

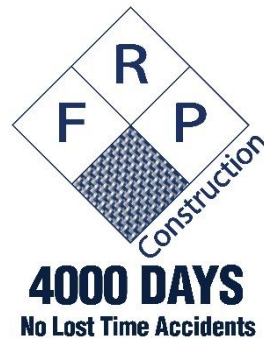


Gravity Sewer Rehabilitation Design

V. Firat Sever, PhD, PE, BCEE

Mo Ehsani, PhD, PE, SE

QuakeWrap, Inc.



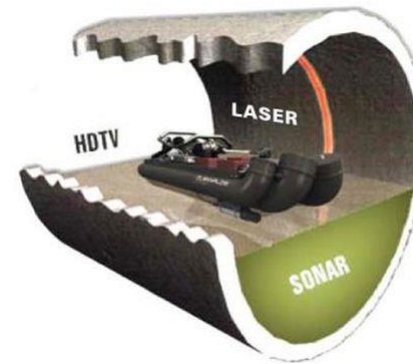


Outline

- Condition Assessment
- Design Methods
- Sewer Rehabilitation Methods
- FRP Lining System for Gravity Sewers



Inspection Methods

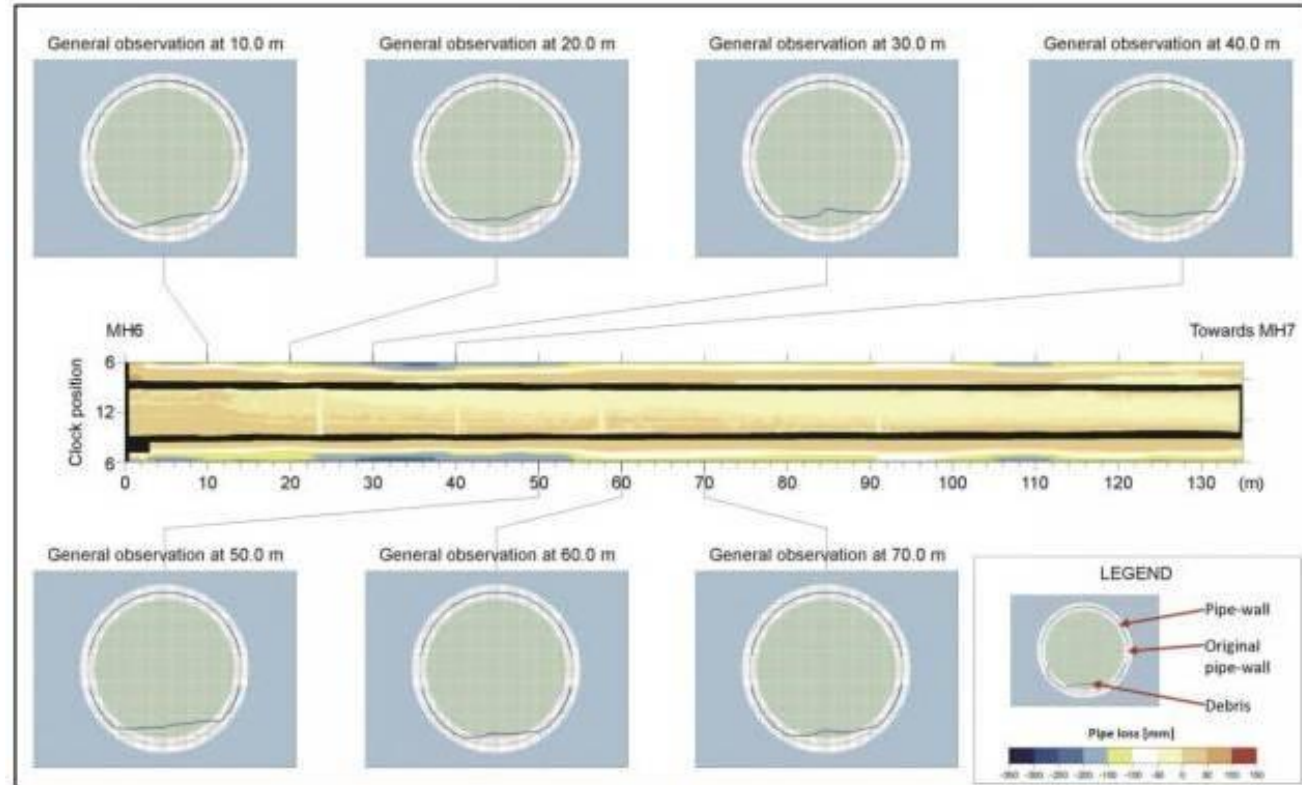


- CCTV
- Multisensor (sonar, laser)
- GPR
- Man-entry
- Other NDT (e.g., ultrasound)





Pipe Penetrating Radar (PPR)





THE **UNDERGROUND** UTILITIES EVENT

Underground Construction Technology | Jan. 29-31, 2019 | Fort Worth, TX

Man-Entry





Manhole Inspection



The screenshot shows the PipeTech Cloud web application interface. The main content area displays a 'Manhole' form with various data entry fields. A dark sidebar on the left contains navigation options such as 'Home', 'Manhole', 'Survey', 'Reports', and 'Settings'. The form fields include:

- Manhole #:** 0000101
- System Owner:** City
- FC Number:**
- Location Details:**
- Rate to Invert:** 10
- Grade to Invert:** 50
- Rate to Grade:** 5
- Alt. Use:** Sewer
- Man Entry:**
- Visit Date/Time:**
- Manhole Label:**
- Purpose of Survey:** Pre-Excavation
- Sewer Category:**
- Pre-Clearing:** No Pre-Clearing
- Time Cleared:**
- Condition:**
- Depositor Depth:** 0
- Location Code:** A - Main Highway - Urban
- Related to Asset:** A - Working
- Access Point Type:** MAN - Manhole
- Inspection Date:** A - New Inspection
- Polynomial of Elevation:** No
- Working:**
- Finishing:**

At the bottom of the form, there are three tabs: 'Inspection', 'Coordinate System', and 'Data Entry'.



Hole Void Visible (HVV)





