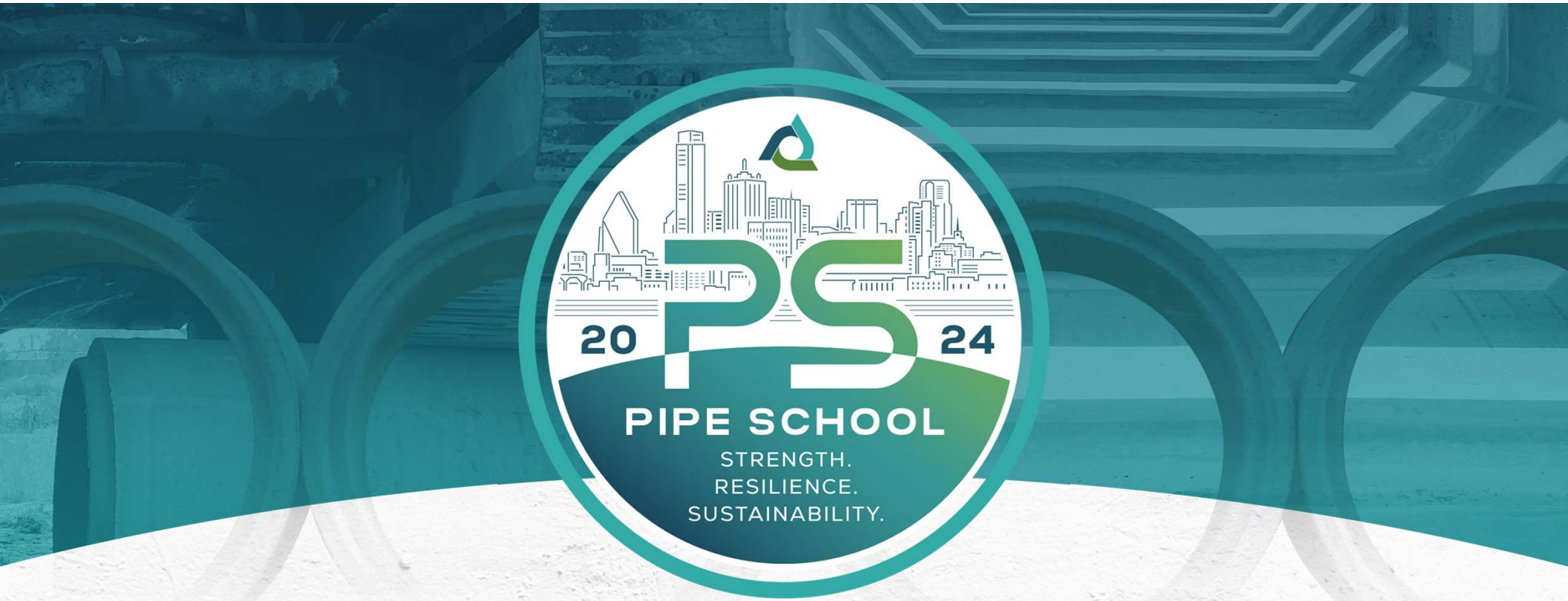

Concrete Pipe Installation

David Matocha

Rinker Materials

AGENDA

Module 1: Basic Pipe Concepts
Module 2: Trench Fundamentals
Module 3: Installation Procedures

ACPA

Learning Outcomes

1. **Explain basic pipe concepts and the benefits of a proper installation.**
2. Explain the fundamental components of a trench.
3. Communicate the purpose of foundation, bedding, and structural backfill.
4. Explain the different steps for a proper installation for reinforced concrete pipe.

ACPA

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ACPA

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3. Communicate the purpose of foundation, bedding, and structural backfill.
4. **Explain the different steps for a proper installation for reinforced concrete pipe.**

ACPA

There is NO Perfect Pipe

- All pipes bring certain strengths and weaknesses.
- Good designers/installers must accommodate for strengths that best benefit the project, while making sure the weaknesses don't jump up and bite you.

Installation is Key

- Careful attention to construction details such as pipe bedding, backfill material, compaction and trench width are vital.
- Poor compaction or poor quality backfill around culverts will result in uneven settlement and structural distress of the culvert which directly effects the long-term performance of the pipe system.

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MODULE 1
Basic Pipe Concepts

ACPA

Expected Service Life

A well installed pipe should stay in service 50 to 100 years with little or no repair.

Benefits

PROPER INSTALLATION

Essential to Pavement Performance

Increases Bearing Capacity

Increases Service Life

Lowers Maintenance Cost

ACPA

Benefits

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Increases Bearing Capacity

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Pipeline Functions

The Soil/Pipe System works as an underground bridge, supporting the loads from above while conducting water below.

