

Hodder Avenue Underpass



Innovative Use of Ultra-High Performance Concrete for Rapid Bridge Construction



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Location



Challenges:

- First grade separated interchange in Northwestern Ontario
- Across the busiest highway
- Short construction season
- Resource constrained
- Harsh climate and De-icing chemical
- Aesthetics to match nearby scenery



Solutions:

- Prefabricated components
- Less on-site working days
- Best use of available resources
- High strength and durability concrete
- Very slender profile with enhanced quality



"Bridge-out-of-a-box"



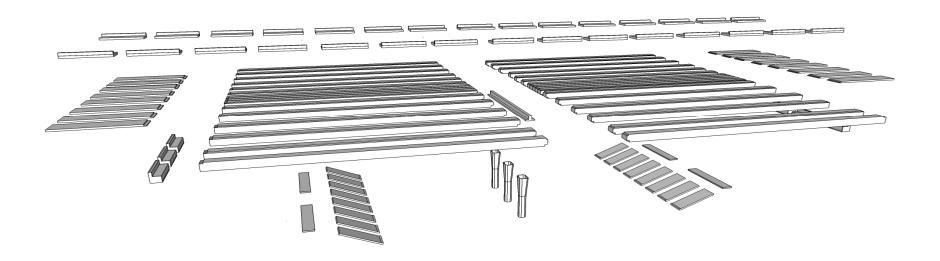
Previous Projects

Name of Structure	Year	Spans (m)	Precast Components
Sunshine Creek Bridge	2007	19.5	Girders, Curbs, Approach slabs
Buller Creek Bridge	2009	27.5	Girders, Curbs, Approach slabs
La Vallee River Bridge	2010	19.7	Girders, Curbs, Approach slabs
Eagle River Bridge	2010	26.2+34.1+26.2	Girders, Curbs, Approach slabs
Wabigoon River Bridge	2010	16.5+27.5+16.5	Girders, Curbs, Approach slabs, Pier column shells
Hodder Ave Underpass	2012	33.5+33.5	Girders, Sidewalks, Parapet walls, Approach slabs, Pier column shells, Pier cap, Abutment caps, Abutment ballast walls, Slope paving



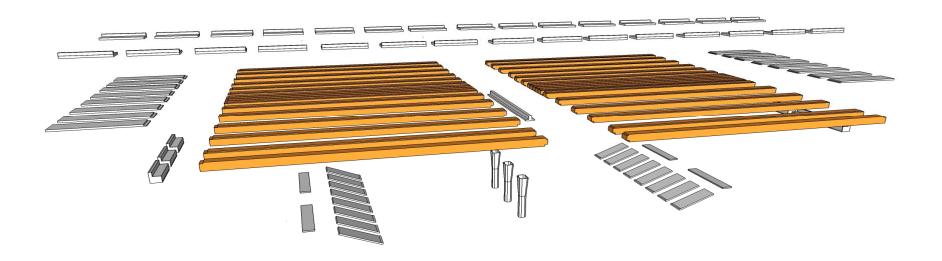
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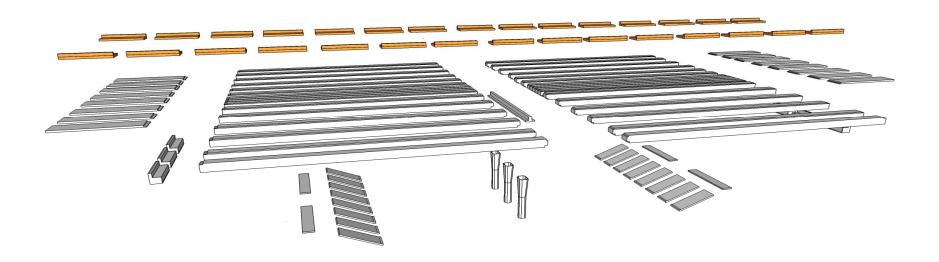
Pre-fabricated components





