Introduction to Trenchless Technology

Continuous Trenching
Old roads, old pipes?

- Superb construction
- Little maintenance
- Low operational costs
- When to rehabilitate?

New roads, old pipes?
We are not alone!

Jack appears in different figures!

……..but mostly not at the same time!

Jack’s appearance

Needs to be

- Minimized or banished
  - Find other ways of rehabilitation
  - Less damage to pavement
  - Less inconvenience to customers
Solution to JACK

Trenchless Technologies

Trenchless Technology

Techniques for utility line installation, replacement, rehabilitation, inspection, location and leak detection, with minimum excavation from the ground surface.

North American Society of Trenchless Technology (NASTT)
Key Points

- Minimal surface excavation
  - Alternative to open cut excavation
- Can have entrance and exit surface excavations – JACK!!!!

- Pipelines usually have diameters less than 900 mm (36 inches) - non person entry

Key Points (Continued)

Typically considers only urban utilities:
- Water and wastewater systems
- Gas, petroleum and chemical pipelines
- Electrical and communications networks
- Access ways and other small diameter tunnels
Excludes: Large tunnels (< 1%)

World largest tunneling machine (14.2 m in diameter)

Chunnel

Method Classification

- Many classification systems proposed
- No industry standard
- Generally TT methods classified into four broad categories
Broad Categories

Trenchless Technologies

New Installations  On-line Replacement  Condition Assessment  Rehabilitation Repair

Locating Mapping  Asset Management

New Installations
New Installations

- Non-Steering Methods
  - Moling
  - Pipe Ramming
  - Auger Boring
  - Pipe Jacking

- Steering Methods
  - Microtunnelling
  - Horizontal Directional Drilling

On-line Method
On-line Method

- Pipe bursting

Gravity Pipes

- vitrified clay,
- brick,
- concrete,
- steel,
- ductile & cast iron,
- asbestos cement (transite),
- pitch fibre
- HDPE,
- PVC
- etc..
Pressure Pipes

- Prestressed Concrete Cylinder Pipes (PCCP)
  - AWWA C301 and C303, lined, embedded core, bar wrapped
- Steel
- Iron (cast and ductile)
- Asbestos cement (transite)
- Wood (solid and stave)
- HDPE
- PVC
- etc..

Pipe Materials

- Metallic
  - Cast iron
  - Ductile iron
  - Copper
  - Steel
  - PCCP
- Non-metallic
  - Wood stave pipe
  - Polyethylene
    - MDPE
    - HDPE
  - PVC
  - Concrete
  - Polymer concrete
  - Asbestos cement
  - Pitch fibre
Pipeline Access

GRAVITY Pipelines
- Partial pipe flow
- Interior access readily available by person, camera, and non destructive testing (NDT) tools
- Pipeline inspection performed live or off line

Pressure Pipelines
- Full pipe flow
- Typically small diameter than gravity pipelines
- Interior access limited (pressure, contamination and disinfection)
- Interior inspection usually requires pipe to be taken off line

Pipeline Condition Assessment

Pipe condition rating
- Deterioration state?
- Video camera imaging (CCTV)
- Acoustic methods
- Magnetic methods
Sahara®: System

Real Time Data Processing

Exact Locations

Corroded Wires & Cylinder
Common Pipe Deterioration

<table>
<thead>
<tr>
<th>Metallic pipe</th>
<th>Non-metallic pipe</th>
</tr>
</thead>
<tbody>
<tr>
<td>▪ Corrosion (reduced pipe wall thickness)</td>
<td>▪ Cracks</td>
</tr>
<tr>
<td>▪ Micro cracks in welds</td>
<td>▪ Fractures</td>
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<tr>
<td>▪ Leaking joints</td>
<td>▪ Deformation</td>
</tr>
<tr>
<td></td>
<td>▪ Collapse</td>
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TRENCHLESS PIPELINE REPAIR
Trenchless Pipeline Repair

GOAL
Return a defective pipeline to a serviceable condition without replacement

*How you reach that goal is the key!*

Lining - Technologies

- Main Line
  - Cured-in-Place Pipe (CIPP)
  - Close-Fit Lining
  - Slip Lining
  - Spray on

Proprietary Technologies
CIPP

Before

After

Close Fit Lining

Before
Slip Lining

Rehabilitation

Spray on linings

- Cement mortar
- Epoxy
Water and Sewer By-Pass

Trenchless Technologies

Tools in a Tool box
Growing Trenchless Industry

Municipal Survey Results
Where are those utilities?
Gas Main in a Sewer Lateral
Clearing a Lateral Blockage?