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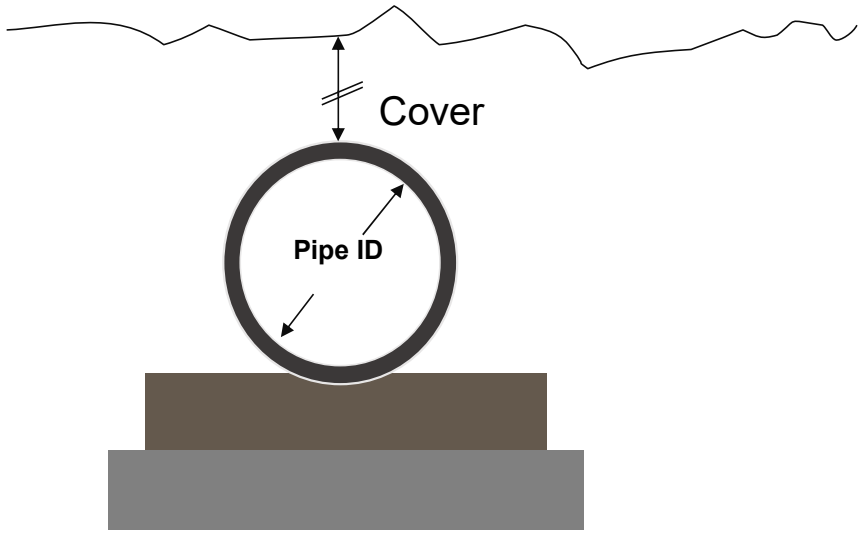
Reinforced Concrete Pipe



Structural System

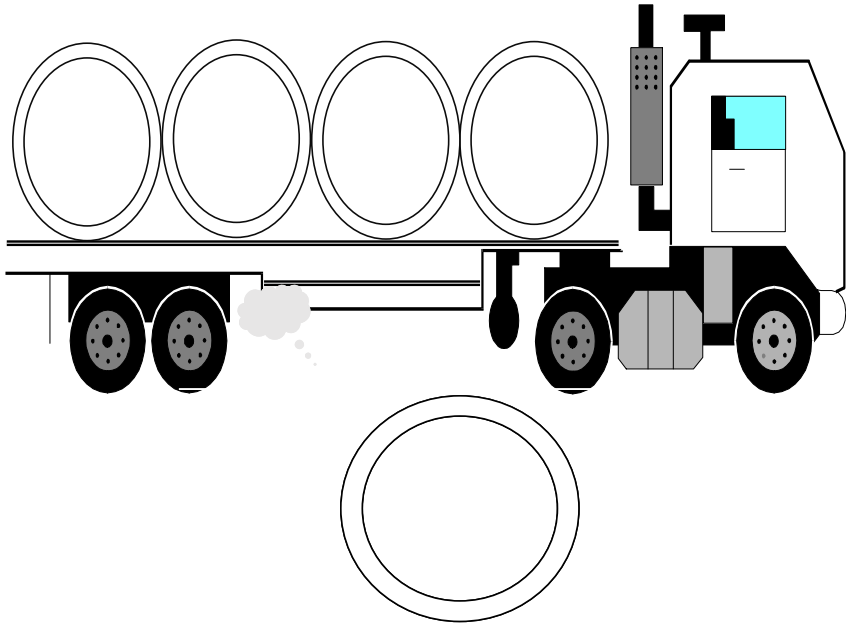
RCP Pipe Wall

60% - 90% of System Strength

Foundation & Bedding

10% - 40% of System Strength

80,000 lbs



60” Pipe (CL IV)

Construction Loading/Damage

Culverts are generally designed for the loads they must carry after construction is completed.

Construction loads often exceed design loads.

These heavy loads can cause considerable damage in flexible pipes and can cause D-load cracking in rigid pipes.


CAT

Construction Loading

"TxDOT Specifications requires a minimum of 4 ft of permanent or temporary compacted fill be in place prior to operating heavy earth-moving equipment to haul over the structure, unless otherwise shown on the plans or permitted in writing"

Proper Cover?

Minimum Cover

RCP

- AASHTO Section 27 for RCP
  - 12” or Bc/8 Unpaved or top of flexible pavement
  - 9” Under bottom of rigid pavement

