSTRUCTOR

**PAUL KING, MS, P.Eng.**
**Vice-President, Engineering**

Paul King is the Vice-President (Engineering) of Rapid-Span Structures located in Armstrong, BC; one of the leading bridge fabricators in western Canada. He has over 30-years experience in the design and fabrication of steel bridges; offering practical insight into economical solutions for steel bridge design.

He holds a bachelor's degree in Civil Engineering from the University of British Columbia and a master's degree in Welding Engineering from The Ohio State University. After graduating he worked in the consulting field for three years before joining Rapid-Span. Since 1992, he has overseen the engineering and quality departments at Rapid-Span; taking part in the design and fabrication of large and small steel bridges across Canada and around the world. His expertise includes steel design, welding engineering and bridge fabrication.

Paul is an active participant in industry organizations dedicated to the advancement of steel bridge design and fabrication:

- CISC National Steel Bridge Committee
- CAN/CSA-S6 Canadian Highway Bridge Design Code: Clause 10 (Steel Bridges)
- CSA W59 Welding Code
- CSA G40.20/G40.21 Structural Quality Steel

## WEEK I.9 | BEARINGS

### OBJECTIVES

*By the end of the class, students will understand:*

1. The function and importance of bearings in the articulation of bridges
2. The various bearing options available and the benefits and drawbacks of each option

### KEY TOPICS

1. Overview of bridge articulation, movements, and importance of bearings
2. Overview of relevant sections of Section 11 of the CHBDC (CSA S6-19)
3. Bearing types / options and benefits / drawbacks of each product
4. Anecdotes from combined experience with various bearings
5. Examples of good detailing and poor detailing (as well as consequences)

### REFERENCES & EVALUATIONS

| | |
|---|---|
| Key References: | • CSA S6:19 CHBDC Section 11<br>• BC MoTI Supplement to CHBDC |
| Eval. Format: | Take home assignment - size an elastomeric bearing for given loads and rotations |

### LEAD INSTRUCTOR

**THIERRY CHICOINE, PhD., P.Eng.**
**Senior Bridge Engineer**

Thierry Chicoine is a Structural Bridge Engineer with 20-years' experience who specializes in the analysis, design, evaluation, and project management of reinforced concrete, prestressed concrete, and steel bridges. He is familiar with a wide range of bridging solutions, including slab-on-girder bridges, box-girder bridges, truss bridges, segmental bridges, cable-stayed bridges, and suspension bridges.

Thierry possesses international experience having worked within multi-disciplinary teams on projects in Canada, the United States, United Kingdom, Denmark, New Zealand, and Australia. He has been involved in the development of innovative construction methods such as bridge sliding and launching to find solutions that are time-saving, cost-effective, and meet the clients' needs.

Thierry's academic background and participation in the S6 technical committee helps him understand the importance of education, research, innovation, and state-of-the-art engineering knowledge.

### SUPPORTING INSTRUCTOR

**CHAD AMIEL, P.Eng.**
**Senior Bridge Engineer**

Chad Amiel is a professional engineer with over 14-years of progressive experience in bridge engineering, from load evaluations, design, and construction engineering to on-site quality assurance and project management. He is experienced in the analysis and design of bridges, retaining walls and culverts, including specialized construction staging such as incremental launching.

Chad has also provided on-site engineering support to contractors, including site supervision on behalf of the lead designer. His experience in construction engineering means constructability is a key feature of his designs.

# WEEK I.10 | DECK JOINTS

## OBJECTIVES

*By the end of the class, students will understand:*

1. The importance of bridge deck joints with respect to bridge articulation
2. The various deck joint options available and the benefits and drawbacks of each product

## KEY TOPICS

1. Overview of bridge articulation, movements, and importance of deck joints
2. Overview of relevant sections of Section 11 of the CHBDC (CSA S6-19)
3. Deck joint types / options and benefits / drawbacks of each product
4. Anecdotes from combined experience with various deck joints
5. Examples of good detailing and poor detailing (as well as consequences)

