

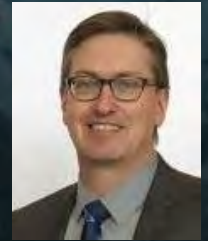
Rehabilitation of Buried Bridges, Culverts & Storm Sewers

63rd *Anniversary*
1961 - 2024 *Celebration*

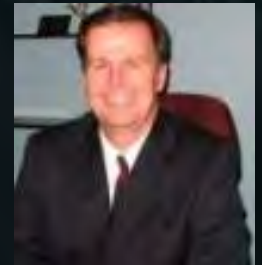
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Ron Prychitko, P.Eng.
Sr. Region Engineer - Armtec Inc.
ron.prychitko@armtec.com



Ray Wilcock
Executive Director - CSPI
rjwilcock@cspi.ca



Agenda

- About the CSPI
- Applications, Shapes, Profiles
- Case Studies
 - Shamrock Lake Culvert Rehab.
 - Howard Ave. Reline
 - Hwy 401, 410 & 403 ON Reline
- Questions



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ArcelorMittal
DOFASCO | HAMILTON



ADVANCED COIL INDUSTRIES



CLIFFS



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roundel

TUBAO

VIACON



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Structural Plate Applications



Wildlife Overpasses



Wildlife Underpasses



Vertical Caissons / Shafts



Bridge Rehabilitation



Watercourse Crossings

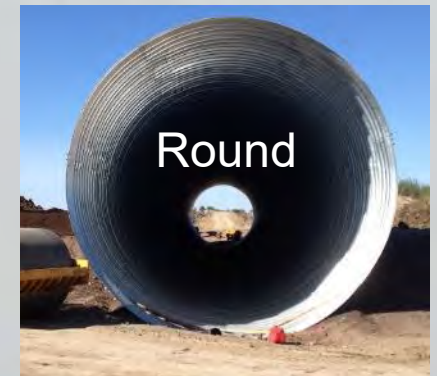
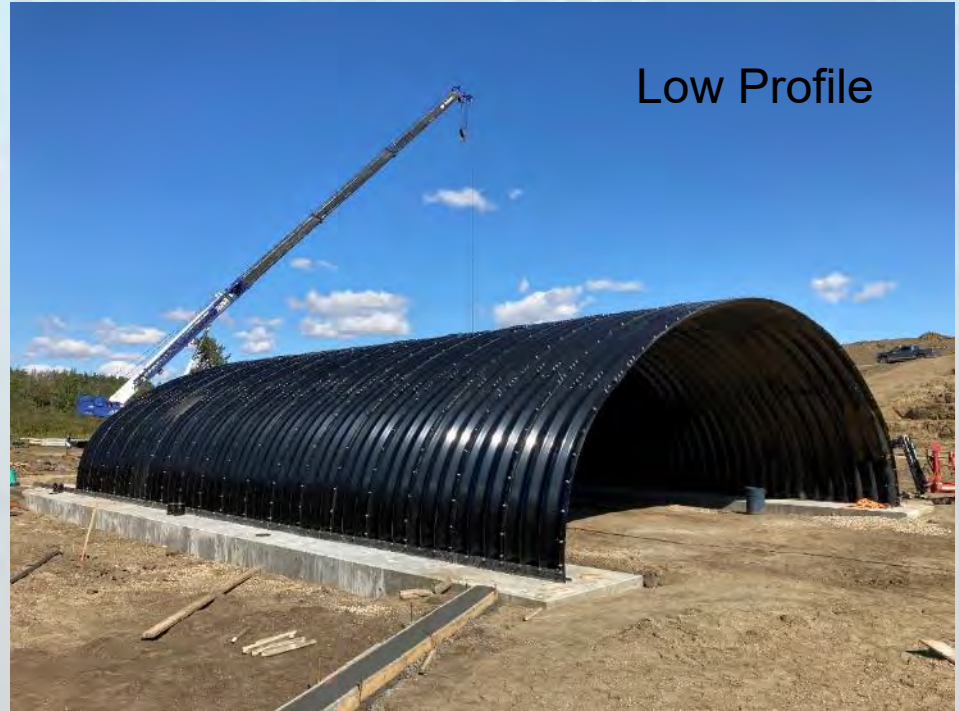
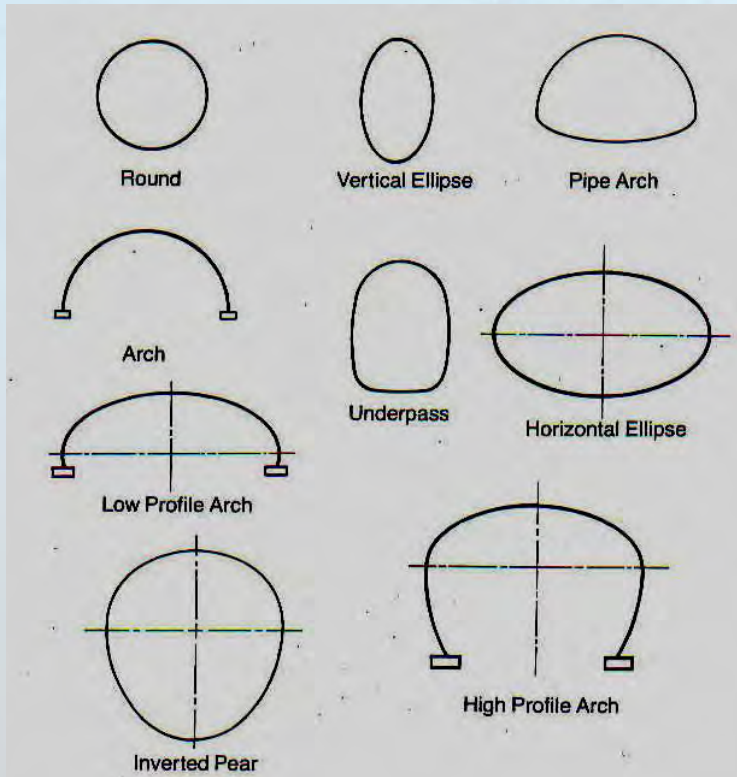