Measured from top of concrete pipe

MODULE 2
Trench Fundamentals

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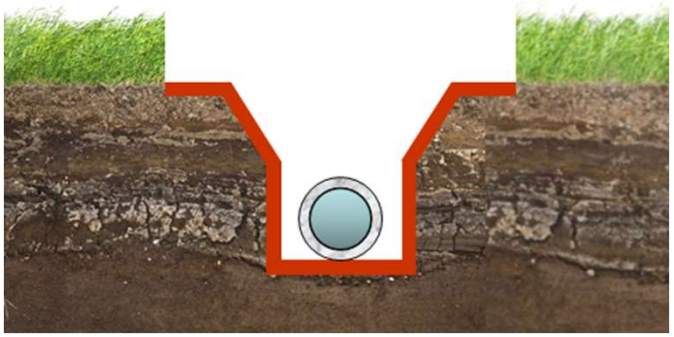
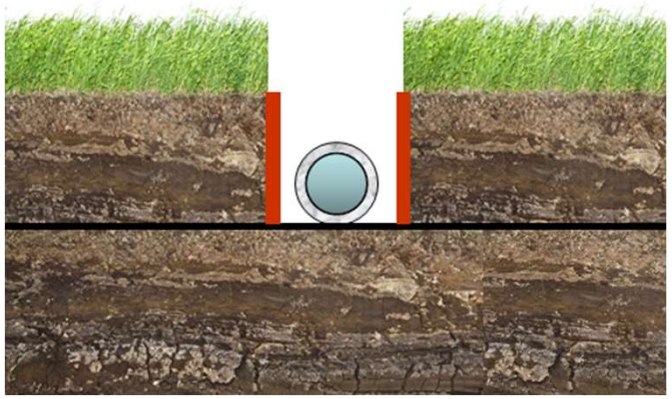
Trench Types