THE **UNDERGROUND** UTILITIES EVENT

Underground Construction Technology | Jan. 29-31, 2019 | Fort Worth, TX

Ovalization/Deformation





Bulging Crown w/ Fracture





Cracks/Fractures





Cross-Bores





THE **UNDERGROUND** UTILITIES EVENT

Underground Construction Technology | Jan. 29-31, 2019 | Fort Worth, TX

Corrosion



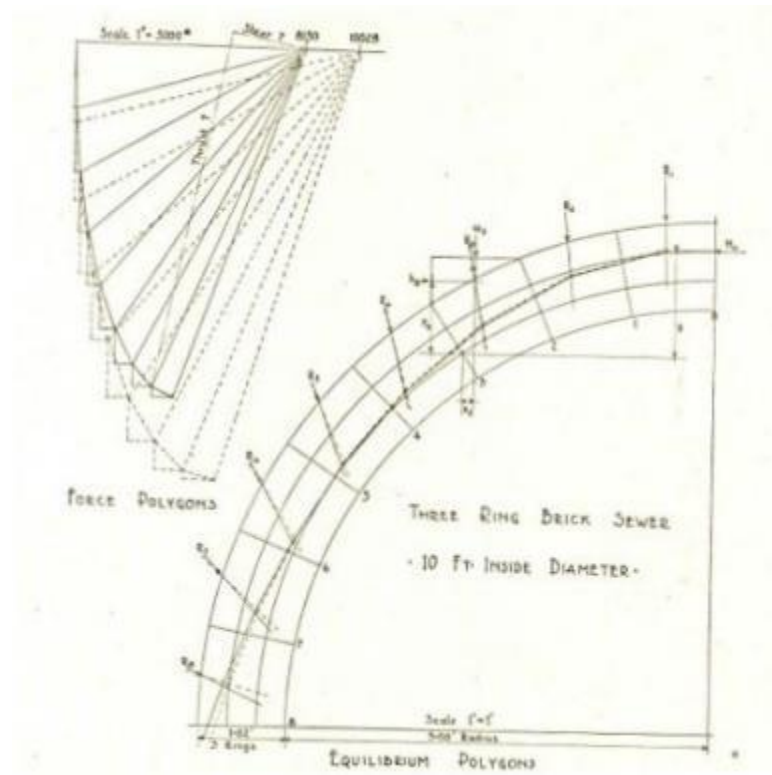


CMP Culverts



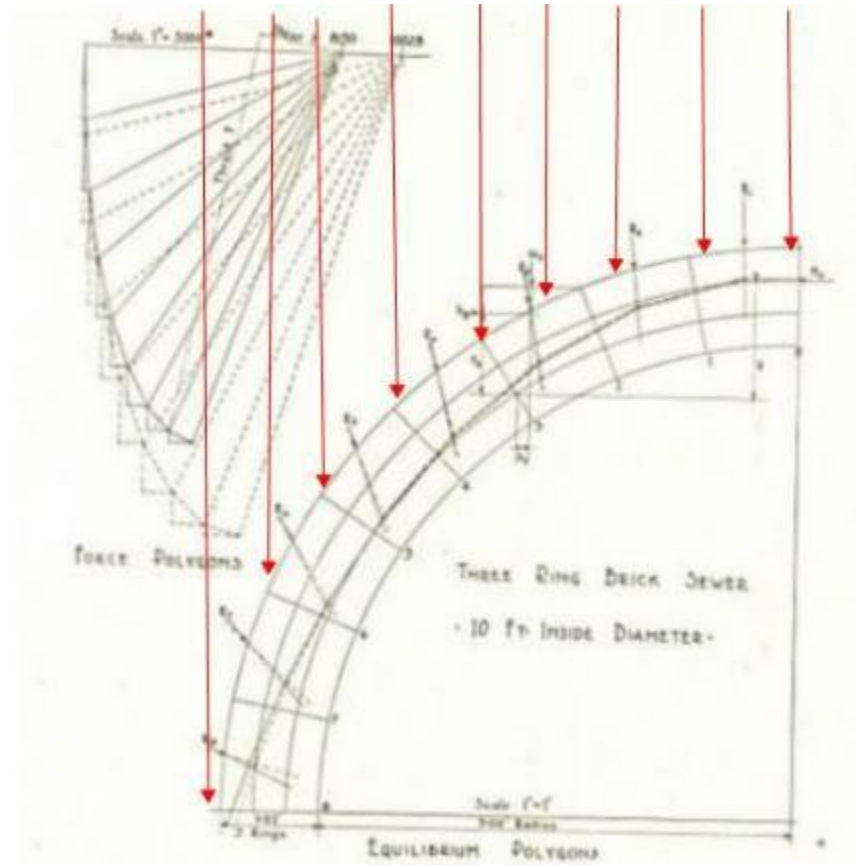


Brick Conduits – Load Distribution



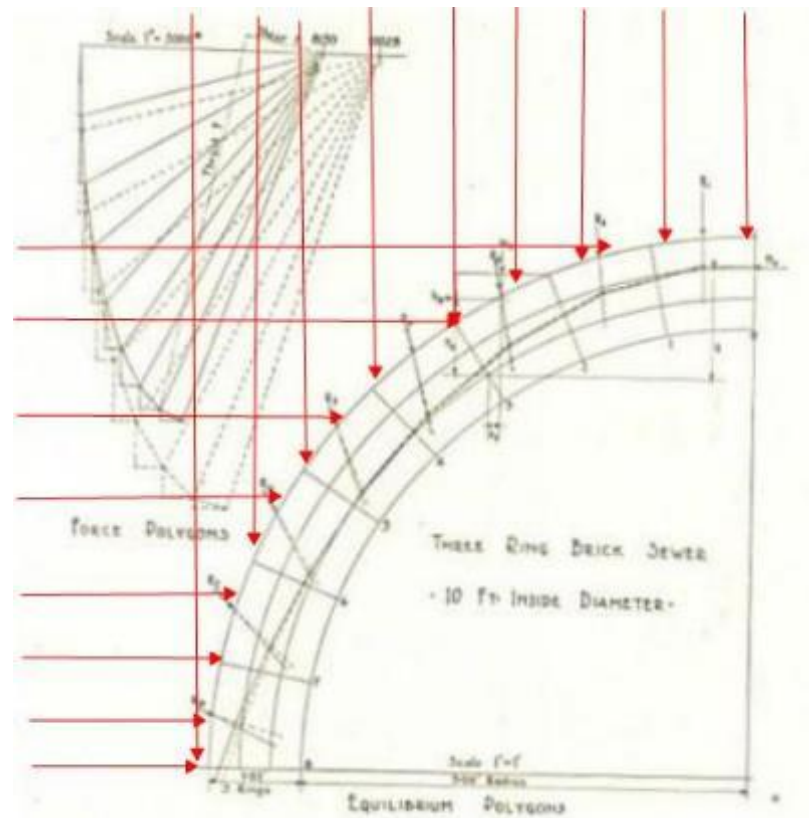


Brick Conduits – Loads contd.



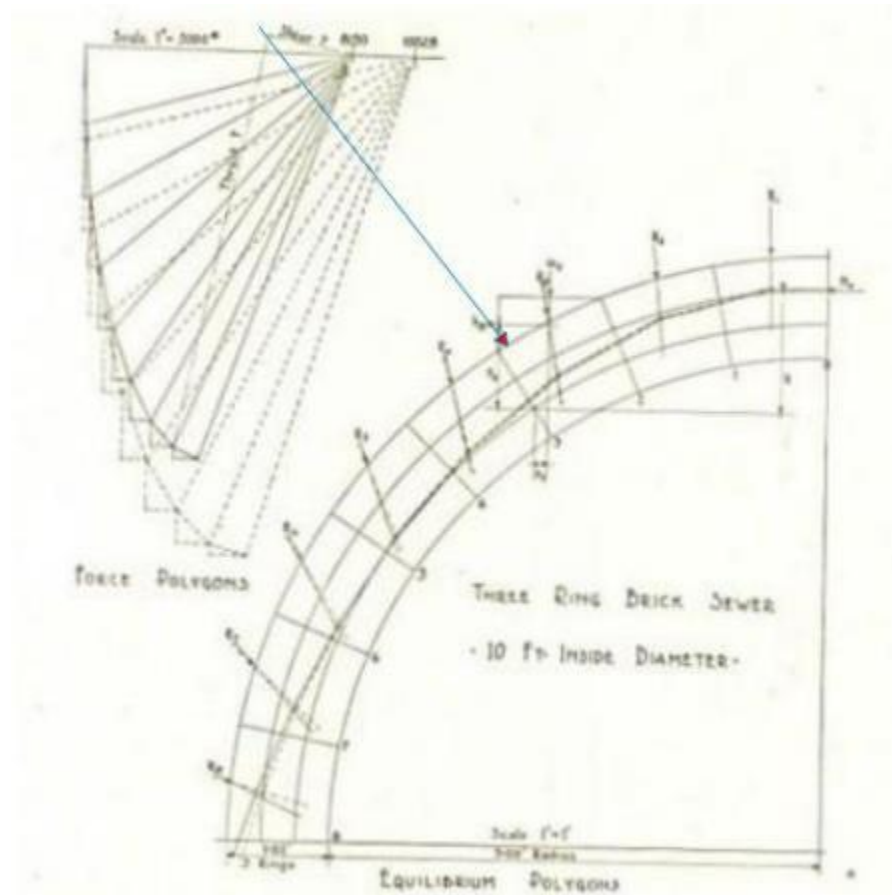


Brick Conduits – Loads (contd.)



