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CONTECH® ENGINEERED SOLUTIONS

Challenges Related to Large-Diameter Sewer Design, Installation & Testing

February 29, 2024

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Introduction

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AGENDA

- **Introduction**
- Pipe Material Selection Process
- Handling & Installation
- The Science Behind Pipe Jointing
- Leak Testing
- Considerations to Address These Challenges
- Conclusion

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THE CONTECH WAY

Contech provides innovative, cost-effective site solutions to engineers, contractors and developers on projects across North America. Our portfolio includes bridges, drainage, erosion control, retaining walls, sanitary sewer and stormwater management products.

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Who are we ... the experts you need to

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Homogenous vs Composite

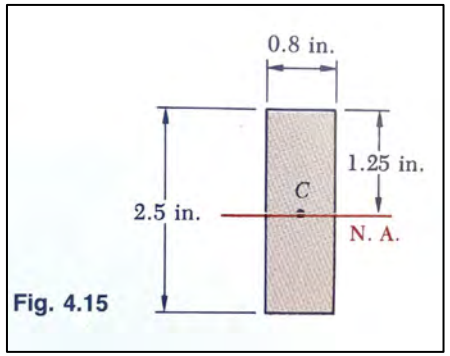


Fig. 4.15

Beer, Ferdinand P & Johnston, E Russel. *Mechanics of Materials.* 2nd Ed., McGraw Hill, 1992.

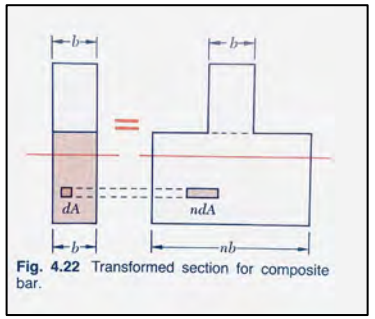


Fig. 4.22 Transformed section for composite bar.

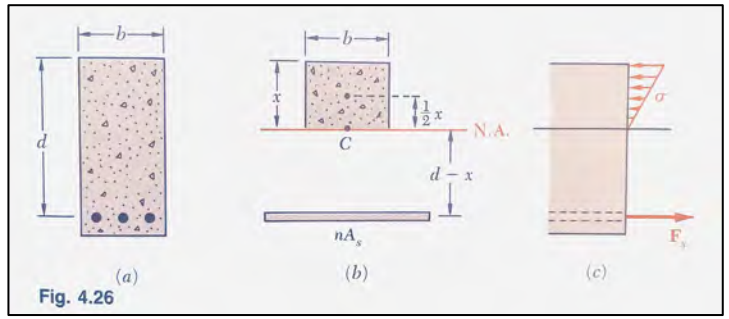
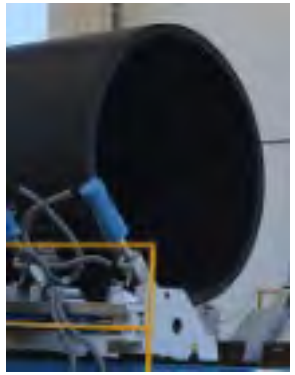


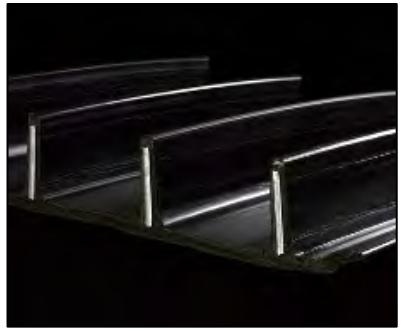
Fig. 4.26

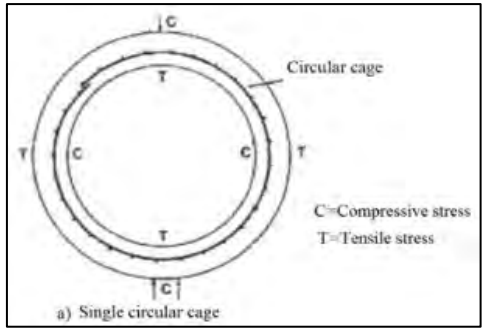
Beer, Ferdinand P & Johnston, E Russel. *Mechanics of Materials.* 2nd Ed., McGraw Hill, 1992.


VCP



Plastics


SRPE



RCP


Fiberglass

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Rigid vs Flexible

Rigid Pipe Definition: Structural distress occurs prior to 2% vertical deflection
Examples: RCP & VCP