Culvert Rehabilitation



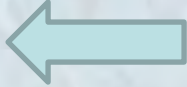
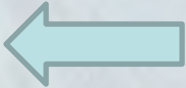
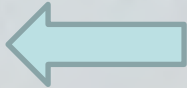
Grade Separations

Shapes



Up to 30+ Meter Spans

Eleven Corrugations

- 38 X 6.5 mm CSP
- 68 x 13 mm CSP
- **19 x 19 x 190 mm** **Spiral Rib**  Howard Ave. Reline
- 76 x 25 mm CSP
- **125 x 25 mm** **CSP**  Hwy 401, 410 & 403 ON Reline
- 152 x 51 mm Structural Plate SPCSP
- **180 x 52 mm** **Structural Liner Plate**  Shamrock Lake Culvert Rehab
- 230 X 64 mm Structural Plate
- 381 x 140 mm Deep Corrugated Plate
- 400 x 150mm Deep Corrugated Plate
- 500 x 237mm Deep Corrugated Plate

Full Peripheral Relining

1. Full reline can minimize project costs and time
2. Minimizes traffic disruption
3. Winter installations typical (low flows)
4. Restore full structural capacity





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Ron Prychitko, P.Eng.
Sr. Region Engineer - Armtec Inc.
Ron.Prychitko@Armtec.com



Case Study #1

Shamrock Lake Culvert Rehabilitation Hwy 11 – 31KM north of Nipigon ON



- **Background**

- **Existing Structure**

- Constructed in 1938
- 76 m long
- 4.9 m span, 2.0 m rise
cast-in-place open
footing culvert
- 16.3 m cover



Background – Condition Assessment



Concrete barrel in very poor condition:

- Concrete deterioration;
- Spalling & exposed rebar throughout;
- Large cracking; and
- Settlement of approximately 0.36 m at center.



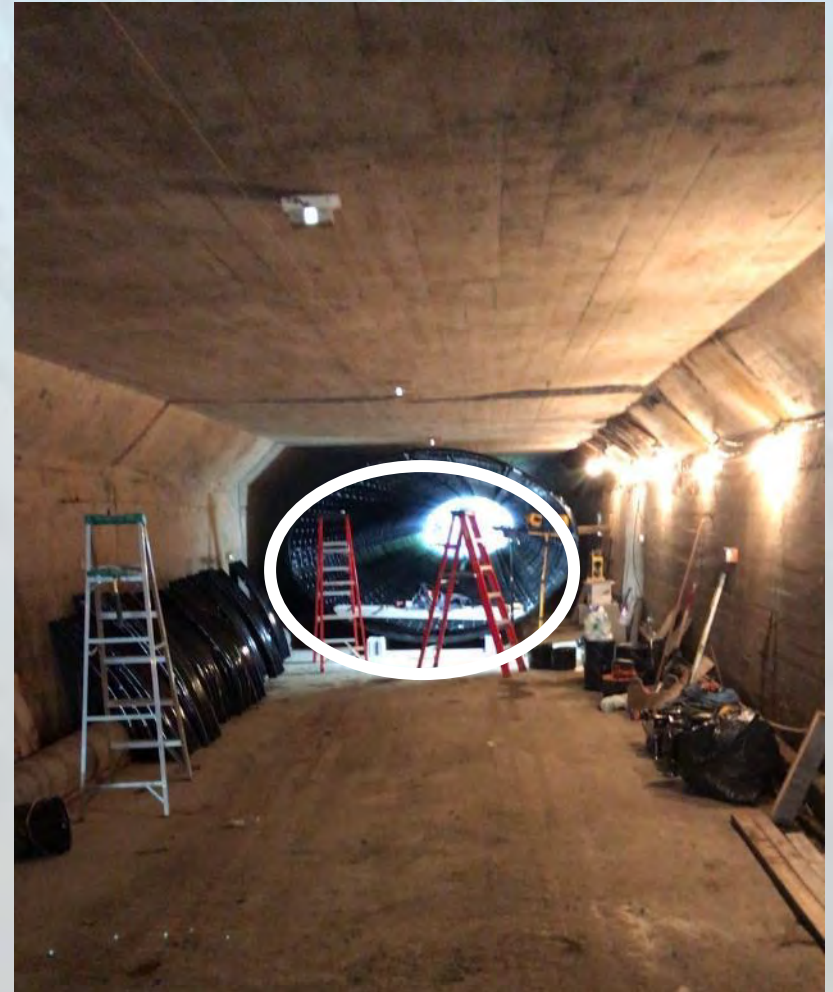
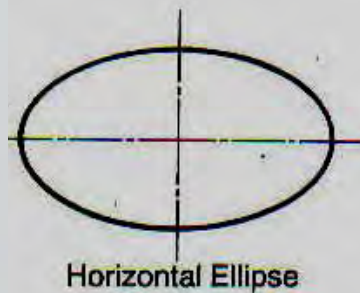
Background – Additional Constraints