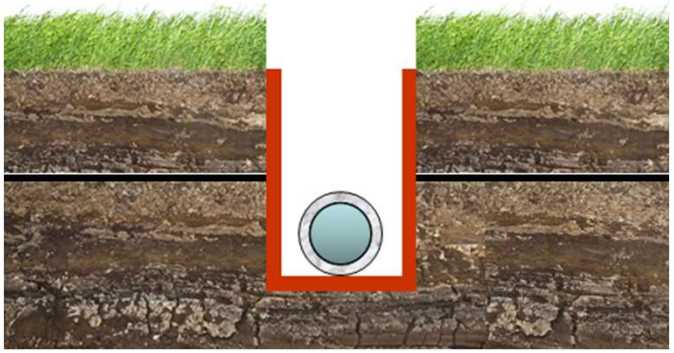
Narrow Trench



Positive Projection



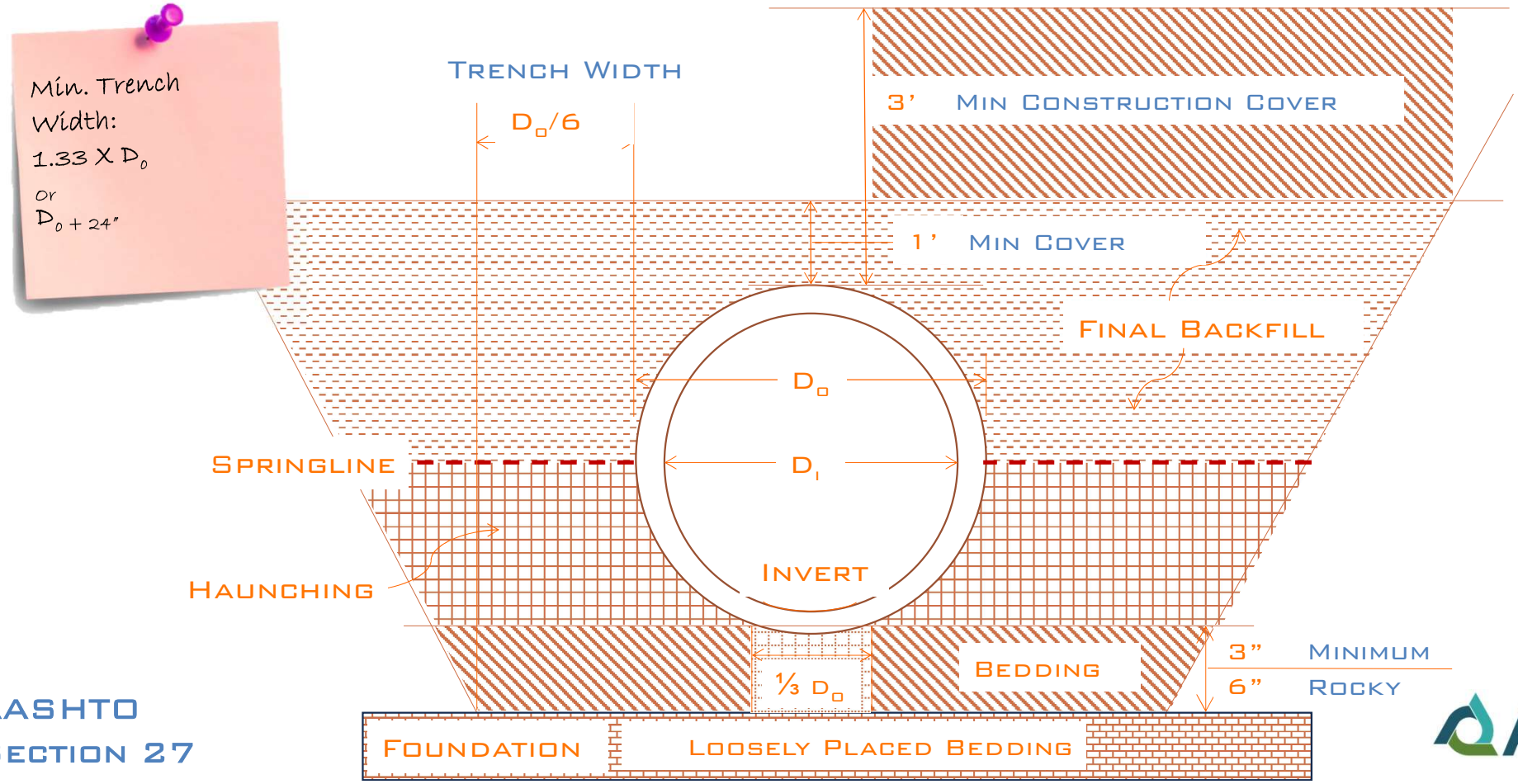
Negative Projection



Jacked or Tunneled

Trench Basics

AASHTO Section 27 - RCP



AASHTO
Section 27

ACPA

Trench Basics

AASHTO Trench Widths

AASHTO Minimum Trench Widths			
Pipe Dia (in)	AASHTO 27 RCP Trench Width (min)	AASHTO 30 Plastic Trench Width (min)	AASHTO 26 CMP *Trench Width (min)
12	40	34	*As Required in Contract Documents AASHTO Section 26.5.1
15	43.5	39	
18	47	44	
24	54	54	
30	61	65	
36	68	74	
42	75	83	
48	82	93	
60	96	113	
66	103		
72	110		
78	117		
80	119.3		
90	131		
96	138		
102	145		
	O.D. +24"	1.5 x O.D. +12"	

26.5—INSTALLATION

26.5.1—General

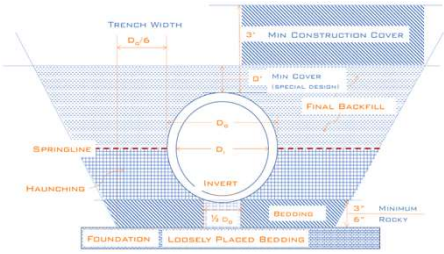
For trench conditions, the trench shall be excavated to the width, depth, and grade shown in the contract documents.

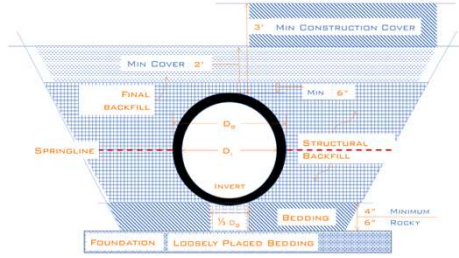
27-8

- The minimum width of a subtrench for Type 1 through Type 3 installations shall be $B_c + 24.0$ in. or 1.33 B_c, whichever is greater, or wider if required for adequate space to attain the specified compaction in the haunch and bedding zones.

30.5.2—Trench Widths

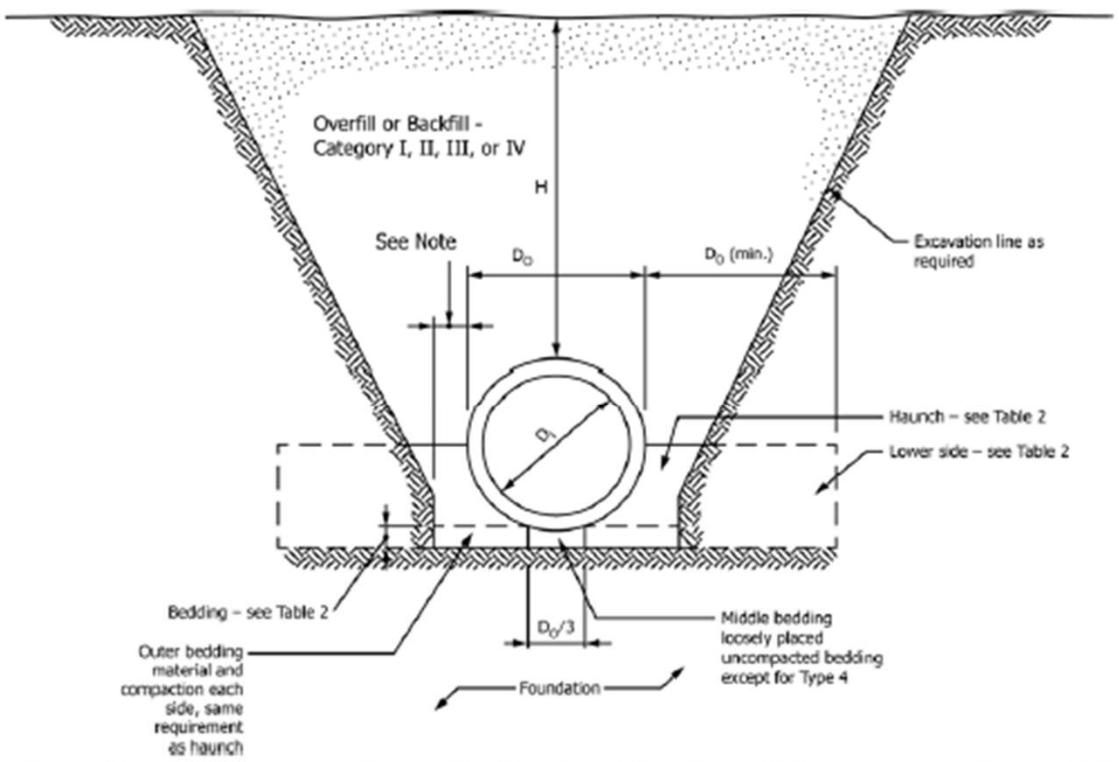
Trench width shall be sufficient to ensure working room to properly and safely place and compact haunching and other backfill materials. The space between the pipe and trench wall should be wider than the compaction equipment used in the pipe zone. Minimum trench width shall not be less than 1.5 times the pipe outside diameter plus 12.0 in. Trenches shall be kept to the specified width, as any increase in trench width will increase the load on the pipe. Structural backfill shall be comprised of well-graded, granular materials, such as AASHTO A-1, A-2-4, and A-2-5 soils, to facilitate better consolidation around the pipe and to minimize the possibility of soil migration and piping of the in situ soils.