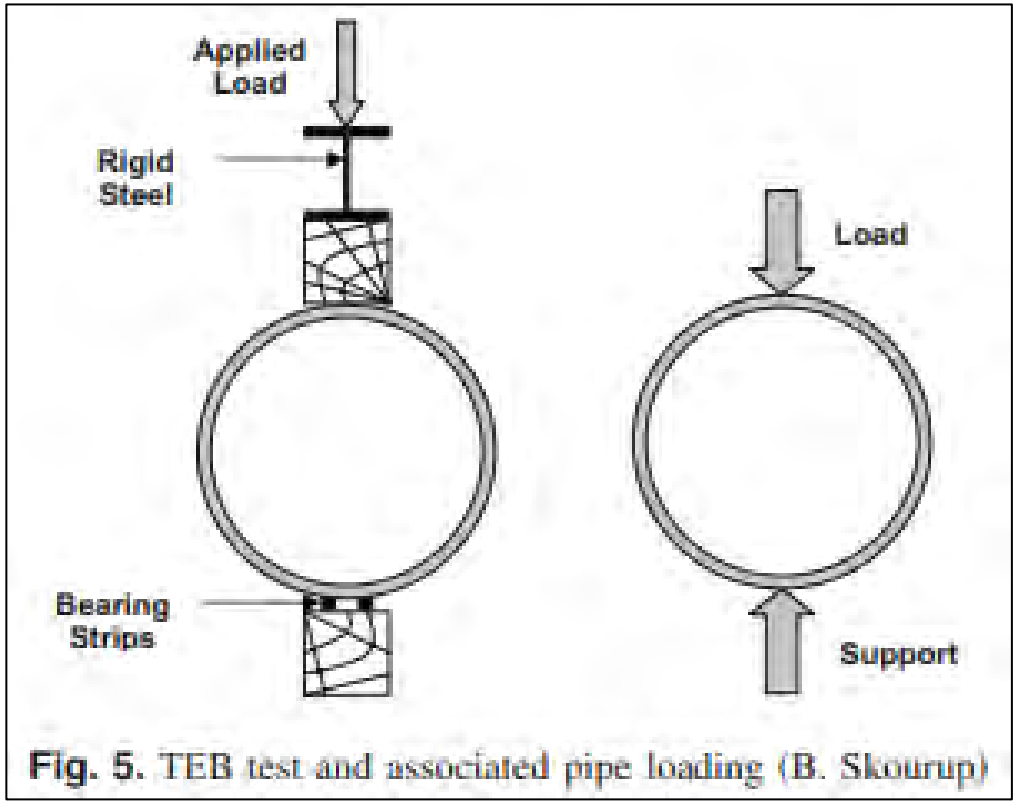
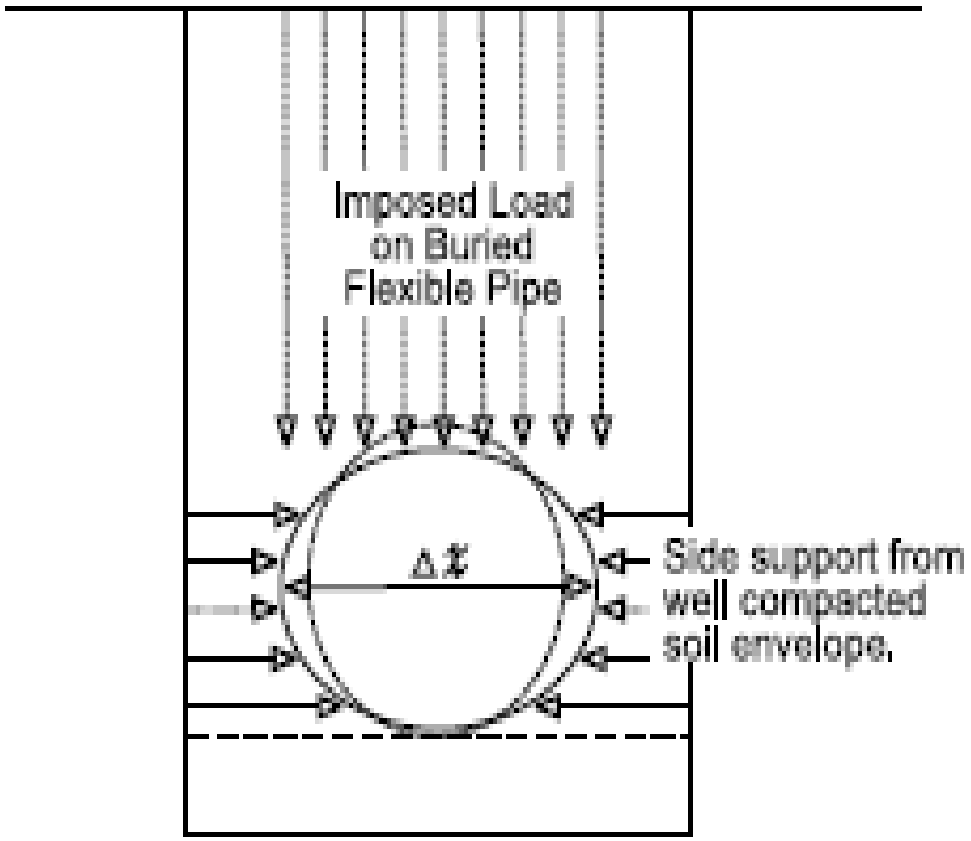


Fig. 5. TEB test and associated pipe loading (B. Skourup)

Erdogmus, Ece; Skourup, Brian N; & Tadros, Maher. *Recommendations for Design of Reinforced Concrete Pipe*. Journal of Pipeline Systems Engineering and Practice. 2010.

Rigid vs Flexible

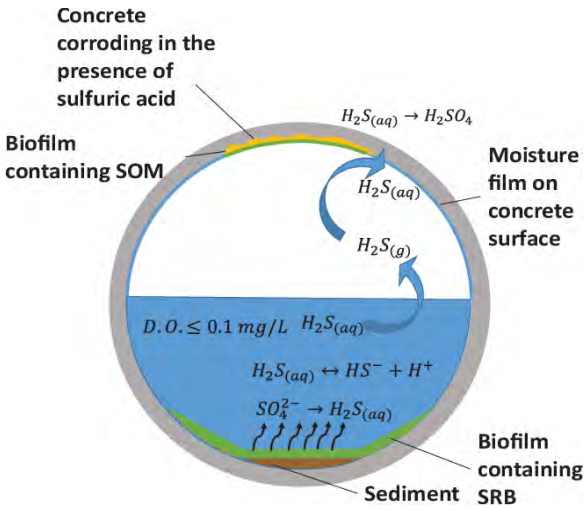
Flexible Pipe Definition: Deflection generally limited to 5% - 7.5%, depending on material



Examples:

- SRPE
- Plastic
  - Rigid Plastics
    - PVC
  - Viscoelastic Plastics
    - HDPE
    - PP
- Fiberglass

Resiliency



- H_2S produced below the water line
- H_2S partitions to gas, converted to H_2SO_4
- H_2SO_4 attacks cement

Chemical (Formula)	Concentration	ABS	CPVC	PP	PVC	PE	PB	PVDF	PEX	PA 11	PK
Hydrogen Sulfide H_2S	Dry	---	180	150	140	140	140	R to 248	140	---	---
	Wet	---	180	---	140	140	---	---	140	---	---

Plastics at Maximum Operating Temperature (°F)

Chemical (Formula)	Concentration	ABS	CPVC	PP	PVC	PE	PB	PVDF	PEX	PA 11	PK
Sulfuric Acid H_2SO_4	5%	---	---	---	---	---	---	---	---	---	R to 73
	30%	120	180	180	140	140	140	R to 248	R to 140	---	N
	50%	73	180	140	140	120	C to 73	R to 212	R to 140	---	---
	60%	C to 73	180	73	140	120	C to 73	R to 248	---	---	---
	70%	C to 73	180	73	140	R to 120	C to 73	---	---	---	---
	80%	C to 73	180	73	140	R to 120	N	C to 248	---	---	---
	90%	C to 73	150	73	73	120	N	R to 212	---	---	---
	93%	N	140	C to 73	73	C to 73	N	---	---	---	---
	94% - 98%	N	130	C to 73	N	C to 73	N	C to 212	N	---	---
	100%	N	N	C to 73	N	C to 73	N	---	---	C to 194	---

