Microtunnelling Advancements in North America

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Presentation Goals

• Provide an overview of the North American microtunnelling industry

• Highlight industry-advancing microtunnel projects recently completed/currently underway in Ontario
Presentation Outline

- Definition of Microtunnelling
- History of Microtunnelling
  - Worldwide → Ontario
- Current state of the industry
  - North America → Ontario
- Industry Advancing Projects in Ontario
  - Long-distance drives
  - Curved drives
  - Drives in rock
  - Large diameter installations
Microtunnelling

**DEFINITION**

- A trenchless method of pipeline installation which includes all of the following features:
  - Remote-controlled
  - Guided
  - Pipe jacking
  - Continuously supported
Microtunnelling History

• Developed in Asia in the late 1960’s (Komatsu, Iseki, Mitsubishi, etc.)
  • Offshoot of slurry shield tunnelling
• Gained popularity in Europe in the 1980s (Iseki, Herrenknecht, Soltau, Wirth, etc.)
Microtunnelling History

• North American industry developed in the late 1980’s/1990s (Akkerman, Herrenknecht, Iseki, etc.)
• First project in Ontario = Welland, 1987 (Iseki)
  • Subsequent projects in 1990, 1994, 1995, 1998 (approx. 2500m total)
  • Mixed success, issues in tills and cobble/boulder-laden soils
  • OCPA design manual for microtunnel pipe
• 12 year hiatus (1999-2011)
Microtunnelling History

• Gore Road Project (2011)
  • Project tendered as a “traditional” tunnel
  • Microtunnelling proposed as an alternative
    • Single-pass installation
    • Increased clearance below critical utilities
    • Jacking pipe (and just about everything else) imported from Ireland
State of the Industry

NORTH AMERICA

• Over 30 Microtunnel Contractors
• Multiple equipment manufacturers with North American presence
  • Others entering the market
• ASCE Guidelines (ASCE 36-15)
• Annual short course at the Colorado School of Mines (over 20 years running)
State of the Industry

ONTARIO

• 3 Ontario-based microtunnel contractors
  • Over 10 equipment spreads
  • 750 to 3300mm diameter (OD)
• 2 concrete jacking pipe manufacturers
• OPSS in development
  • Final draft completed on Sept. 30, 2015
Industry Advancements

• In the past 4 years, there have been an number of industry-advancing microtunnel projects

• Focus on Ontario-based projects
  • Long-Distance Drives
  • Curved Drives
  • Drives in Rock
  • Large Diameter Installations
Long Distance Drives

• Elgin Mills PD6 600mm CPP Feedermain Project
• North Don Sanitary Sewer
• 2nd Concession Reconstruction
Long Distance Drives

Elgin Mills PD6 600mm CPP Feedermain Project

• 740m Drive Length
• 1500mm ID Reinforced Concrete MT Pipe
• 3 Horizontal Curves
  • R=400m L=180m
  • R=3000m L=83m
  • R=400m L=80m
• Glacial Tills, Sands, Silts
• Longest Microtunnel in Canada
• Longest Curved Microtunnel in North America
Long Distance Drives

Elgin Mills PD6 600mm CPP Feedermain Project

| HORZ. CURVE RADIUS | R=400m - L=180m  
| R=3000m - L=83m  
| R=400m - L=80m |
| MAX. JACKING FORCE | 150T |
| NO. OF INTERJACKS | 4 |
| DRIVE DURATION | 51 Days |
| SOIL TYPE | Glacial Till, Sands, Silts. |
| MTBM TYPE | HERRENKNECHT AVN1500 |
Long Distance Drives
Elgin Mills PD6 600mm CPP Feedermain Project
Long Distance Drives
North Don Sanitary Sewer

• Max Drive Length 635m
• 600m and 467m Drive also on the project
• 1200mm ID Reinforced Concrete Microtunnel Pipe
• Glacial Till, Sand, Silt
Long Distance Drives
North Don Sanitary Sewer

<table>
<thead>
<tr>
<th>CURVED DRIVE No. 3</th>
<th>NORTH DON SAN. SEWER</th>
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<tbody>
<tr>
<td>DRIVE LENGTH</td>
<td>635m</td>
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<tr>
<td>INTERNAL DIAMETER</td>
<td>1.2m</td>
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<td>VERT. CURVE RADIUS</td>
<td>-3567m and 4338m</td>
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<td>VERT CURVE LENGTH</td>
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<td>HORZ. CURVE RADIUS</td>
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<td>SOIL TYPE</td>
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<tr>
<td>MTBM TYPE</td>
<td>HERRENKNECHT AVN1200</td>
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</table>
Long Distance Drives
North Don Sanitary Sewer

Prior to construction, contractor to confirm underside of slab elevation. Contractor to lower microtunnel grades in this area if in conflict with ex. slab.

Prior to commencing tunneling works, excavate and remove existing footings in the path of the proposed sewer. See DWG D-06 for further details.