- Located within Nipigon Palisades Conservation Reserve
- Critical spawning habitat for Brook Trout within culvert
- Unknown depth of concrete footing

Criteria – Trenchless Liners

- Liner Pipe needed to maximize hydraulic capacity
- Minimize increase in velocity
- Ensure section was structurally adequate
- *Full Periphery Horiz. Ellipse Liner balanced these criteria*



Liner Options Considered



TUNNEL LINER PLATE

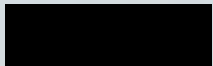


SPCSP

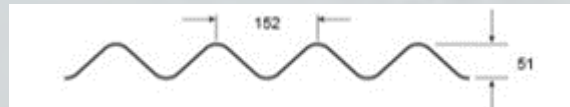
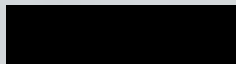


DEEP CORRUGATED

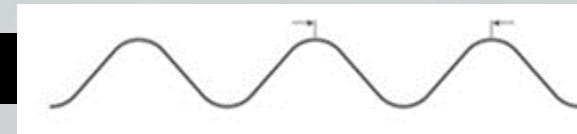
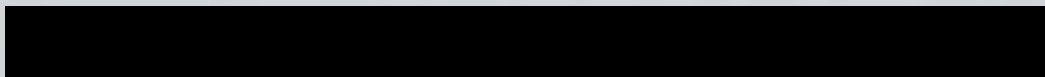
TUNNEL LINER PLATE



SPCSP



DEEP CORRUGATED ARCH



Span - metres

Product Details

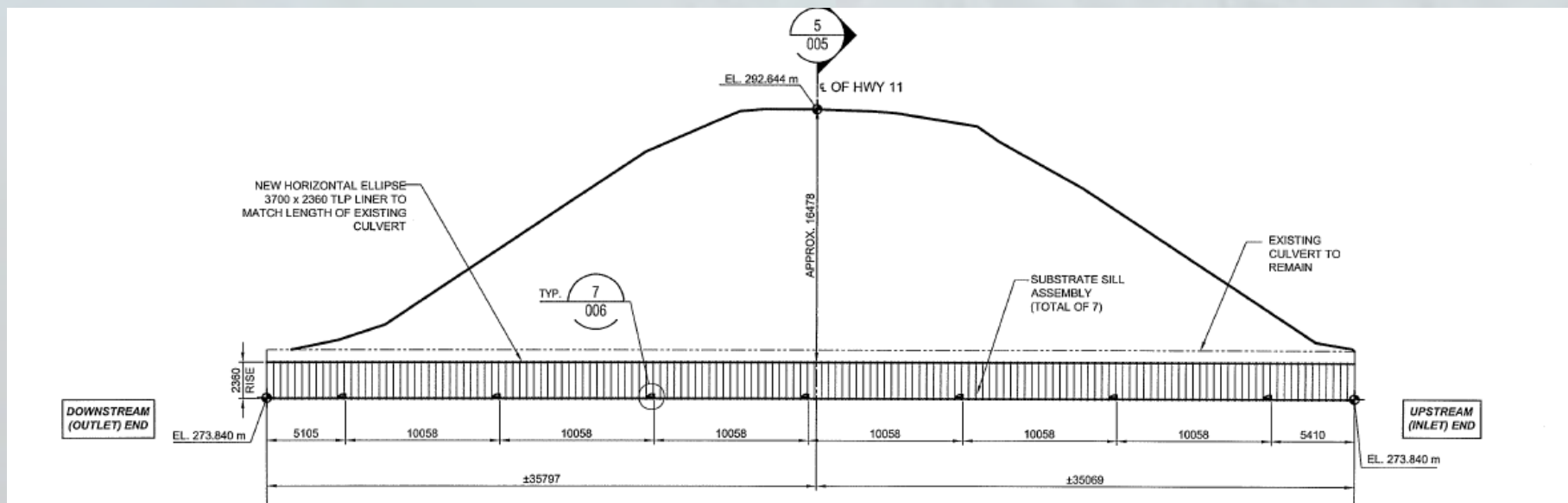
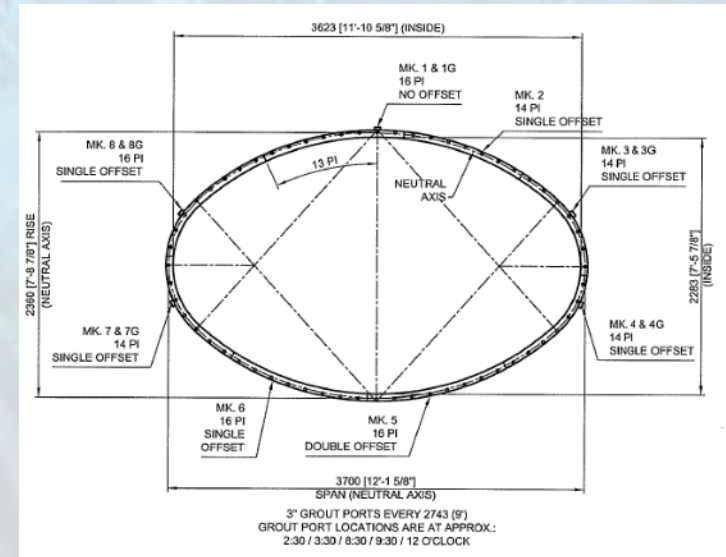
Tunnel Liner Plate