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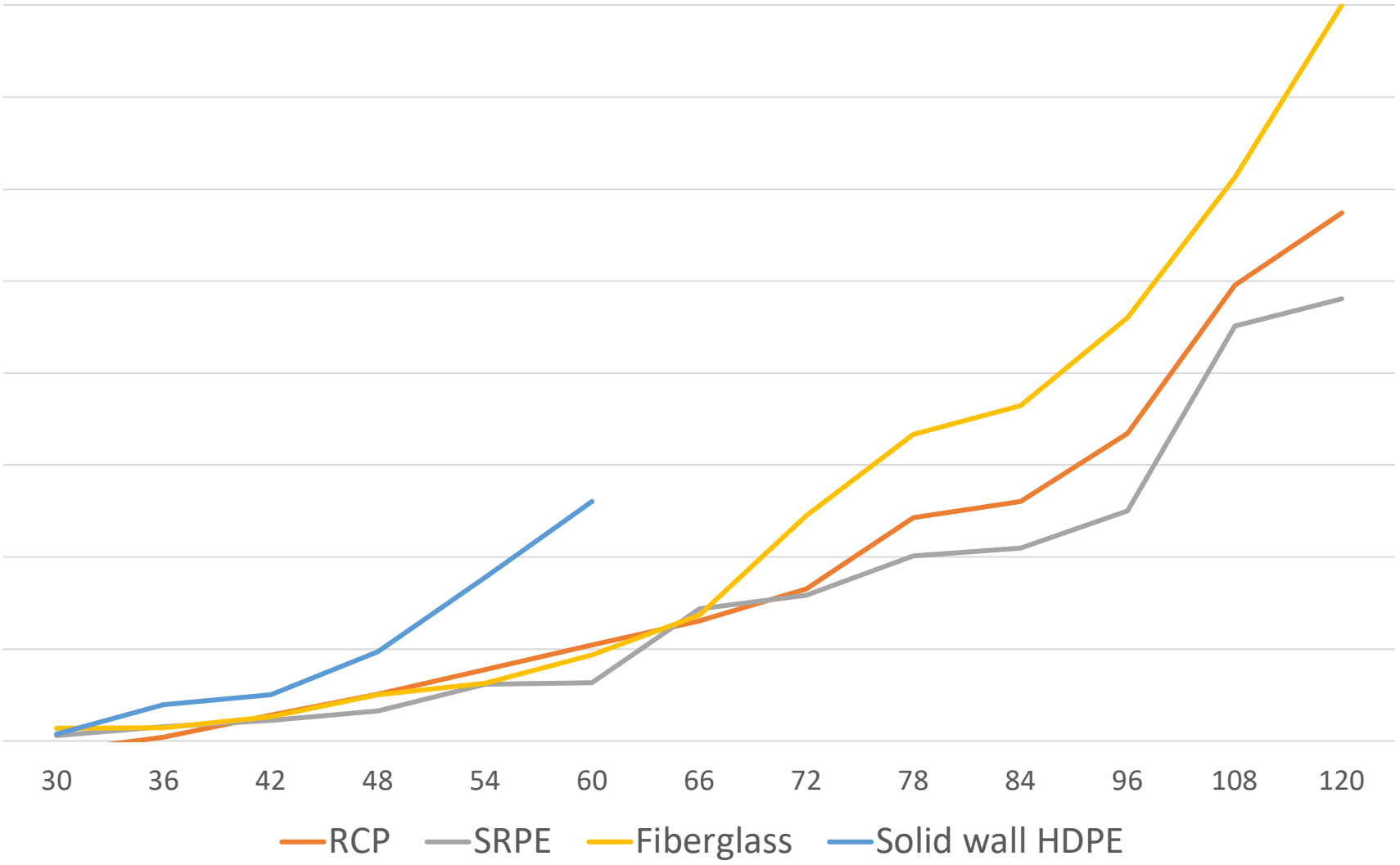
Pricing Comparison



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Case History

Hamilton Drain Storm Sewer

Owner: City of Des Moines, IA

Engineer: Kirkham Michael

Contractor: RW Excavating Solutions, LLC

Description:
- **2,640’ of 84” bell/spigot**
- **Elbows**
- **Risers**
- **Laterals**
- **Field Modifications**

Installation Date: Winter 2022

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POLL QUESTION #1

1. Have you ever been involved in a 30” or larger diameter sanitary sewer project?
2. Yes
2. No

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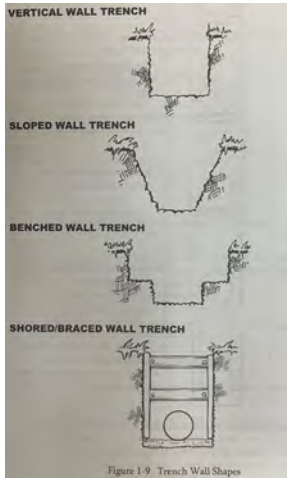
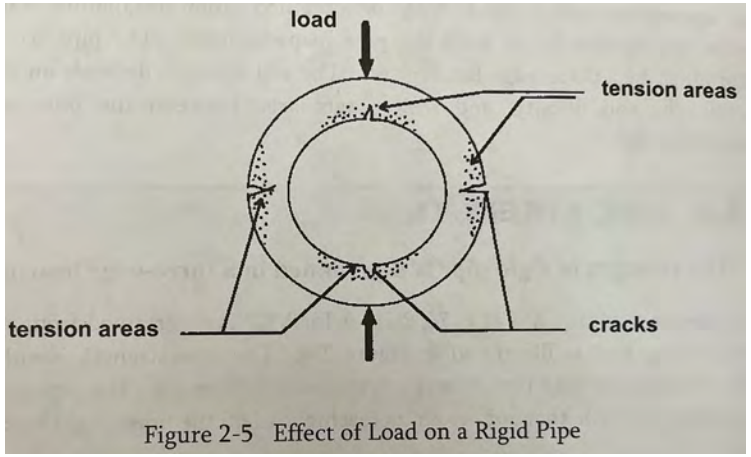
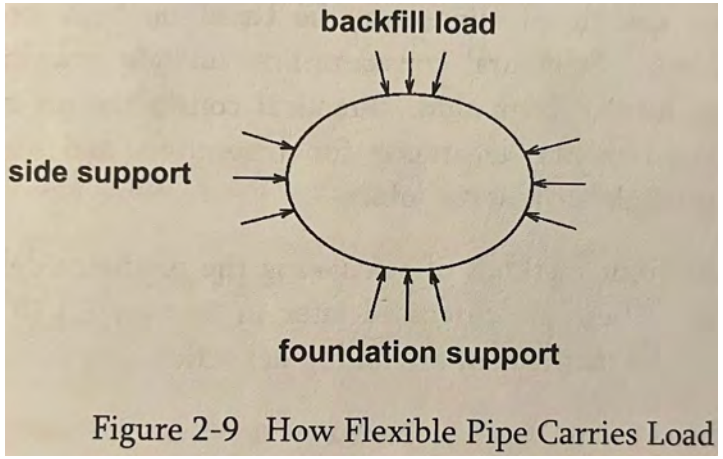
Unloading and Handling