EX. TWIN BOX CULVERT:
W. CELL INV. 1188.89
(CONCRETE SLAB)
E. CELL INV. 1186.07
(CONCRETE SLAB)

UNDERSIDE OF FOOTING
ELEV. 1184.78

SAND CLAY

41.5m-1200mm san ø -0.60%
40.0m-1200mm san ø 0.00%

Silty Clay

Tunnelling Association of Canada (TAC) – Ontario Chapter
Challenges and Innovations in Tunnelling
Long Distance Drives
2\textsuperscript{nd} Concession Reconstruction – Trunk Sewer

- Max Drive Length 668m
- 1200mm ID Reinforced Concrete Pipe
- Glacial Till, Sand, Silt
- Longest 1200mm ID Drive in North America
Long Distance Drives

2\textsuperscript{nd} Concession Reconstruction – Trunk Sewer

- Vertical Profile
Long Distance Drives

2nd Concession Reconstruction – Trunk Sewer

• Horizontal Profile

<table>
<thead>
<tr>
<th>CURVED DRIVE No. 1</th>
<th>2nd Con Reconstruction</th>
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<tbody>
<tr>
<td>DRIVE LENGTH</td>
<td>668m</td>
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<tr>
<td>INTERNAL DIAMETER</td>
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<td>VERT. CURVE RADIUS</td>
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<td>HORZ. CURVE RADIUS</td>
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<td>CURVE LENGTH</td>
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<td>DRIVE DURATION</td>
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<tr>
<td>SOIL TYPE</td>
<td>Till, Cobbles, Boulders</td>
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<td>MTBM TYPE</td>
<td>HERRENKNECHT AVN1200</td>
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Curved Drives

• Keswick WPCP Effluent Outfall Expansion Project
  • First curve in Canada
  • First spatial curved microtunnel in North America
  • First Wet Reception of MTBM in Canada

• West Don Sanitary Trunk Sewer
  • Tight Radius microtunnelling – R=250m
Curved Drives

Keswick WPCP Effluent Outfall Expansion Project

- Increase diameter to 1200mm ID RCP
- Introduction of curves to eliminate shafts
Curved Drives

Keswick WPCP Effluent Outfall Expansion Project

- Longest Drive = 335m
- Spatial Drive = 208m
- Vertical $R = 6600m$; Horizontal $R = 875m$
Curved Drives

West Don Sanitary Trunk Sewer

- 350m long tunnel
- 250m continuous radius
- 1200mm ID RCP
- 20m deep launch shaft
- 15m water head
- Glacial till with boulders
- First use of Jack Control System in Canada
Curved Drives

West Don Sanitary Trunk Sewer

• Site Layout
Curved Drives
West Don Sanitary Trunk Sewer

• Jack Control Technology
  • Use of hydraulic joint packer at pipe joints instead of a wood based packer to evenly distribute the jacking force through the pipe wall
Drives in Rock

• North Trunk Trenchless Scugog River Crossing – Kawartha
  • 220m – 1500mm ID – 120 to 150 MPa Limestone

• Kenilworth Ave. Combined Sewer Overflow Project
  • 319m – 1500mm ID – Queenston Shale and Limestone Layers – Curved Alignment

• Etobicoke Creek – Under Construction
  • 575m – 1800mm ID - Alluvium and Georgian Bay Shale
Drives in Rock

North Trunk Trenchless Scugog River Crossing – Kawartha
Drives in Rock
Kenilworth Ave. Combined Sewer Overflow Project

<table>
<thead>
<tr>
<th>KENILWORTH AVE. N. CSO</th>
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<tbody>
<tr>
<td>DRIVE LENGTH</td>
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<tr>
<td>INTERNAL DIAMETER</td>
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<tr>
<td>VERT. CURVE RADIUS</td>
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<tr>
<td>HORZ. CURVE RADIUS</td>
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<tr>
<td>MAX. JACKING FORCE</td>
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<tr>
<td>NO. OF INTERJACKS</td>
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<tr>
<td>DRIVE DURATION</td>
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<tr>
<td>SOIL TYPE</td>
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<td>MTBM TYPE</td>
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<td>PRIMARY LINING</td>
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Drives in Rock

Etobicoke Creek Trunk Sanitary Sewer

• 575m long drive
• 1800mm ID RC jacking pipe
• Crossing beneath the busiest runway at Canada’s busiest airport
• Georgian Bay formation bedrock
Large Diameter Installations

- 2nd Concession Reconstruction – Forcemain Casing
  - 330m – 2000mm ID – 2400mm OD - RCP

- 37th St. Storm Sewer Construction - Calgary
  - 2500mm ID Installation

- Burbrook TSS London
  - 2500mm ID Installation
Large Diameter Installations
2nd Concession Reconstruction – Forcemain Casing

• 330m Long Tunnel
• 2000mm ID RCP
• 11m Deep Launch Shaft
• 7m Water Head
• Saturated Sands and Silts
Large Diameter Installations

2nd Concession Reconstruction – Forcemain Casing
Large Diameter Installations

2nd Concession Reconstruction – Forcemain Casing
Large Diameter Installations

37th St. Storm Sewer Construction - Calgary

- 415m Drive Length
- Tunnelling parallel to existing street
- 2500mm ID RCP
- 15 - 10m deep shafts
- Bedrock with transition into till conditions
Large Diameter Installations

London Burbrook TSS

- 2 crossings (50m & 175m)
- Crossings beneath live rail lines
  - 22 track shunting yard
  - 2 track line
- 2500mm ID RCP
- 8 - 11m deep shafts
- Saturated sands, gravels, and till
Closing

• The microtunnelling industry in North America is strong
• Growth of the microtunnelling industry in Ontario has been remarkable
• Ontario-based projects are setting new benchmarks, particularly as regards:
  • Curve drives
  • Long-distance drives
Questions

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