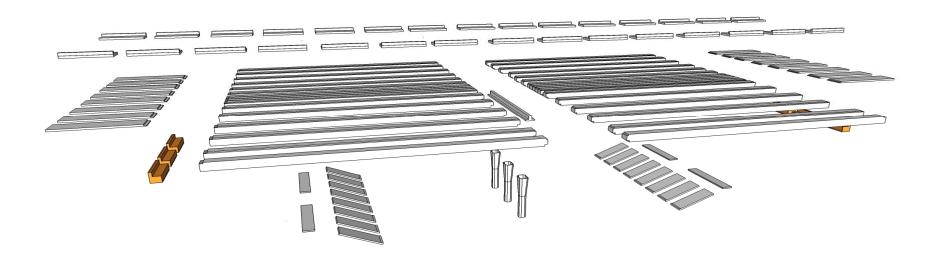
32 Prestressed Box Girders





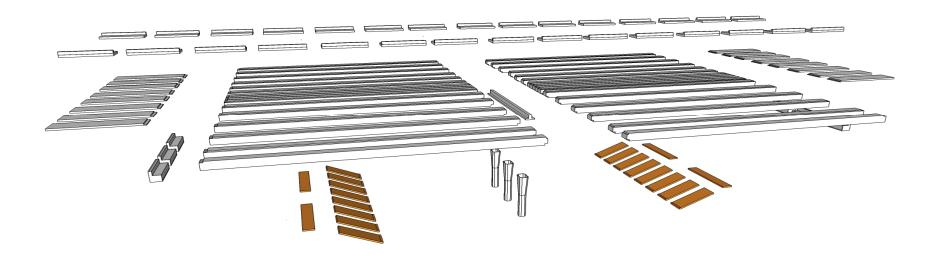
30 sidewalk/parapet wall panels





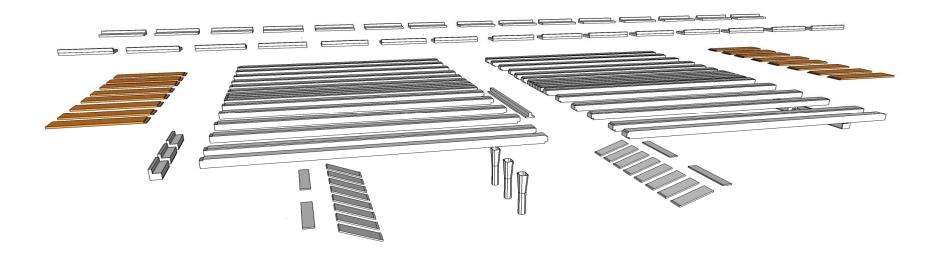
2 Ballast walls and Abutment caps





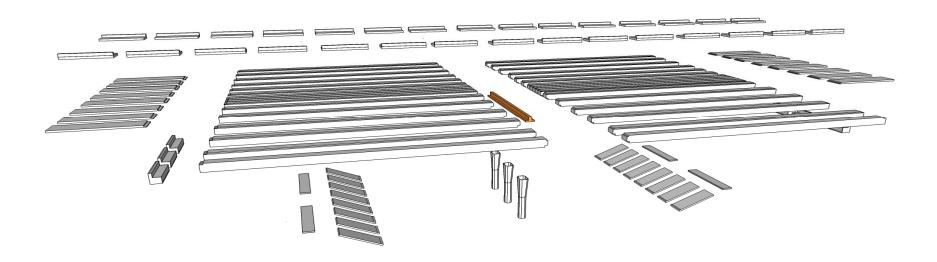
20 slope paving panels





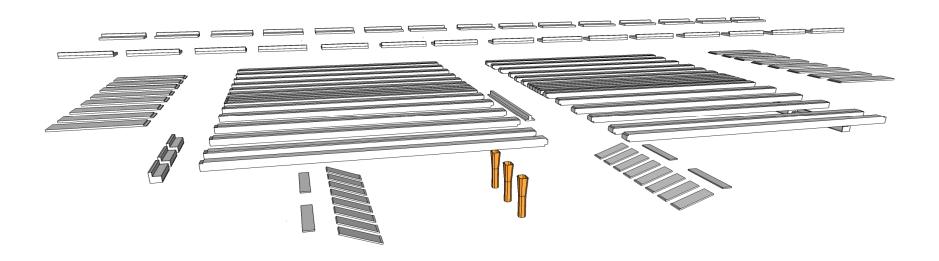
16 approach slab panels





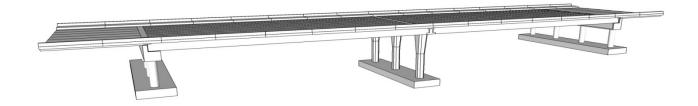
An inverted-T shape UHPC pier cap





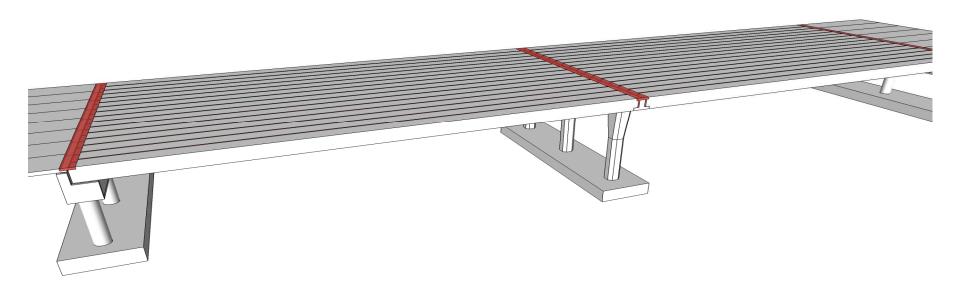