## REFERENCES & EVALUATIONS

| | |
|---|---|
| Key References: | • CSA S6:19 CHBDC Section 11<br>• BC MoTI Supplement to CHBDC |
| Eval. Format: | Take home assignment - calculate thermal and other movements, and joint detailing |

## LEAD INSTRUCTORS

**DAVID ELLIS, P.Eng.**
**Division Manager, Bridges (Victoria)**

David Ellis manages the McElhanney Bridge Division based out of Victoria, BC. He has over 11-years of experience working on bridge and transportation projects throughout BC, which included field roles during the construction of the Pitt River and Port Mann Bridges while working for Kiewit. Since a career shift to consulting in 2012, David has been involved in several major highway infrastructure improvement projects throughout Canada.

Throughout his career, David has worked on a wide range of deck joint solutions, including the procurement and installation of large displacement multi-gland modular joints on the Port Mann Bridge, field modifications to the Pitt River Bridge finger joints, and design of repairs to the Lion's Gate Bridge deck joints – which included modeling the impact of displacements and rotations from wind and seismic load cases using second order analysis with a three-dimensional finite element model and building a two-dimensional balsa wood model of the joint.

**PAUL SARGENT, M.Eng., P.Eng.**
**Senior Bridge Engineer**

Paul Sargent is a Senior Bridge Engineer with over 23 years of experience in structural engineering. He has experience in new bridge design, bridge inspections, bridge evaluation and rehabilitation, seismic analysis and retrofits, live load assessments, value engineering, failure assessments, and bridge erection / demolition schemes.

Paul's bridge experience includes highway bridges, forestry and resource road bridges, municipal bridges, pedestrian overpasses, railway overpasses, light rapid transit guideways, ferry ramp structures, prestressed concrete superstructures, steel superstructures, timber superstructures, curved and skewed bridge geometry – giving him exposure to a wide range of deck joint systems. He has been the Engineer of Record for bridge replacement and bridge rehabilitation projects throughout BC. He is also a certified Journeyman Carpenter.

## WEEK I.11 | CONSTRUCTABILITY

### OBJECTIVES

*By the end of the class, students will understand:*

1. Overview of bridge construction methodologies
2. Design of bridges for constructability

### KEY TOPICS

1. Review of bridge construction methodologies
2. Constructible and not-so-constructible bridges
3. Fabrication issues and limitations (not discussed in Class 1.8)
4. Transport issues and limitations
5. Field connections in steel and concrete structures
6. Roles and responsibilities in design and construction
7. Temporary components

### REFERENCES & EVALUATIONS

| | |
|---|---|
| Key References: | Photos, inputs from Scott Marshal (Conforce) and Paul King (RapidSpan) |
| Eval. Format: | Take home assignment - a simplified conceptual design of bracing required for construction or erection |

### LEAD INSTRUCTOR

**NIKOLA CUPERLOVIC, P.Eng.**
**Specialist, Special Structures**

Nikola Cuperlovic is a senior bridge specialist working for Associated Engineering in Vancouver, BC. Nik has worked on a number of new bridge designs, as well as retrofits of many big and small bridges. He was also a design lead for a number of bridge erection designs in Canada and internationally, including major cable stayed, arch, suspension and steel and concrete girder bridges.

Nik started his career working for a bridge contractor, and as a design engineer, worked in close cooperation with steel and concrete fabricators and contractors on design-build project and construction, which gave him a strong understanding of bridge building issues. Previously, Nik co-presented four SEABC bridge engineering courses in bridge design and analysis.