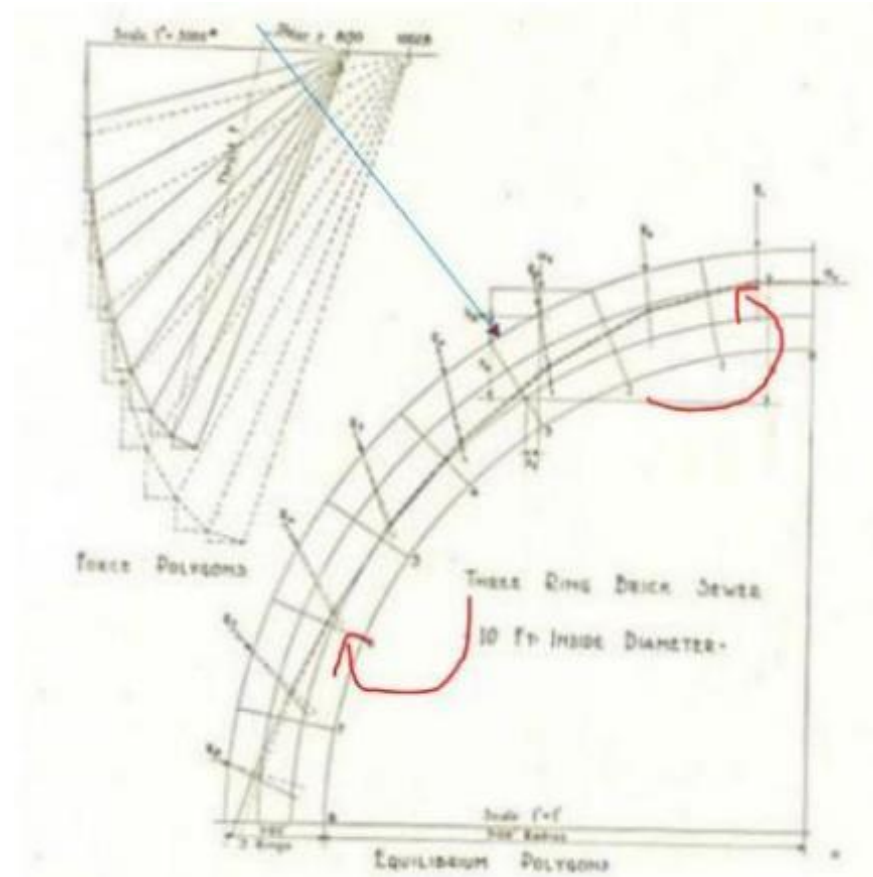


Brick Conduits – Loads (contd.)