3 UHPC pier column shells





Components assembled





Field-cast UHPC joints



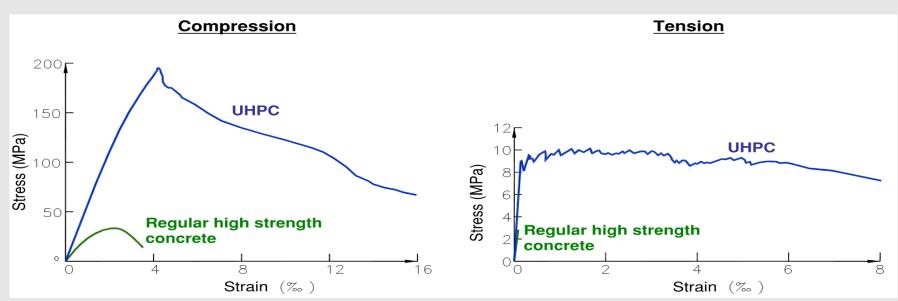
UHPC

- Ultra-High
 Performance
 Concrete (UHPC)
- Cement matrix with internal fibres



UHPC

 Compressive strength up to 200 MPa Tensile strength up to 10 MPa





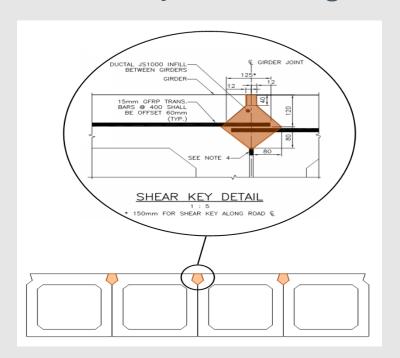
UHPC

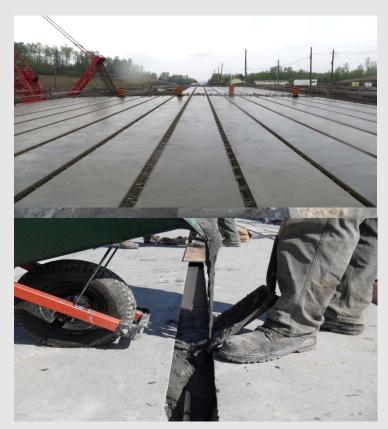
- High strength
- Ductility
- Durability
- Fluidity Self-consolidating