ASTM C-1479 Standard Installations

The precast concrete pipe/soil system shall be constructed to conform to the requirements of ASTM C-1479.



NOTE 1—Clearance between pipe and trench wall shall be adequate to enable specified compaction but not less than $D_O/6$.

FIG. 3 Standard Trench Installations

ASTM C-1479

Standard Installations - Trenches

Installation Type	Bedding Thickness	Haunch and Outer Bedding	Lower Side
Type 1	D_o/24 minimum; not less than 3 in. If rock foundation, use D_o/12 minimum; not less than 6 in.	95 % Category I	Undisturbed natural soil with firmness equivalent to the following placed soils: 90 % Category I, 95 % Category II, or embankment to the same requirements
Type 2	D_o/24 minimum; not less than 3 in. If rock foundation, use D_o/12 minimum; not less than 6 in.	90 % Category I or 95 % Category II	Undisturbed natural soil with firmness equivalent to the following placed soils: 85 % Category I, 90 % Category II, 95 % Category III, or embankment to the same requirements
Type 3	D_o/24 minimum; not less than 3 in. If rock foundation, use D_o/12 minimum; not less than 6 in.	85 % Category I, 90 % Category II, or 95 % Category III	Undisturbed natural soil with firmness equivalent to the following placed soils: 85 % Category I, 90 % Category II, 95 % Category III, or embankment to the same requirements
Type 4	No bedding required, except if rock foundation, use D_o/12 minimum; not less than 6 in.	No compaction required, except if Category III, use 85 % Category III	No compaction required, except if Category III, use 85 % Category III

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MODULE 3
Installation Procedures

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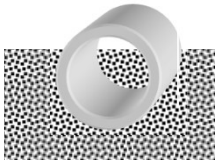
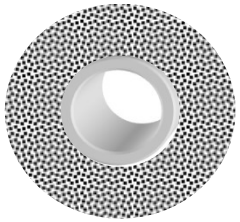
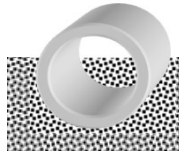
Installation Methods
Embankment/Trench/Jacking



Trench



Tunnel



Embankment

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Installation Steps

Safety

Divert Drainage

Excavate Trench

Explore Foundation

Place structural bedding material to grade

Install pipe to grade

Compact bedding outside the middle 1/3 of pipe

Place structural bedding in lifts

Complete structural backfill to springline

Minimum Cover

Installation Steps

Safety
Divert Drainage
Excavate Trench
Explore Foundation
Place structural bedding material to grade
Install pipe to grade
Compact bedding outside the middle 1/3 of pipe
Place structural bedding in lifts
Complete structural backfill to springline
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Place structural bedding in lifts
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Minimum Cover

Excavation
Dewatering

ASTM C1479: Section 6.2

- “Where surface water or groundwater conditions exist, the site and trench shall be dewatered.”