# WEEK I.12 | CONSTRUCTION QC

## OBJECTIVES

*By the end of the class, students will understand:*

1. The importance of oversight beyond the 'IFT' drawing set and requirements of EGBC with respect to field reviews
2. Key specifications and contract requirements relating to bridge construction

## KEY TOPICS

1. Overview of EGBCs EOR responsibilities after tender in the context of bridge construction projects, including a summary of the BC MoTI requirements for highway bridges
2. Overview of various specifications (Ministry SSHC, various CSA specs, etc.)
3. Examples of specification interpretation, including discussion on pipe pile construction / quality issues (ASTM A252 vs API, weld inspection testing requirements for spiral pipe, etc)
4. Anecdotes from experience with field reviews and in-plant inspection

## REFERENCES & EVALUATIONS

Key References:
- BC MoTI Standard Specifications for Highway Construction
- Parks Canada Specifications
- National Master Specifications
- Master Municipal Contract Documents
- Various CSA Specifications

Eval. Format: Take home assignment – answering contractor queries on commonly used technical specifications (RFIs)

## LEAD INSTRUCTORS

McElhanney

**ERNIE WONG, M.ASc., P.Eng.**
**Senior Bridge Engineer**

Ernie Wong is a Senior Structural Engineer with over 20-years of professional experience in structural engineering, with a focus on bridges and heavy industrial buildings (including small hydroelectric power infrastructure).

The majority of his experience is with bridge and structural projects for the Ministry of Transportation and Infrastructure. Ernie is specifically involved in the design and construction of new highway bridge structures, including bridge replacements, and assessment and rehabilitation of existing highway bridges.

In addition to his role leading the design of significant bridge projects, including engineering services throughout construction, Ernie has been instrumental in the development and execution of in-plant quality assurance. This has led to Ernie being very familiar with the standards and procedures for inspections, design, and construction of municipal and provincial infrastructure projects.

McElhanney

**CHRISTIAN COPP**
**Project Manager / Technologist**

Christian Copp is a Technologist with over 13-years of experience working on bridge and structural projects. Over the past decade, Christian has steadily taken on more responsibility in our in-plant quality assurance business and currently manages all of the in-plant quality assurance work that McElhanney provides to the Ministry of Transportation and Infrastructure (MoTI) and the Ministry of Forests, Lands, Natural Resource Operations and Rural Development (MFLNRORD).

Christian's role at McElhanney includes overseeing a team of 12 part- and full-time employees throughout British Columbia and Alberta who cumulatively provide quality assurance services for hundreds of bridges each year. This includes everything from cattleguard structures to steel girder bridges hundreds of meters in length.

## WEEK I.13 | BARRIERS AND RAILINGS

### OBJECTIVES

*By the end of the class, students will understand:*

1. The philosophy for barrier design in North America
2. Test levels for a variety of barrier applications
3. Barrier types and design requirements
4. Strategies for barrier designs without crash-testing

### KEY TOPICS

1. Introduction, background, barrier design philosophy
2. Test levels and warranting / "Barrier Buddy"
3. Barrier types and concepts: shapes, flexibility, curbs, snags, ZOI
4. Kahoot: local barrier examples and types
5. Detailed barrier design
6. Combination barriers and multi-modal protection
7. Barrier End Treatments
8. Frequently Asked Questions / Q & A
   a. Bridge vs Roadside Barriers

### REFERENCES & EVALUATIONS

| | |
|---|---|
| Key References: | • CSA S6:19 CHBDC Section 12<br>• BC MoTI Supplement to CHBDC<br>• TAC Guide to Bridge Traffic and Combination Barriers<br>• Various Jurisdictional Resources |
| Eval. Format: | Take home assignment – barrier warranting + short answer questions on barrier design |

### LEAD INSTRUCTOR

**KEITH HOLMES, M.Eng., P.Eng.**
**Manager, Bridges (BC & Yukon)**

Keith Holmes is the Bridge Group Manager for WSP in British Columbia and Yukon with over 20-years of experience on major infrastructure works in BC and overseas. Keith has served a key role on many of BC's largest projects including Sea-to-Sky Highway, Port Mann / Highway 1, and Kicking Horse Canyon Phase 4.

Keith authored the 2010 TAC Guide to Bridge Traffic and Combination Barriers and led full-day workshops to support the TAC Guide in major cities across Canada. Keith presently serves on the Section 12 Sub-Committee for the Canadian Highway Bridge Design Code (CHBDC) and has provided barrier related updates to the BC MoTI's 2016 and 2021 Supplement to the CHBDC.