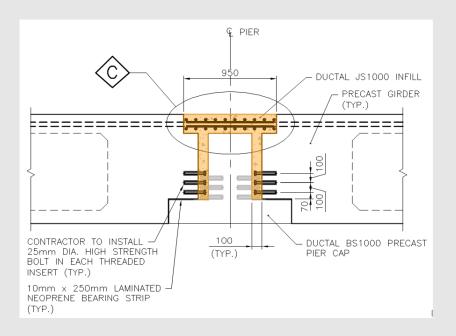
• Shear key between girders







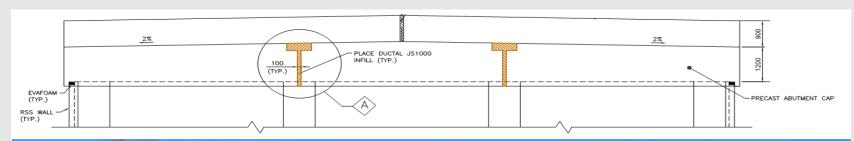
Continuity joint over pier







Abutment cap joints



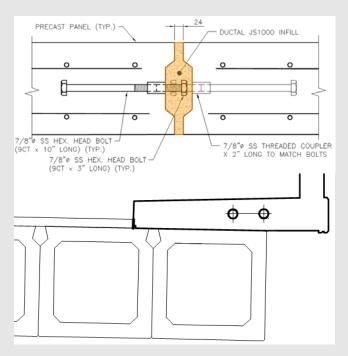




Approach slab panel joints



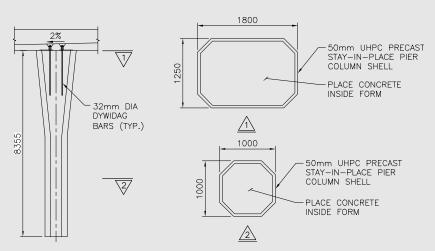
Sidewalk/parapet wall panel joints





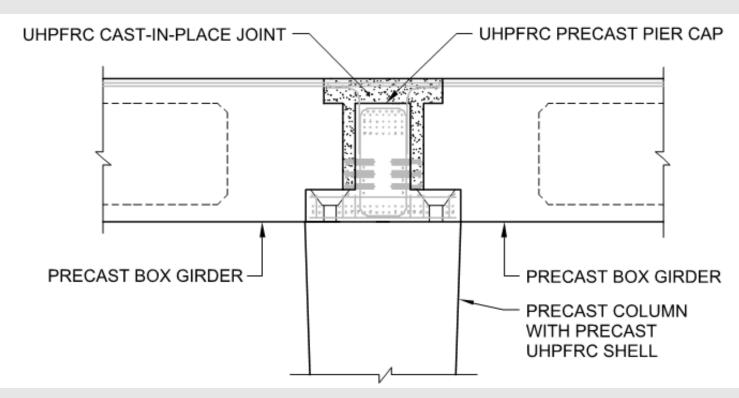
Pier Columns with UHPC Shells

- Construction Stay-in-place form with reinforced concrete infill
- Durability Low porosity protective shell
- Aesthetics Octagonal flaring geometry

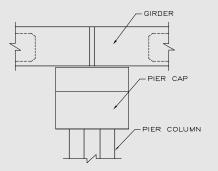






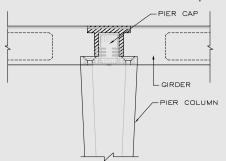


Conventional pier cap design





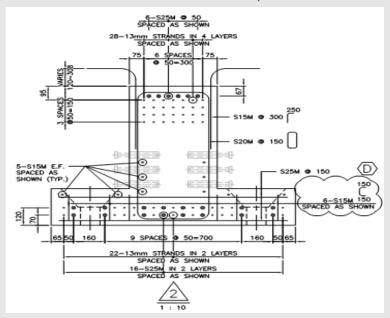
Hodder embedded pier cap design







- Inverted-T shaped pier cap
- Prestressed and precast with UHPC







• Finished pier cap with columns



• Finished pier cap with columns







Highlights:

- On-site working days is 80% of conventional method
- Erect each girder in 15 minutes
- Less formwork and associated safety issue
- Effective use of UHPC and precast resources
- Unique design of pier cap and joint
- Stay-in-place pier column form
- Minimized impact on the traffic
- Enhanced quality, durability and aesthetics



Aesthetics



Typical Highway Bridges





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Typical Highway Bridges



Slenderness

Examples Elevation Span-todepth ratio Hodder Ave. Underpass, Thunder Bay, Ontario 29.1 (Photo: Lafarge) A bridge over Highway, Ontario Approx. (Photo: Hatch) 14.0 WEST ABUT. EAST 40335 40335 ABUT. Doane Road Underpass over Highway 18.3 404, Queensville, Ontario 42000 42000 Queensville Side Road Underpass over 19.1 Highway 404, Queensville, Ontario



Traditional highway bridges







Scenario of innovation







Hodder Ave. Underpass



• Hodder Ave. Underpass



Awards and Publications





- PCI Harry H. Edwards Industry Advancement Award
- PCI Design Award (Main Span 76–150 Feet)
- Ontario Concrete Awards Structural Design Innovation Award
- Ontario Concrete Awards Material Development and Innovation Award
- "Hodder Avenue Underpass A Modular Construction Approach and a Unique UHPC Pier Cap Design" 9th International Conference on Short and Medium Span Bridges
- "Building a Better Bridge with UHPC" Construction Canada Magazine



Hodder Ave. Underpass

- Expedites construction on site, optimizes resources
- Highly adaptable solution
- Can be fabricated by any precast company, assembled by any contractor at any location
- Precast/Prestressed Concrete Institute (PCI):
 Could be solution to all deficient bridges in North America
- Ministry of Transportation of Ontario (MTO):
 Plan to use it for a number of planned highway bridges



Hodder Ave. Underpass