- Assembled from the Inside
- 180 mm x 52 mm Corrugation
- Reline Applications
- Custom Shapes



Shamrock Lake Culvert Reline

- Shape: 3700 mm x 2360mm
Horiz. Ellipse
- Height of cover > 16m
- Length of Reline = 76m

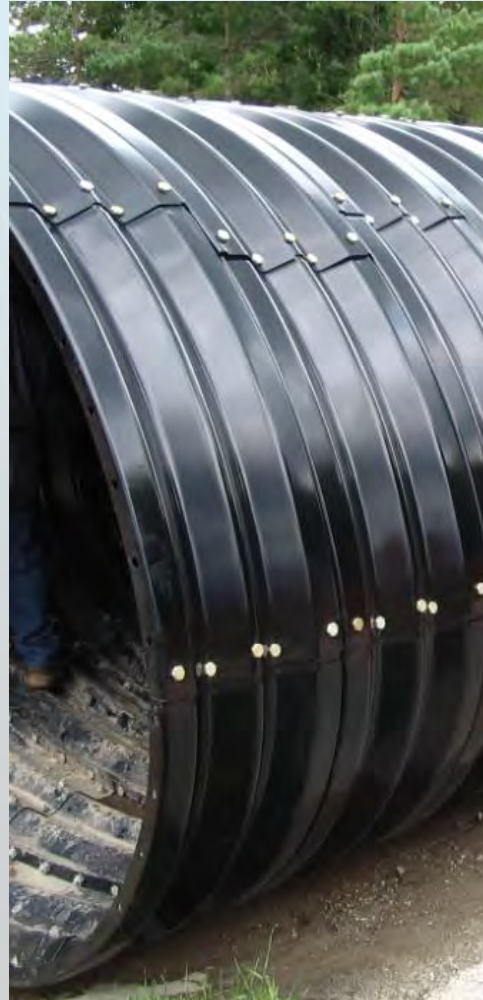


Coatings Available

Galvanized steel



Polymer-coated steel ✓



Aluminum



PERFORMANCE GUIDELINES

cspi.ca

- Know the Water – Test the Water
- Know the Flow / Abrasion
- Know the Environment
- Define DSL
- Match EMSL

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TECH. BULLETIN
ISSUE THIRTEEN | 02.22.12

Performance Guideline for Buried Steel Structures

1.0 Introduction

The purpose of this Guideline is to assist practitioners in selecting appropriate structure type, end protection details and the optimum coating and plate thickness combination to enable corrugated steel plate structures to meet design service life specifications. Consideration of the application exposure, location and the site specific environmental conditions are key parameters when estimating the material service life of buried flexible steel structures. This guideline is intended to supplement local knowledge of the performance of buried plate structures.

Common applications for Corrugated Plate, some of which are shown in Figure 1 pictures, include:

- Culverts on watercourses - Full periphery round, pipe-arch and elliptical pipes
- Short span bridges on watercourses - Open bottom arches and box shapes
- Grade separations (non-watercourse applications) - Vehicular, pedestrian or wildlife underpasses or overpasses; utility crossings

Figure 1 – Structural Plate Installations



PIPE-ARCH CULVERT WITH BURIED INVERT ON WATERCOURSE



OPEN BOTTOM ARCH ON WATERCOURSE



PEDESTRIAN UNDERPASS

Corrugated steel plate can be exposed to a variety of environmental conditions, as shown in Table 1.

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TECH. BULLETIN
ISSUE ONE | 02.22.12

Performance Guideline for Corrugated Steel Pipe Culverts (300mm to 3,600mm Diameter)

Reference: National Atlas of Canada, 5th Edition, 1985 - 1995.

The above map illustrates the variability in soil chemistry across Canada. Regional characteristics should be considered when selecting a suitable CSP pipe material.