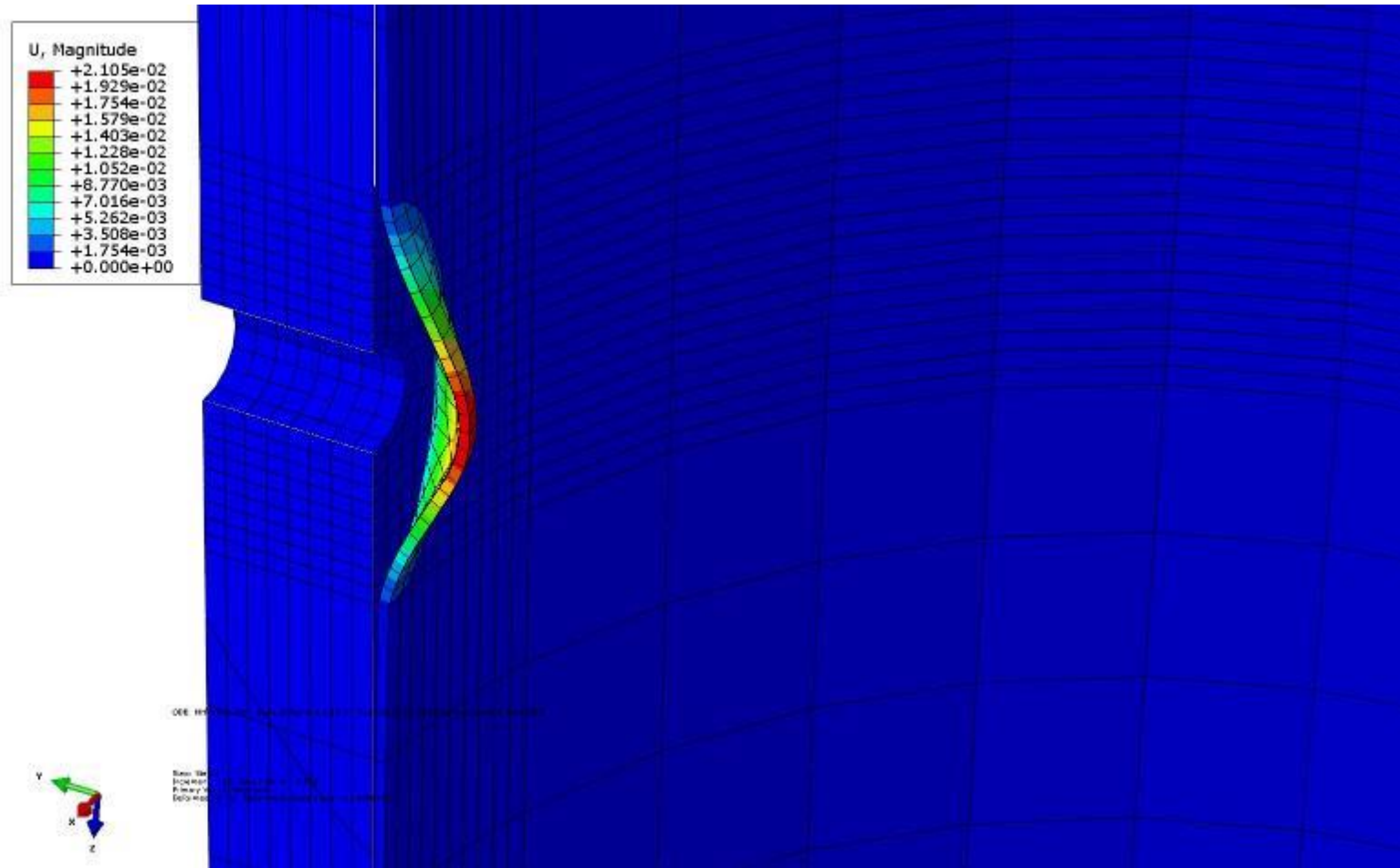


Brick Conduits – Loads (contd.)





Groundwater Pressure





Design Factors

- Flexible (e.g., polymeric liners)
- Rigid (e.g., cementitious)
- Fully-structural (stand-alone)
- Semi-structural
- Condition
- Loads
- Soil type
- Environmental effects
- Site access conditions