Installation Considerations

- Excavation Safety
  - OSHA
  - Trench protection
  - Access
- Pipe Load/Deflection
  - Depth/Height of Cover
  - Live Loads
  - Sag, Installed, Lag



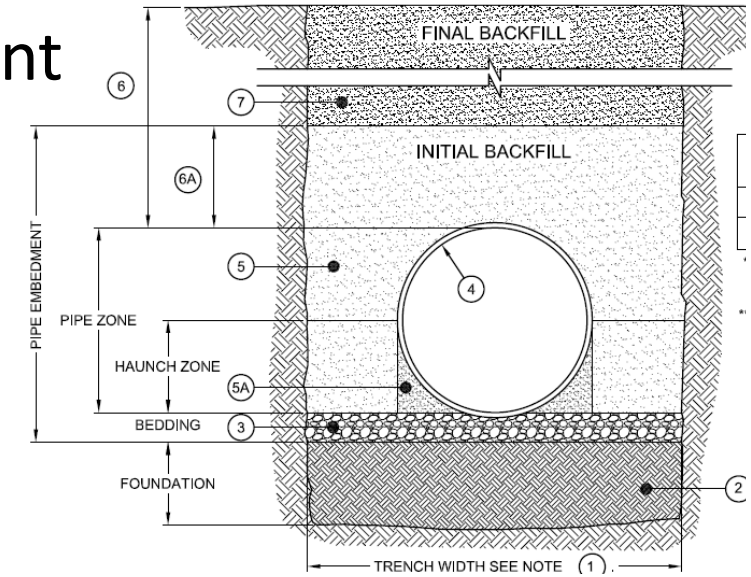




Howard, Amster. Pipeline Installation 2.0. 2nd Edition., Relativity Publishing, 2015.

Typical Installation Steps

- Excavation and Trenching Dimensions
- Foundation and Bedding
- Pipe Placement and Joining
- Haunching and Embedment
- Backfill and Compaction



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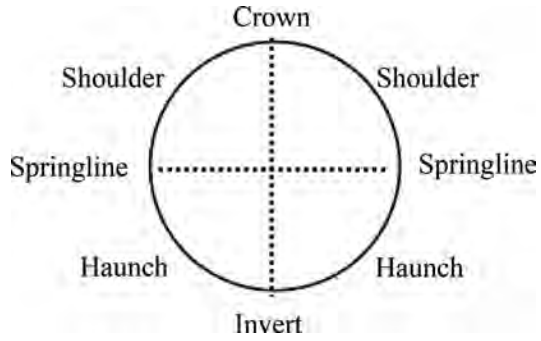
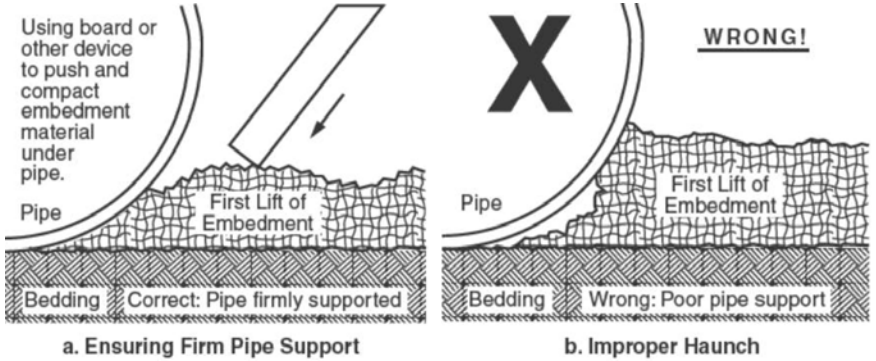
Haunching and Embedment

Figure 5-1 Using Pogo Stick in Pipe Haunch Area

Howard, Amster. Pipeline Installation 2.0. 2nd Edition., Relativity Publishing, 2015.





AWWA Manual 45, 2014.

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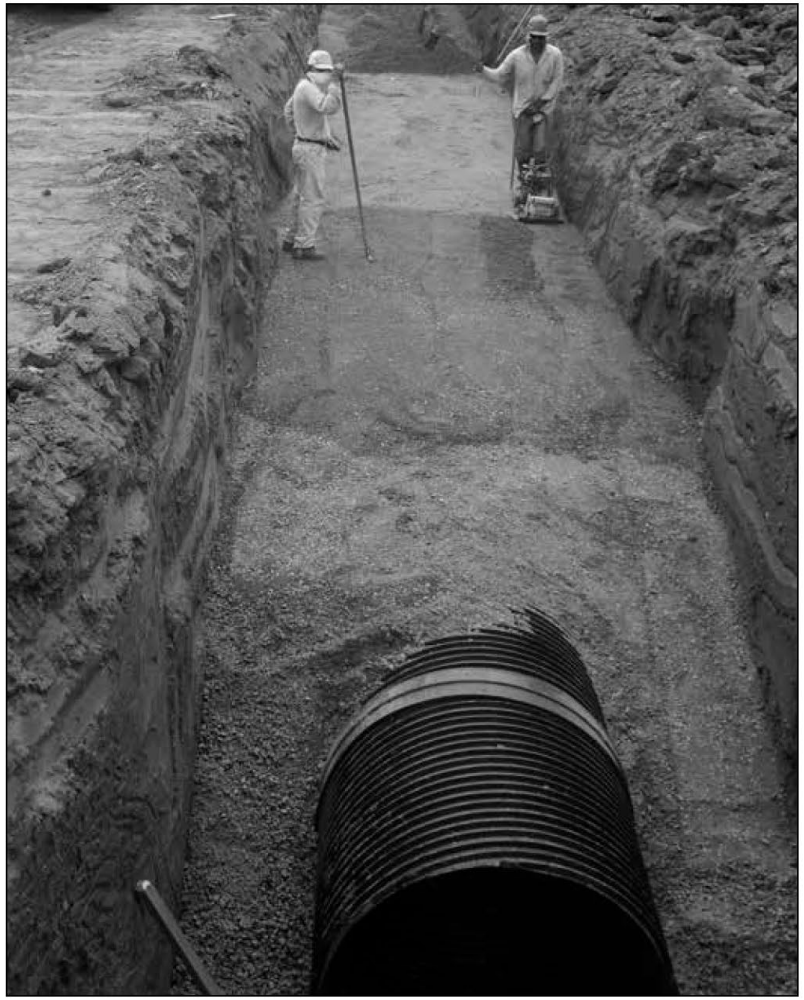
Backfill and Compaction