<http://data1.nrcan.gc.ca/soil/soilmap/soilmap.html?file=/data/soil/soilmap/soilmap.html>

6000 SHEPPARD AVE. E. UNIT 101, SCARBOROUGH, ONTARIO M1S 4T6 | 416-291-3636 | info@cspi.ca | www.cspi.ca

Liner Assembly & Bracing

- Shoring (house) jacks installed every 4.5 ft
- W beam installed at the invert



Assembly

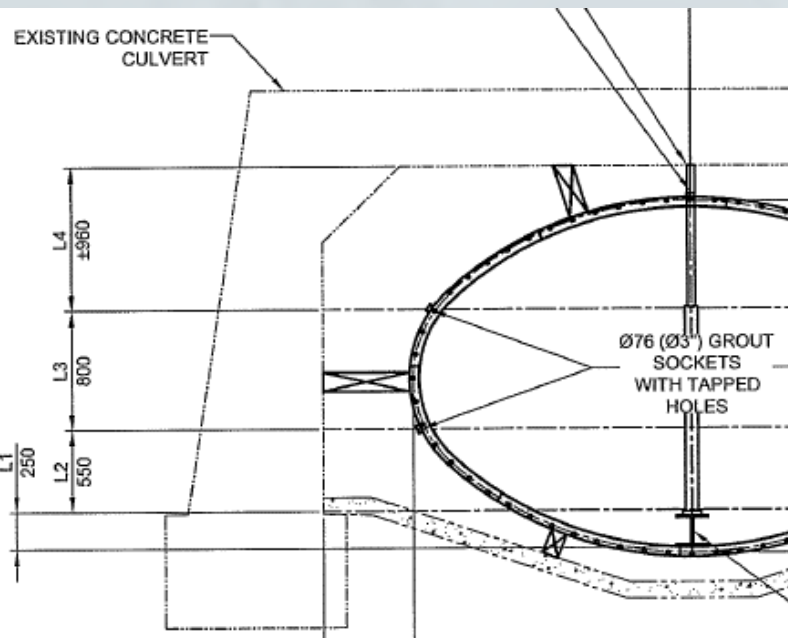
Bolt Torque check

- ✓ Minimum Random Test- 10% bolts
- ✓ Require 95% minimum pass specification



Grouting Check list

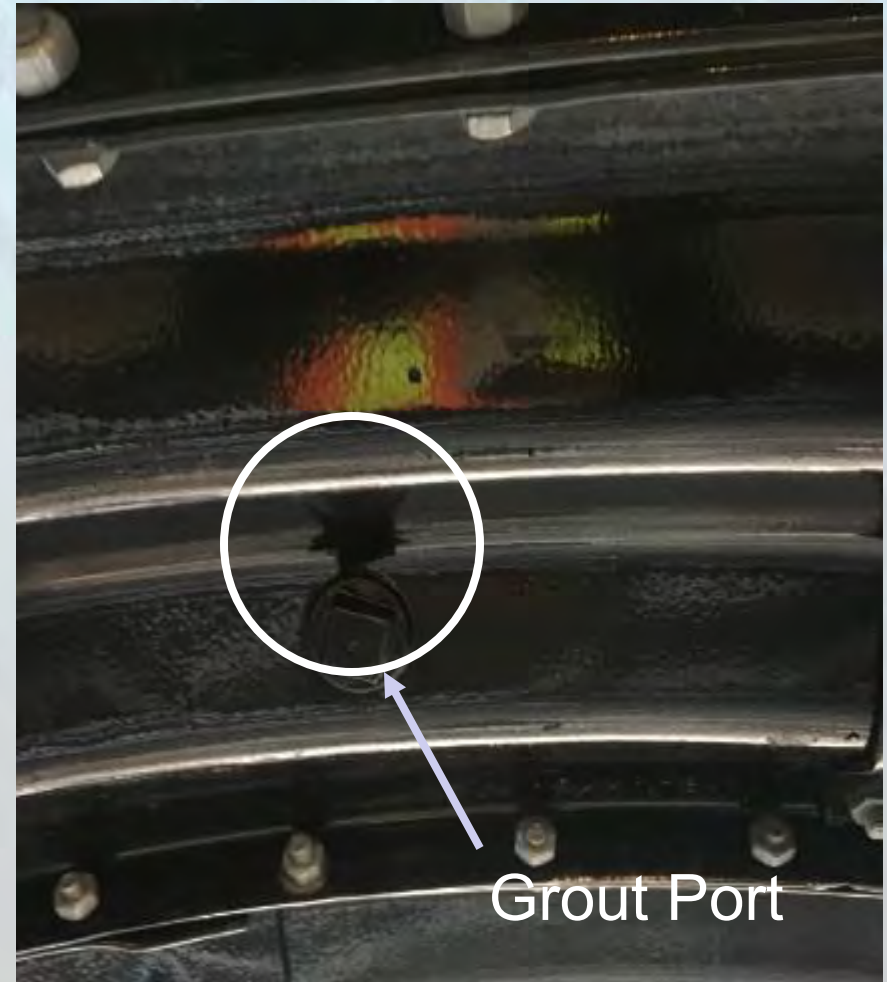
- Bulkheads progressively formed attach end of the structure.
- Grout Ports – 5 located every 9.0 ft.
- 4 Grout Lifts
- Non-shrink grout: 2- 5 MPa



Grouting

Monitor During Grouting

- ✓ Check grout elevation
- ✓ Monitor structure shape
- ✓ Monitor grout consistency
- ✓ Clean grout seepage
- ✓ Check venting (final grout lift)