Sample Design Equations

ASTM F1216 – partially deteriorated

$$P = \frac{2KE_L}{(1 - \nu^2)} \cdot \frac{1}{(DR - 1)^3} \cdot \frac{C}{N}$$

Soil Load – Flexible Pipe/Liner

$$\omega = C_p \gamma D^2$$

Ovality

ASTM F1216 – fully deteriorated

$$q_t = \frac{I}{N} [32 R_w B' E'_s C (E_L / D^3)]^{1/2}$$

Host Pipe Support

Stress Concentration

Modified Timoshenko– buckling

$$P_c = (2EC\alpha\beta) / [(1 - \nu^2)(DR)^3 SF]$$

Internal Pressure: Thin-walled vessels

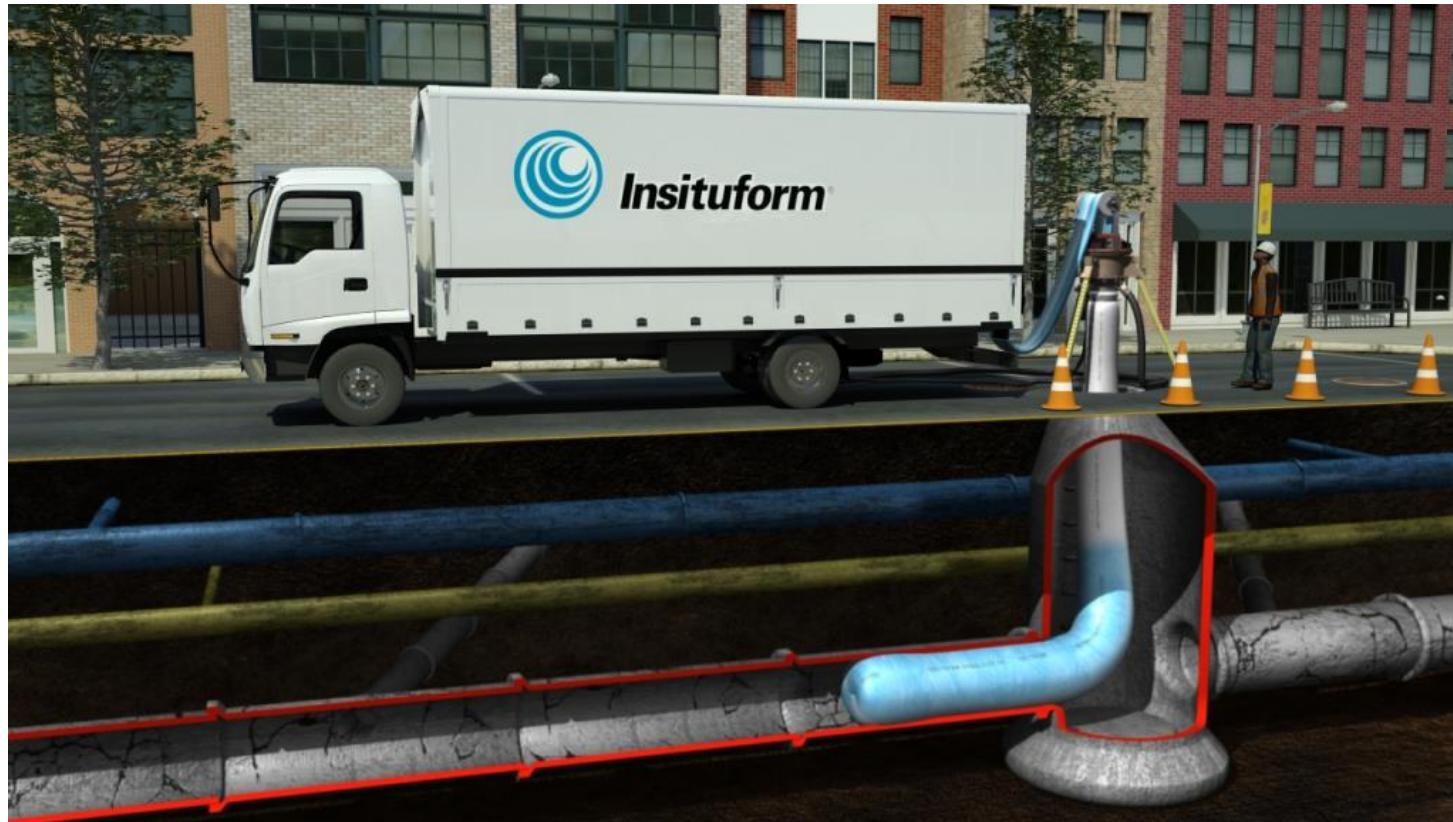
$$\sigma = \frac{PD}{2t}$$



THE UNDERGROUND UTILITIES EVENT

Underground Construction Technology | Jan. 29-31, 2019 | Fort Worth, TX

CIPP





THE UNDERGROUND UTILITIES EVENT

Underground Construction Technology | Jan. 29-31, 2019 | Fort Worth, TX