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Installation Verification – Construction QA/QC

- Compaction Testing
- Material Inspections
- Standard Practices
- Manufacturer Procedures
- Post-Install Video/Survey

Sewervue.com

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SRPE Installation Video

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Why are joints one of the most important design considerations in large diameter pipe systems?

Strength

Joints

Cost

Installation

Hydraulics

Service Life

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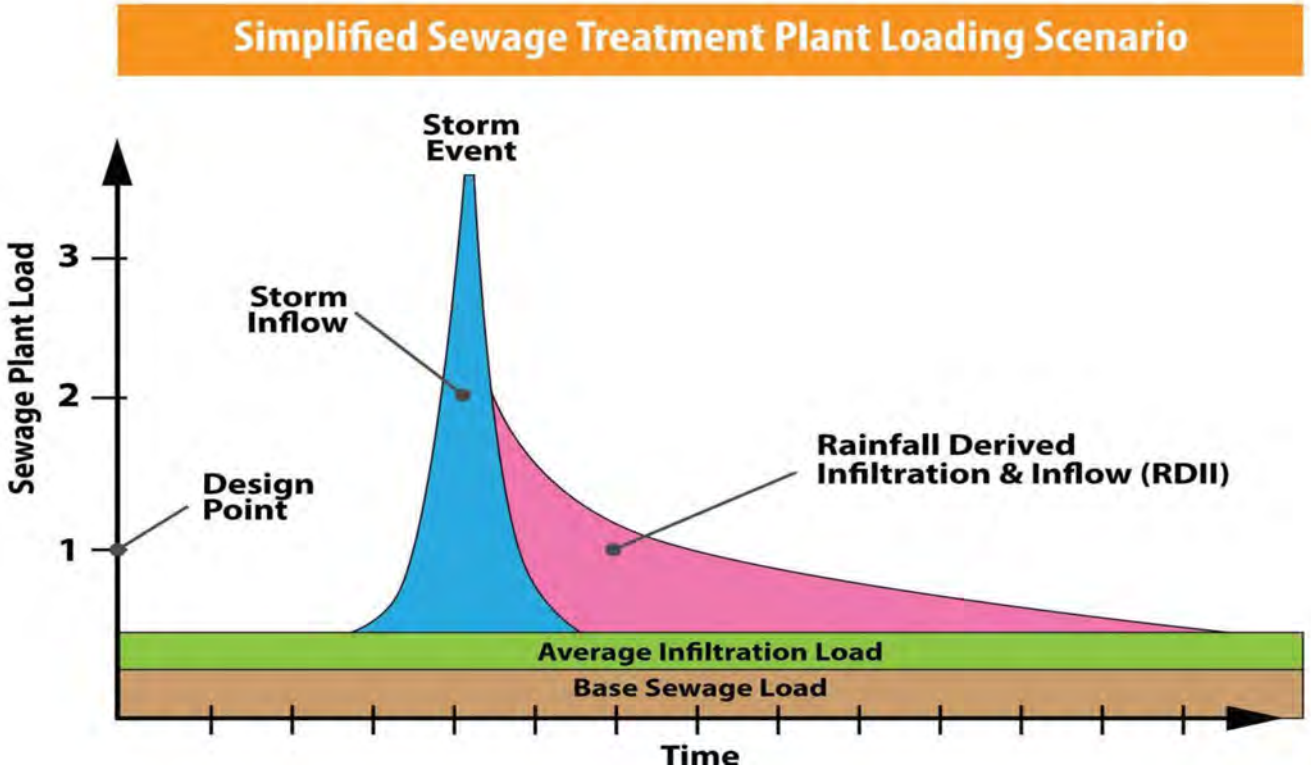
Inflow & Infiltration (I&I)



- Pipe Joint Infiltration
- Cracks in Pipe Wall
- Poor Structure Connections
- Seepage into Manholes
- Incorrect Lateral Tie-ins

What is an Acceptable Joint? ASTM D-3212

- First published in 1973
- Test for reliability and performance requirements
- Isolate joint, reach internal pressure of 10.8 psi and hold for 10 minutes with no leaks
- Test with straight configuration and with vertical ring deflection of 5%

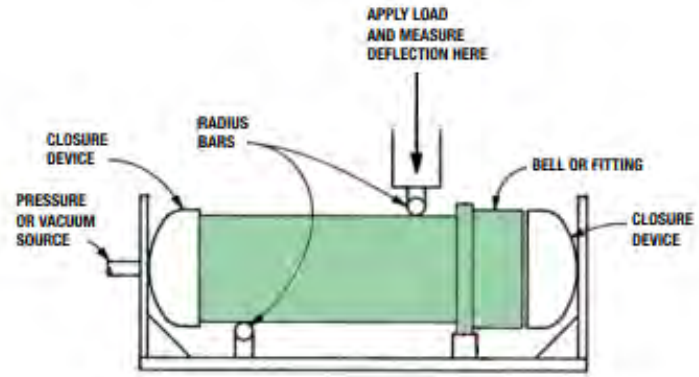


Figure 4 – ASTM D3212 Shear Deflection Test Setup (5% Ring Deflection)

ASTM D-3212: Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals

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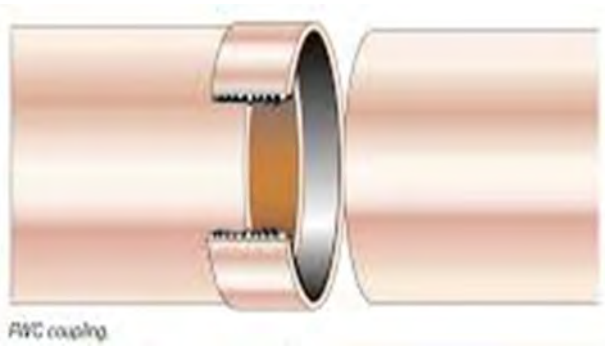
Preparing for Infrastructure Growth