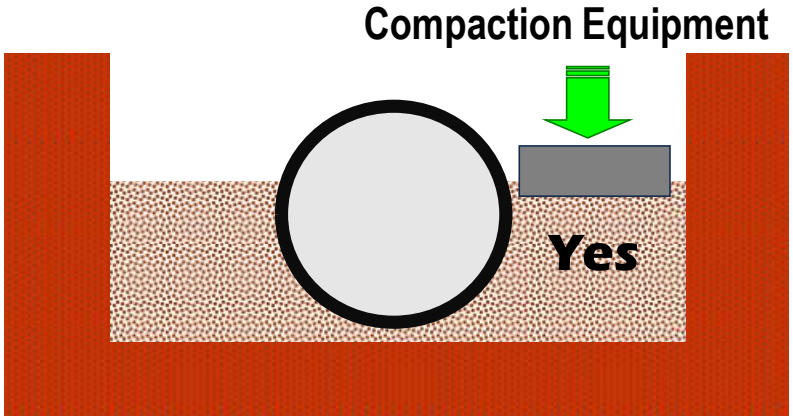

Excavation
PIPE

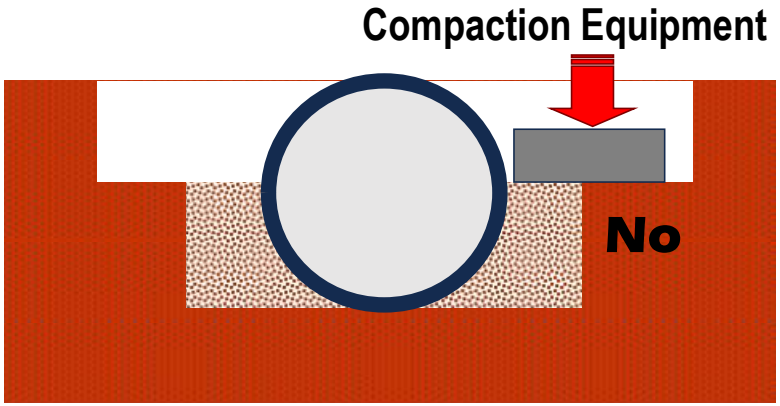

Best Practices
Take Your Time - Importation Step

How WIDE should a trench be excavated?

How
D
E
E
P
should a
trench be
excavated?

Proper Trench Width





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Foundation

Support the Structure

- **Existing (in situ) material at bottom of trench is either suitable or unsuitable for pipe installation.**
- **Unsuitable foundations require remediation.**
- **Firm foundation needed during installation**
- **The foundation must support the bedding, pipe, embedment, and backfill.**
- **Foundation should provide uniform support throughout the project to minimize differential settlement.**
- **Cradles formed in the foundation should not be used.**

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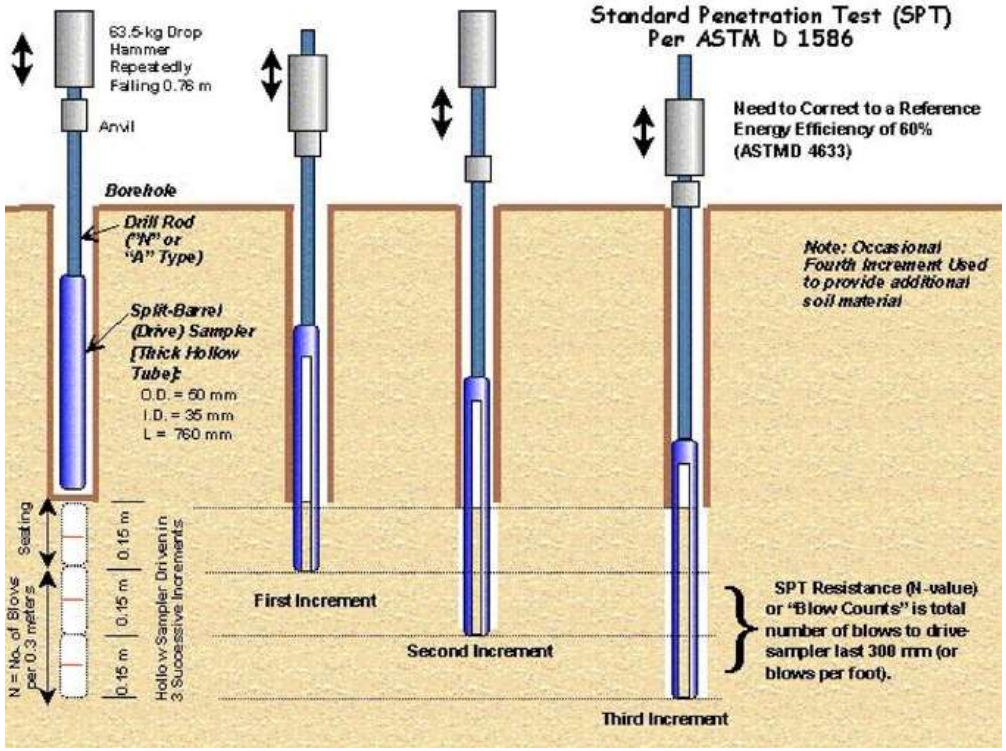
Foundation
Support the Structure



