See undermining for structural rehabilitation

Backscatter Computed Tomography to Enhance Culvert Rehabilitation
• **It is possible to conduct a rehab that achieves the same results as a new installation.**
  – Proper understanding of the problem
  – Allows a precise solution to be engineered
  – Meeting performance specs of a new installation and exceeding performance specs of the original installation
• The soil envelop is load bearing
• Soil instability will compromise the entire structure
• Voids create stress risers in the pipe
• Ultimately leads to deformations in the roadway and potential failure
Current Inspection Methods

- **Visual Inspection** can Identify
  - Corrosion, Joint failure and misalignment, deformation, ovality, channel misalignment and scour
  - Difficult to make consistent and repeatable and ultimately it is impossible to assess structural integrity based on visual results alone

- **Acoustic (Knock) Test** can identify
  - Regions suspected of undermining or voiding
  - Good screening tool, however it is subject to false positive void results and is difficult to report in a systematic fashion

- Neither provide conclusive information about structural integrity or soil stability
• Unseen cues of structural deficiency represent an information gap
  – Undermining
  – Soil movement
  – Piping
  – Void formation

• Visual and Acoustic
  – Are not definitive but are useful as a screening tool

• Backscatter Computed Tomography (BCT) is used to fill the information gap
  – Identify, visualize and quantify voids
  – Post construction QA/QC (grout placement)
INSIGHT™, the first CAT scan for infrastructure

- backing material
- void
- steel wall
Tomographic Image

1. Scanner houses radiation collimator and detector
2. Scanner placed adjacent to asset of interest
3. Data collected for a single plane through the asset
4. That data represents a density map of the asset
Inversa’s Culvert Map

- To scale representation of the culvert including:
  - visual indicators
  - acoustic anomalies
  - BCT locations
- BCT provides conclusive structural diagnostics of the soil envelope
- All data in the culvert map is referenced in complete culvert report
Engineer a Solution

• **Every site is unique**
  – Local soil conditions
  – Construction practices (time of install)
  – Burial depth (soil load requirements)
  – Traffic load (risk of failure)
Large Void from Water Piping

A water channel (piping)

Soil

Void

Corrugated Steel
Uniform Soil Void

Soil

Void

Corrugated Steel
Uniform Void, Pipe Slippage

Corrugated Steel

Soil

Void
Based on currently available information assumptions are made from inconclusive inspection data about
- failure mode
- soil stability
- grout placement
Robust Solution

• With new technology
  – failure modes, soil stability and grout placement can be accurately visualized and understood
  – Allowing you to engineer a precise solution
  – Meeting performance specs of a new installation and exceeding performance specs of the original installation
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Cast Iron Water Pipe with Corrosion

10.3 mm
7.9 mm
A BCT image of weld root corrosion on an out of service pipe sent to Inversa by client for qualification.
HDPE with Concrete and Void

**Figure** R&D BCT image and graph of 2 layer HDPE pipe with concrete and simulated air gap

**Figure** R&D physical setup two 21mm thick layers of HDPE filled with concrete