- The need for larger pipe systems is growing over time
  - Storm Drainage, Sanitary Trunklines, Raw Water Intakes, Large Irrigation, Flood Control, and WWTP outfalls.
- Joints for Larger Pipe Diameters
  - Gasketed Bell & Spigot
  - Collar Joints
  - Welded / Butt-welded
  - Bolted Flange Rings



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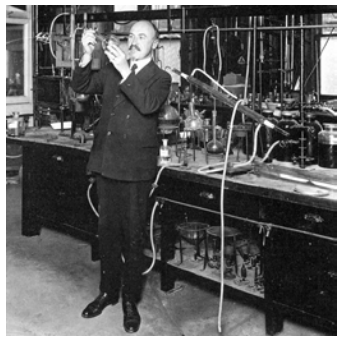
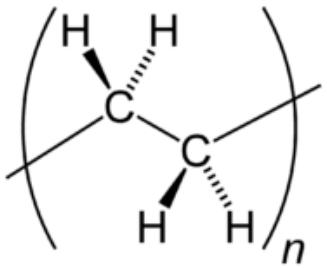
Taking a Closer Look at Polyethylene (PE)

- Initially used as solid wall pipe in the late 1950s in the oil & gas industry
- Highly resistant to many corrosive chemicals found in drainage and wastewater applications including hydrogen sulfide (H_2S) gas.
- Sustainable and requires less energy to fabricate, transport, and install than many other heavier materials.
- Highly resistant to abrasion and provides a long service life.
- Used today in many critical applications including natural gas, potable water and sanitary sewers.





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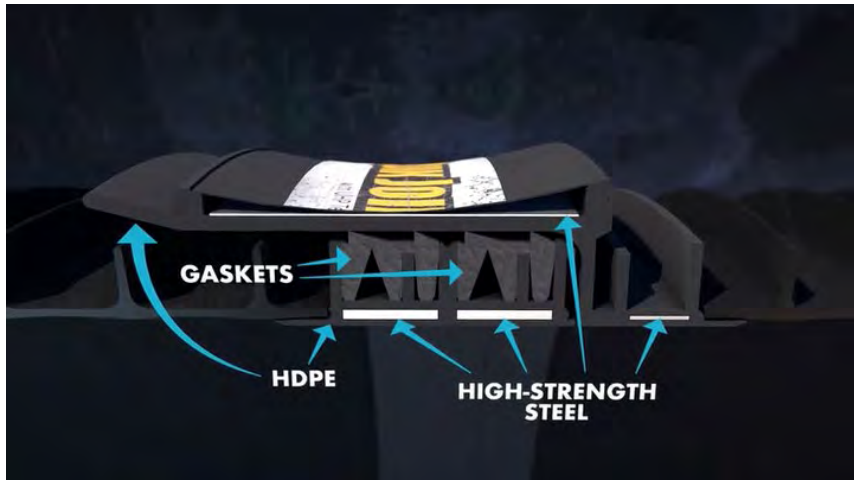
Addressing Limitations of PE in Large Diameter Pipe Joints

- HDPE is a viscoelastic material, and its deformation potential is stress and time dependent. It is subject to “creep”.
- Modulus of steel = 29,000,000psi vs. Modulus of PE = 152,000psi
- Reinforcing the bell and spigot ends of the joint with high-yield steel ensures consistent gasket compression and integrity of the joint for the life of the pipe.



Material Selection Considerations

Pipe Material	Diameter	Standard Length	Pick Weight	2000’ Sewer
SRPE	72”	24 ft	1,600 lbs	83 joints
Fiberglass	72”	20 ft	7,000 lbs	99 joints
RCP	72”	8 ft	16,800 lbs	250 joints

- Fewer joints equate to added insurance against future issues and maintenance.
- Lighter, longer sections results in a faster installation time.
- Fewer joints means less time and money spent testing.

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POLL QUESTION #2

2. What is your preferred material selection for a 30” or larger diameter gravity sanitary sewer system project?
    - Fiberglass
    - PVC
    - HDPE
    - SRPE
    - RCP

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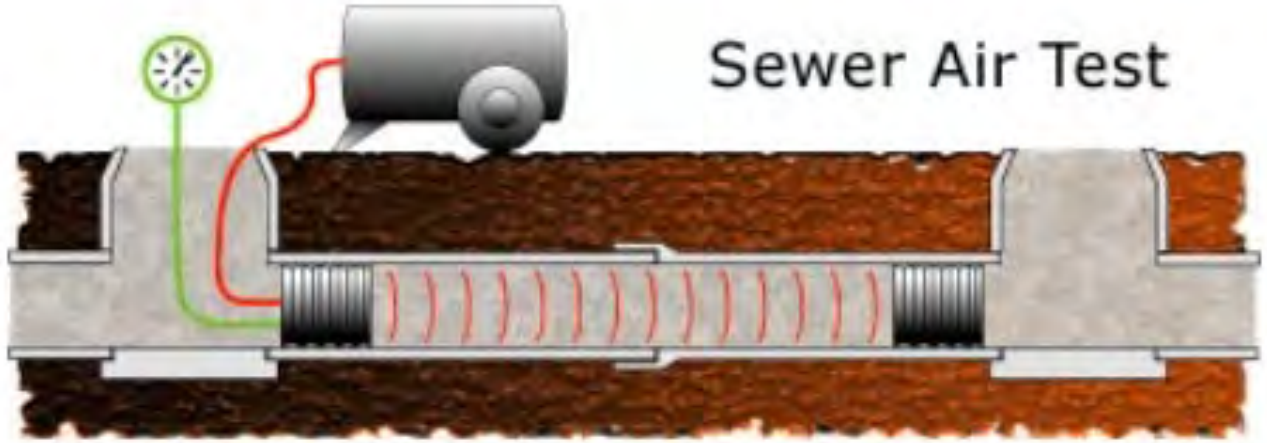
Industry Standards

- ASTM F1417 - Plastic Sewer Low-Pressure Air
- ASTM C 924 - Concrete Sewer Low-Pressure Air
- ASTM C 969 - Hydrostatic Testing (Rare)
- Visual Inspection (Diameters larger than 24" or 30")
- ASTM C 1103 - Joint Isolation