*Additional info: Guideline for Performing Foundation Investigations for Miscellaneous Structures (Reclamation 2004)

Foundation Evaluation*

N Value (blows per ft)	Bearing Support Remediation
<5	Needs Remediation
5-10	Needs Geotech Eval
	(Cohesive Soils)
10-30	Should be Suitable
>30	Extremely Hard
	(Sands)
10-50	Should be Suitable
>50	Extremely Hard

Amster Howard, 2015

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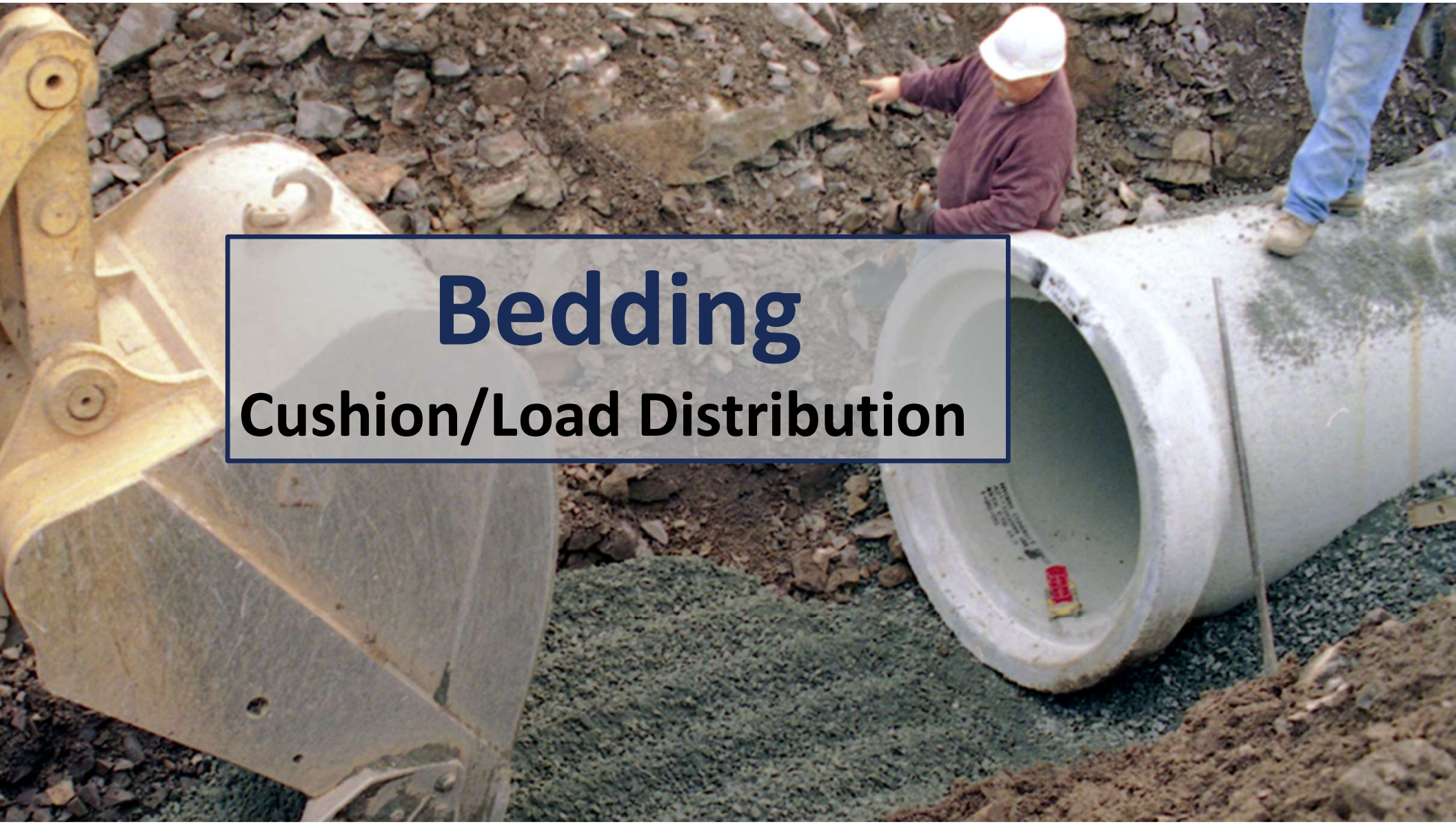
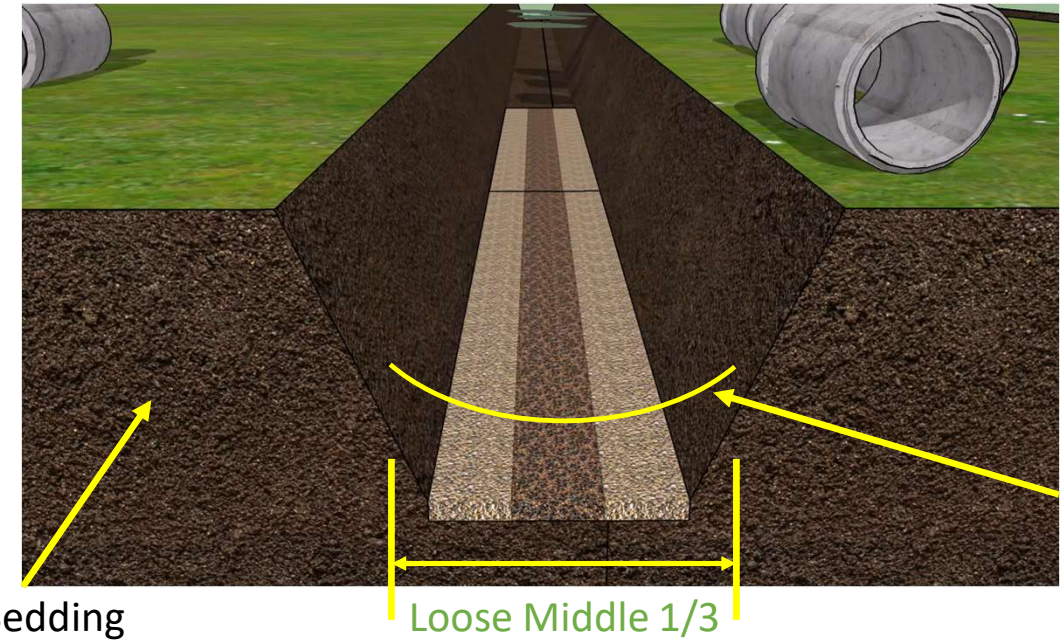