Sliplining (Deform/Reform)





Geopolymer





THE **UNDERGROUND** UTILITIES EVENT

Underground Construction Technology | Jan. 29-31, 2019 | Fort Worth, TX

Rigid Sliplining (CC-GRP)





THE UNDERGROUND UTILITIES EVENT

Underground Construction Technology | Jan. 29-31, 2019 | Fort Worth, TX

CFRP Lining



Sliplining w/ StifPipe®



Composite Sandwich Concept



Steel I-beam



T 

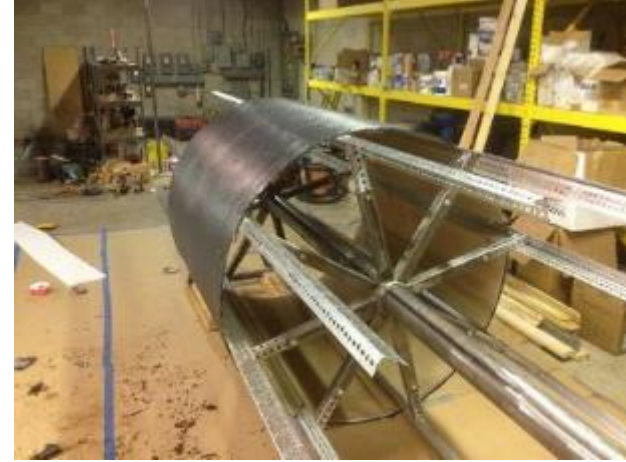
RELATIVE STIFFNESS

1

WEIGHT (Pounds/ft²)

0.910

Avalon Pump Station Project

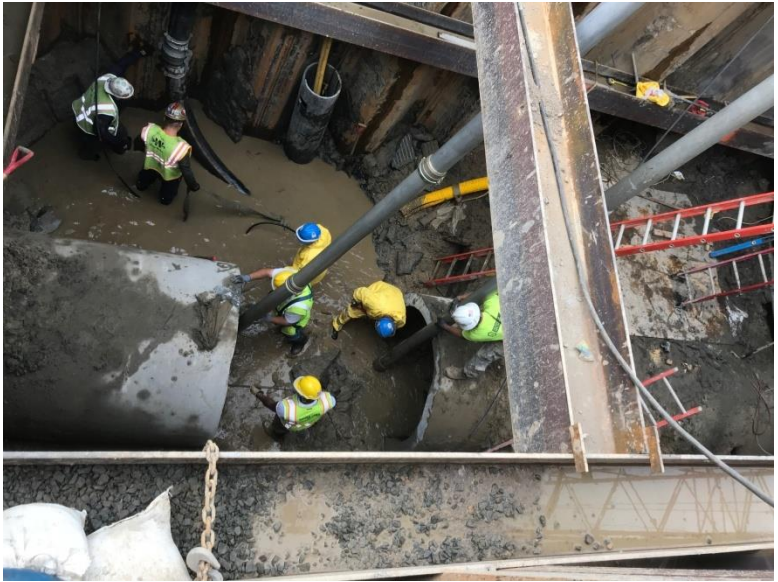


Avalon Pump Station Project ... Cont'd



StifPipe® Built in a Pipe

Edison, NJ Sept. 2018



Thank You!

Contact:

Firat Sever

fsever@quakewrap.com