ASTM F1417 Low Pressure Air (Plastics)



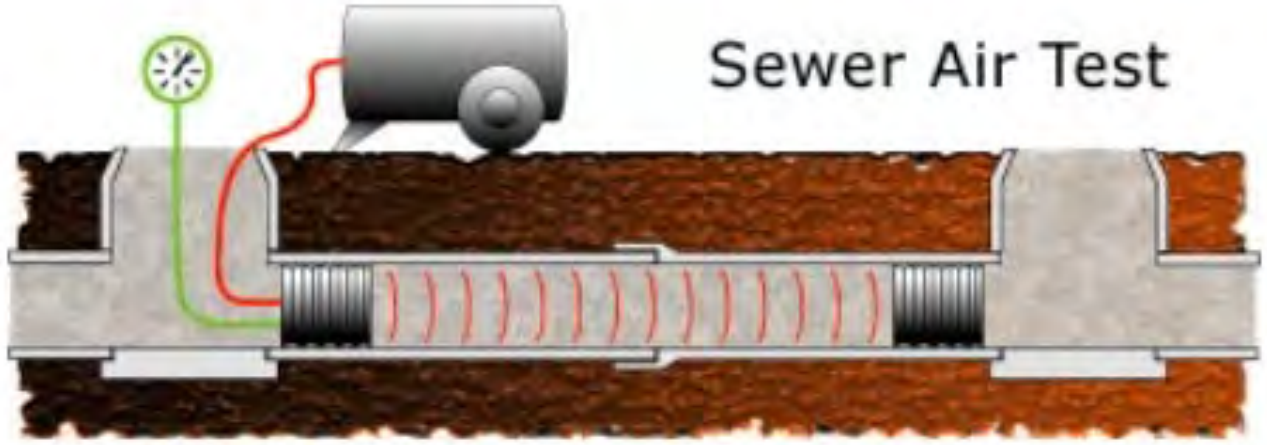
F1417 – 11a (2015)

TABLE 1 Minimum Time for a 1.0-psig Pressure Drop for Size and Length of Pipe for $Q = 0.0015$

NOTE 1—See Practice UNI-B-6.

NOTE 2—Consult with pipe and appurtenance manufacturer for maximum test pressure for pipe size greater than 30 in. in diameter.

ASTM C 924 Low Pressure Air (Concrete)



Note 1—The user of this practice is advised that air test criteria presented in this practice are similar to those in general use. The test and criteria have been used widely and successfully in testing smaller diameter pipe, but additional data are required to confirm the safety and applicability or develop criteria for pipe larger than 24 in. in diameter. Larger pipe will be accepted more conveniently by visual inspection and individual joint testing.

Hydrostatic Testing – ASTM C 969

- Rarely Performed:
  - Available Water Resource
  - Time Consuming
  - Expensive

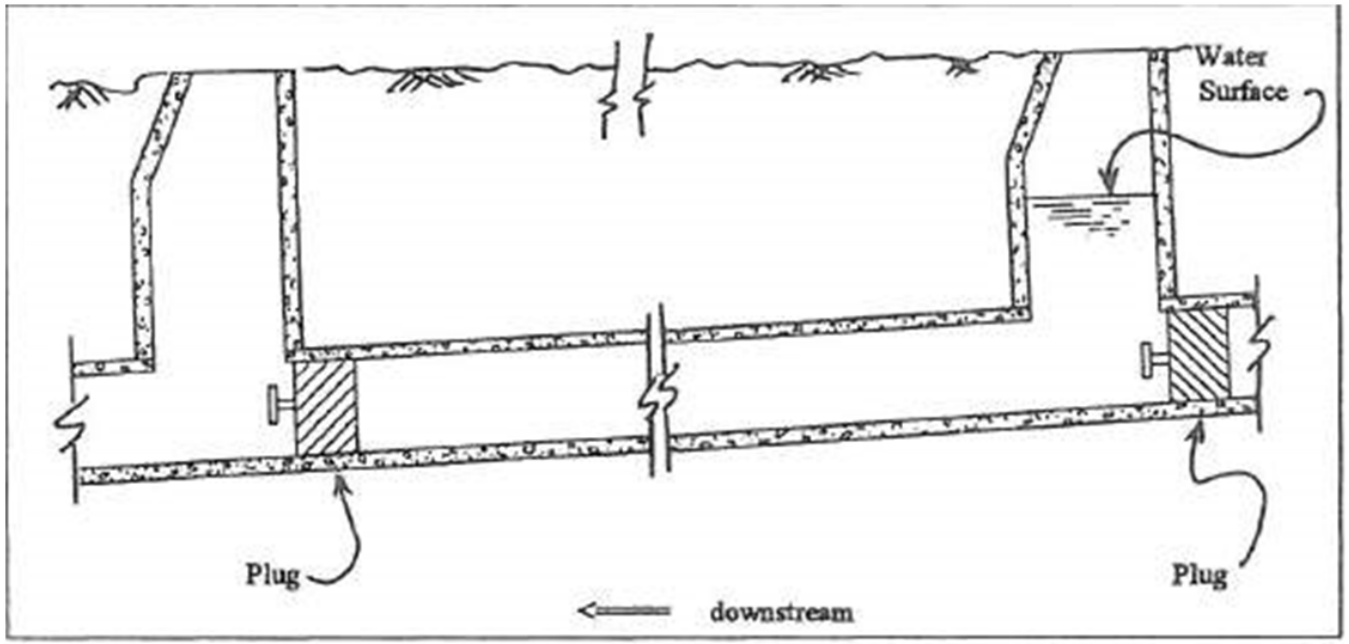
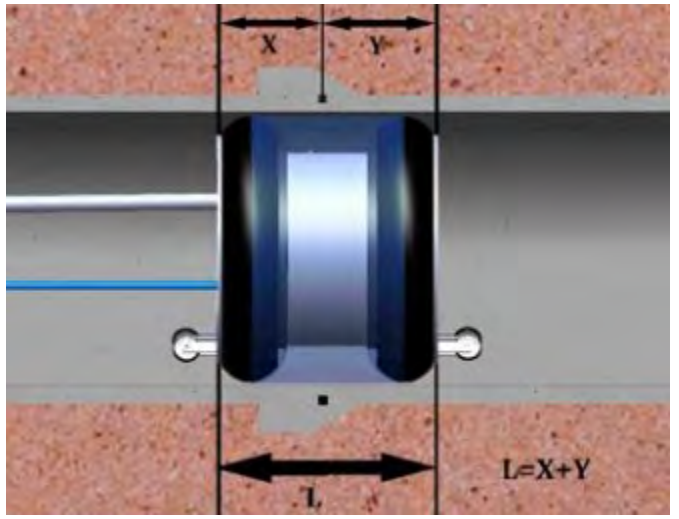