Summary – Shamrock Lake Reline

- Cost savings
- No disruption to traffic. No detours
- Ideal product for inside assembly
- Custom shape optimized hydraulics
- Structural Liner
- Polymer Coating for long service life
- Lightweight plates eliminates the need for heavy equipment
- Economic procurement to site
- Lowest carbon footprint solution



Case Study #2

Howard Ave. Reline (Windsor ON)

Location: Howard Ave. at EC Row Expressway
Pipe: 2m span Pipe-Arch SPCSP (Galv.) - 1975
Length: ~100 meters

Challenges:

- High traffic intersection
- High usage of De-icing chemicals
- Downstream from a junk yard (corrosive water)





St Aid 4U Training
& Supply Windsor



Parais Rd E

E C. Row Expy

E C. Row Expy

N Service

E C. Row

Howard Ave

Starbucks
Takeout



Tommy's Bar-B-Q



Howard Ave - Reline

Existing Culvert – Invert deterioration



Howard Ave. Reline



- Relined: 2005
- Pipe: 1200mm diameter Spiral Rib Pipe (SRP)
- Coating: Polymer
- Hydraulics: Manning's n of .012
- Method: Sliplining

Howard Ave - Reline



Insert 1st Section

11.02.2005 09:36

Various Methods of Inserting Reline Pipe



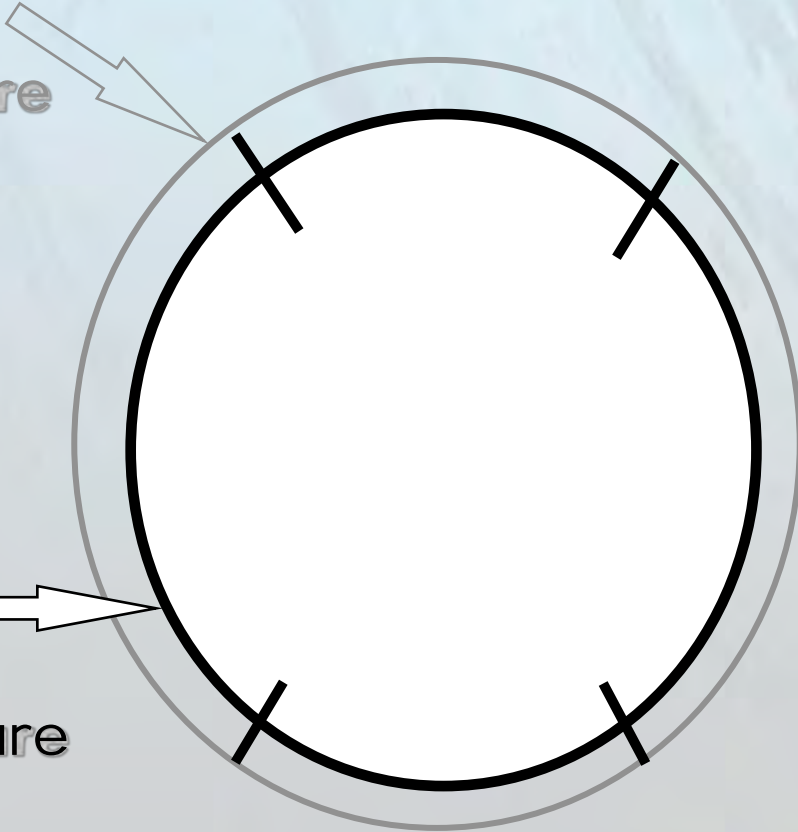
Block the 1st Section



Profile View

Adjusting Rods set Line and grade

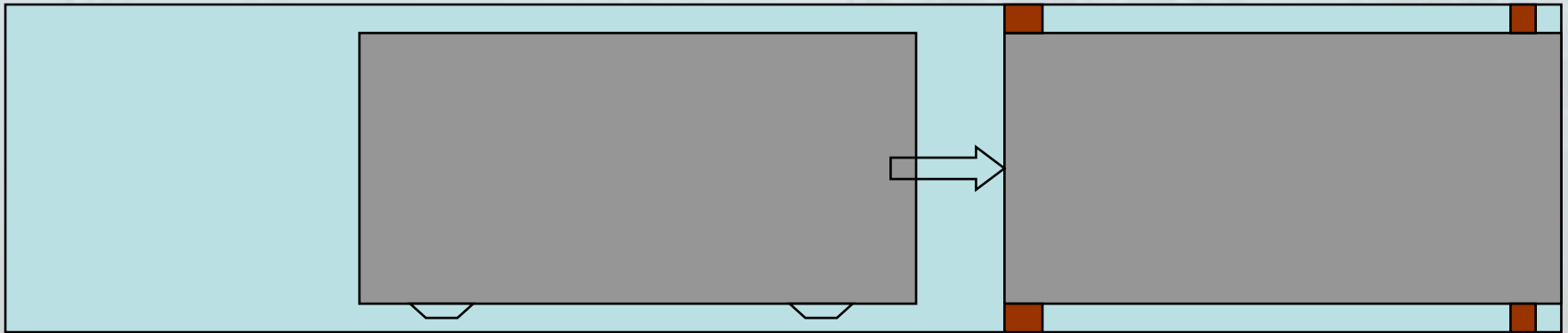
Old
Structure



New
Structure



Place the Next Section



Profile View

Install Internal Expanding Band & Gasket



Profile View

Install Internal Expanding Coupler Band & Gasket



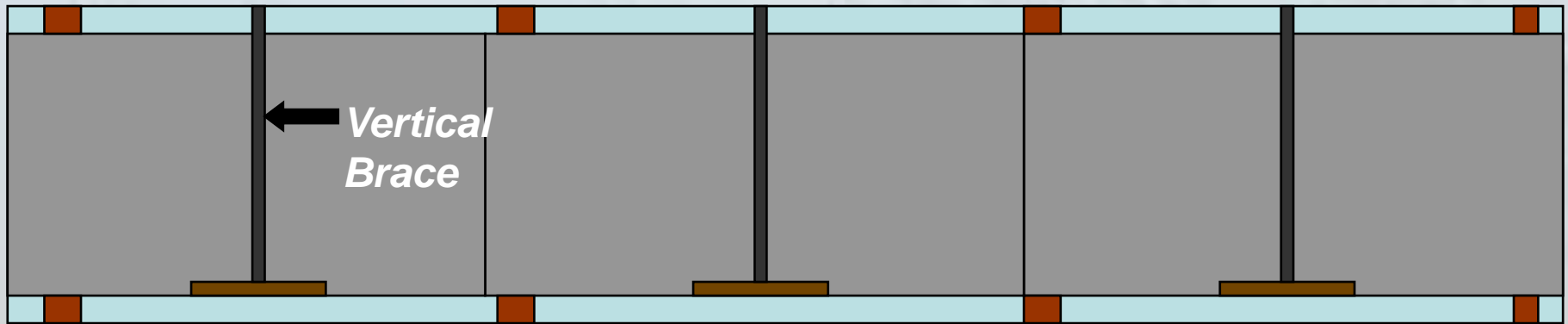
Repeat Until All Sections Are Installed



Profile View

Install Bracing

Prevents Flotation During Grouting



Profile View

Howard Ave Windsor

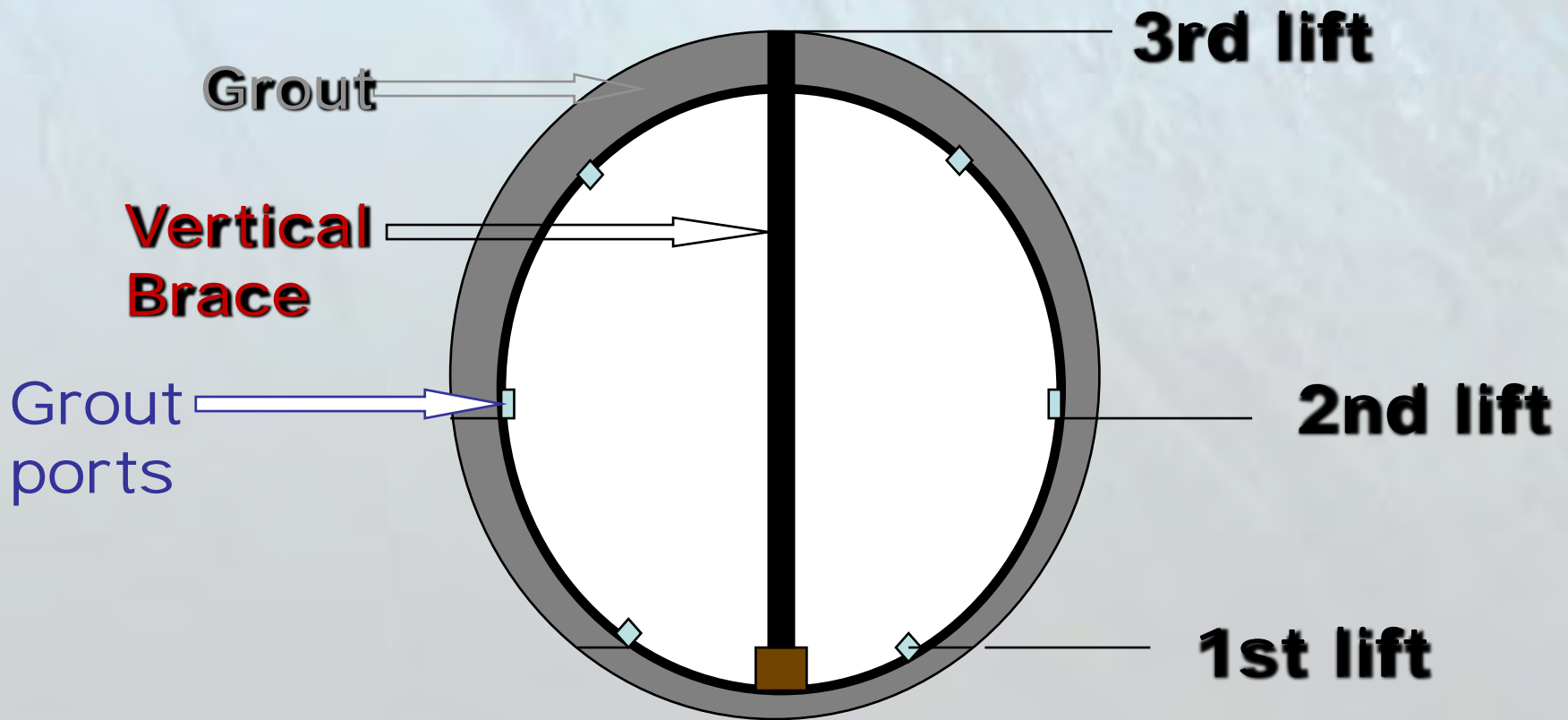
Pipe is secured
in-place using
screw (house)
jacks