Utility Location and Mapping
Pipe line location

- "As built" or "As Recorded" drawings
  - Not accurate
  - Often do not know where it is (plan or depth)
- Cost of not knowing:
  - Line hits
  - Increased construction costs
- Subsurface Utility Engineering (SUE)

Pipe line location

- Cost of not knowing:
  - Line hits
  - Increased construction costs
- Subsurface Utility Engineering (SUE)
Cost of Not Knowing

Basic Tenets of SUE
SUE Quality Levels
ASCE Standard Guideline

Quality Level “D”

- Utility Contact Phase
- Records Research
(Visible Features)

Quality Level “C”

Determine Horizontal Alignment

Quality Level “B”
Typical QL-B Designating Project

- Electromagnetic
- Magnetometer
- Resonant Sonics
- Acoustical
- Pulse Induction
- Ground Penetrating Radar

Typical GPR Survey

- Soil fill horizon
- Utility
Utility Locating

Quality Level “A”
- Utility Exposed
- Accurate X, Y, Z Locating
- Size, Material and Condition

Survey/Data Management
- Conventional
- GPS
- SUM
- GIS
Mobile GIS?

Utility Locating Quality Level “A”

- Non-Destructive Excavation
- Air/Water & Vacuum Units
Existing Water and SUE Data

What is Cost of Not Knowing?

Studies show that there is a payback of at least $4.00 for every $1 spent on SUE.

- Reduced construction delays
- Improved asset operation maintenance and planning
- Effective spending of rehabilitation $$:
  - One Ontario relined cement mortar pipe beside it was labeled on GIS system as unlined DI.
  - Liner wrinkled and had to be removed
Trenchless Technology vs. Open cut excavation

Social Costs

Economic:
- Traffic disruption
- Pedestrian disruption
- Commercial and business disruption

Environmental:
- Noise and vibration
Social Costs (con’t)

Safety
- Worker safety
- Emergency service access

Indirect costs
- Loss of residual life of adjacent utilities and pavement structures

Social Costs
- Not traditionally included in construction costs
- Sometimes difficult to quantify or specify
- Becoming more relevant for rehabilitation and construction in urban areas
Social Costs
Environmental Costs

Typical Urban Project Costs

- Restoration: 75%
- Materials: 5%
- Construction: 20%
**Typical Urban Project**

- Social costs savings
  - Traffic delays (cars & people)
  - Economic loses (business)
- Environmental
  - Noise
  - Greenhouse gases
- Public perception

**Advantages of TT**

New installations
- Faster pipe installation
- Environmentally friendly???
- Lower social costs
- Less labour intensive
- Lower green house gas emissions?
- Deeper services

Rehabilitation
- Limited excavation
- Fast
- Low social costs
- Line remains in service
- Lower construction cost???
### TT Limitations

<table>
<thead>
<tr>
<th>New construction</th>
<th>Rehabilitation</th>
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<tbody>
<tr>
<td>- Limited contract specifications available</td>
<td>- Quality assurance</td>
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<tr>
<td>- Installation impact on pipe or other buried structures?</td>
<td>- Materials, construction</td>
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<tr>
<td>- Contractor experience</td>
<td>- Industry marketing</td>
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<tr>
<td>- Who takes the risk?</td>
<td>- Installation cost?</td>
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<tr>
<td></td>
<td>- Inspection techniques</td>
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<td></td>
<td>- Design techniques</td>
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<tr>
<td></td>
<td>- Failures - cost of not knowing</td>
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