Figure 12 - 4 Exfiltration Test [11]

Visual Inspections – Large Diameters

- Various technologies and vendors
- Better suited for condition and shape analysis
- Limited to what can be seen

Joint Isolation Testing Equipment – ASTM C 1103



- Various technologies and vendors
- Limited in size per type and vendor
- Better suited for rigid pipe design
- Time consuming and expensive

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POLL QUESTION #3

3. How often do you see installed joint testing for pipe diameters 72" and larger?
   - Never
   - Sometimes
   - Often

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QuikJoint® Video

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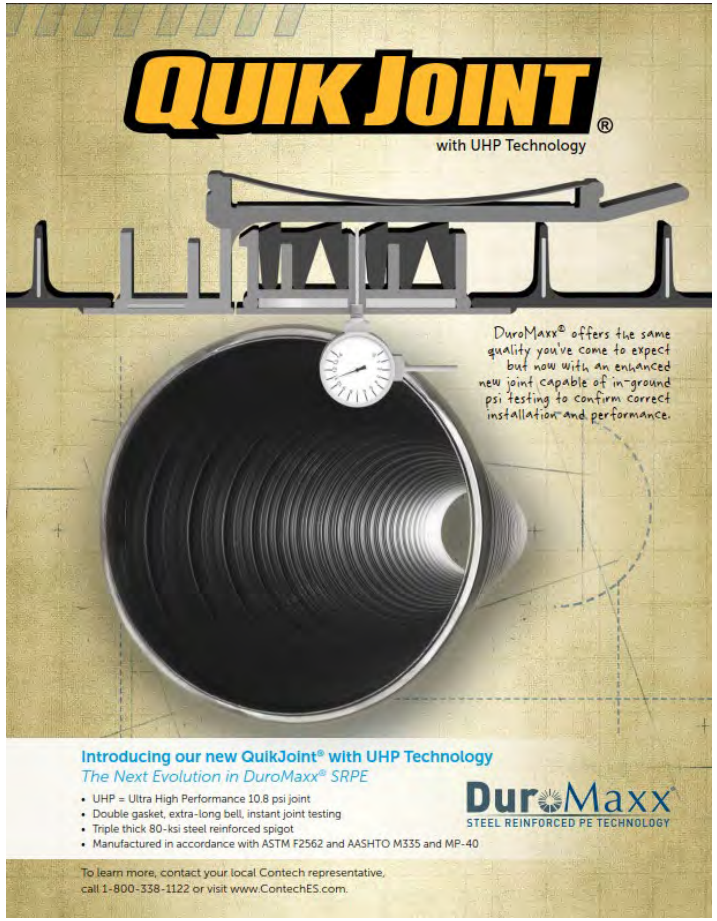
QuikJoint® w UHP Technology

- Testable Bell & Spigot Joint
- All DuroMaxx® Diameters
- Bell & Spigot Steel Reinforced
- Redundant Gaskets
- Field Tested in Minutes



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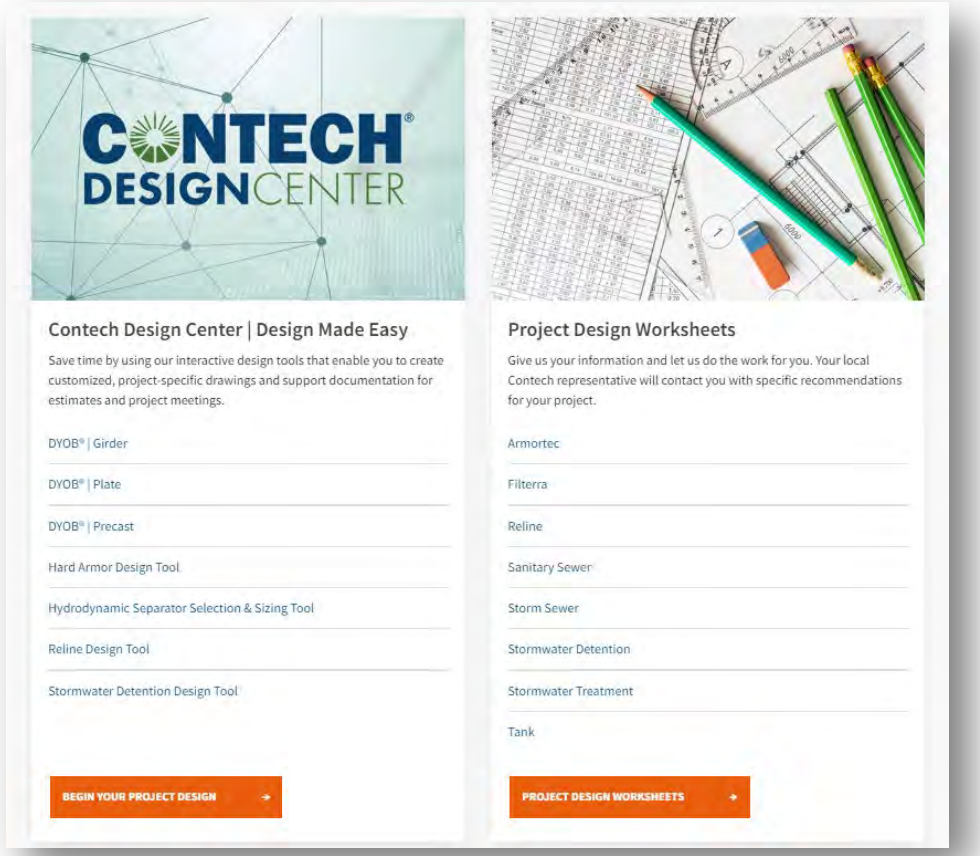
RESOURCES

- www.ContechES.com
  - Contech Design Center
  - Project Design Worksheets
  - Technical Documents
  - PDH Articles
  - Case Studies & Blogs
  - Local Resources



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Questions and Answers with:

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Editorial Director
Informed Infrastructure

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