Grout Placement



Grout in Stages



Grouting



Howard Ave - Reline

Completed project 2005



Howard Ave - Reline

Inspection date: March 2017
PH: 6.0
Chlorides: 363 ppm



Coating Thk
Min. 10 mils





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Ray Wilcock
Executive Director - CSPI
rjwilcock@cspi.ca



Case Study #3

HWY 401, 410 & 403 ON Reline

Built Date:	1974
Location:	Intersection of Highway 401, 410 & 403 An average of 320,000 vehicles per day
Existing Pipe:	3050mm RCP storm sewer
Length:	200 meters
Culprit:	Road Salt
Owner:	MTO
Consultant:	Morrison Hershfield
Contractor:	Underground Services

Replacing the sewer was not an option given the impact on transportation, commerce and public opinion.



Ontario 401

Ontario 401 Express

410

Kitchen Crafters.ca

Ampere Metal Finishing

403

PPG Aerospace

CGD - Kitchen Cabinets & Countertops

All Graphic

Dewey College

AGAT Laboratories

Express



CRACKED AND CORRODED RIGID SEWER PIPE

401, 410 & 403 ON Reline

Solution: Reline in 2004

Material: 2850mm Galvanized CSP
Coal tar epoxy coating on the invert
125 x 25mm profile with 4.2mm gauge
Composite drainage fabric was installed outside the CSP at joint connections

Challenge: Installation
Damaged section of the RCP was over 150 meters from the outlet, under the main traveled portion of the 401
CSP had to be fabricated in 3.15 meter lengths to negotiate the bends in the existing sewer
Internal couplers were used

Fork Lift Truck with carrying frame





CSP WITH SCREW JACKS AND GROUT PLUGS

Time to Reline

- 3 months versus a planned target of 6 months

Reline Procedure (Small and large diameter pipes)

➤ Available on the CSPI website at www.cspi.ca

Reline Procedure for Small Diameter Culverts Using Corrugated Steel Pipe (For reline of culvert pipes 1000 mm Diameter and Smaller)

Replacing deteriorated culverts and storm sewers under a heavily traveled roadway or deep fill can be an expensive and disruptive operation. The detouring of traffic required for conventional reconstruction can create significant costs and public inconvenience. Relining with corrugated steel pipe will minimize project cost and time. Access is restricted in smaller diameter pipes so all cleaning, pipe insertion, coupling and grouting is done from the pipe ends or access points. Long lengths of strong, rigid, securely coupled CSP are ideal for this procedure. Designed to carry the full load above the pipe the total wall thickness of CSP remains relatively thin to optimize effective end area for maximum flow capacity.



CULVERT BUILT WITH CSP-ROWS SALT & SAND



POLYMER LAMINATED CSP RELINE PIPE FULLY BROUGHT

Procedure

The following are suggestions only to assist qualified engineers and contractors in developing a construction plan. Each project is unique and will benefit from local experience and expertise.

1. Survey the existing host pipe noting unusual inward projections, deflections and damage. Take measurements to determine the largest liner size that will fit inside the host pipe allowing room for outside diameter of liner pipe, slide rails and approximately 50mm minimum grout space all around. Review the external working area, noting obstructions that may limit pipe lengths, equipment size, access and material storage.
2. Review the flow characteristics of the reduced diameter liner pipe and ensure that hydraulic requirements will be met. CSP is available in a variety of corrugations to meet both smoothness (Manning n value) and structural requirements.
3. Drain the water and clear the host pipe of silt and debris removing any obvious obstructions. Water needs to be controlled with cofferdams, pumps, and piping as appropriate. Ensure that all environmental requirements are met.

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Reline Procedure Using Corrugated Steel Pipe and Corrugated Steel Pipe Arch (Liners 1000 mm Diameter and larger)

Replacing a deteriorated culvert, storm sewer or small bridges under a roadway can be an expensive and disruptive operation. High costs are associated with demolition and removal of the existing structure. The disruption of traffic required for conventional reconstruction can create significant costs and inconvenience. Relining with corrugated steel pipe will minimize project cost and time.



Procedure

The following are suggestions only to assist qualified engineers and contractors in developing a construction plan. Each project is unique and will benefit from local experience and expertise.

1. Survey the existing or host structure noting unusual inward projections and damage. Take measurements to determine the largest liner size that will fit inside the host allowing room for pipe walls and bolts, slide rails and approximately 50 mm. minimum all around for grout. Survey the external working area, noting obstructions that may limit pipe lengths, equipment size and material storage.
2. Dewater and clear the host pipe of debris removing any obvious obstructions. Water needs to be controlled with cofferdams, pumps, and piping as appropriate. Ensure that all environmental requirements are met.

Questions

Rehabilitation of Buried Bridges, Culverts & Storm Sewers



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