Bedding
Cushion/Load Distribution

Bedding
Cushion/Load Distribution

AASHTO: 3”-4”-6” thick – middle 1/3 should be loosely placed to cradle pipe invert.

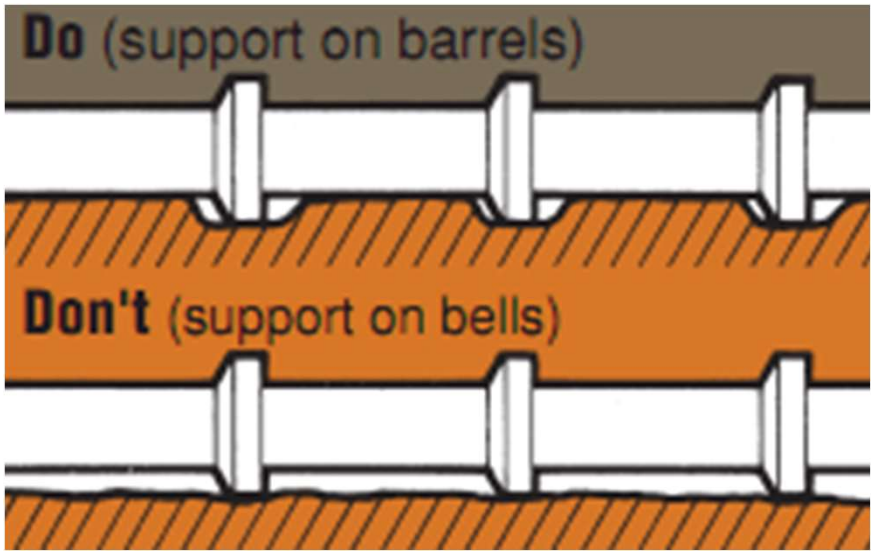


The bedding acts as a cushion/cradle for the bottom of the pipe as it works to distribute the load to the foundation.

Stable and Uniform Bedding

Bedding
Cushion/Load Distribution

Set bedding to grade, and provide bell holes in bedding for flared bell pipe to keep bearing on pipe barrel



Placing Pipe/Joining

Joints & Connections

Joining

Understanding Connections

AASHTO R82 - Joint Selection for Highway Culvert and Storm Drains

- Four Basic Joint Leakage Allowances:
  - **Soil Tight**
    A joint that is resistant to infiltration of particles larger than those retained on the No. 200 sieve. There is no ASTM joint specification for a soil tight joint.
  - **Silt Tight**
    A joint that is resistant to infiltration of particles that are smaller than particles passing the No. 200 sieve. **ASTM C443 (max 2psi)**
  - **Leak Resistant**
    A joint which limits water leakage at a maximum rate of 200 gallons/inch-diameter/mile/day for the pipeline system for the project specified head or pressure. **ASTM C443 (max 10.8psi)**
  - **Watertight**
    A joint that provides zero leakage of water infiltration and exfiltration for a specified head or pressure application. **Special Design**

Joining
Understanding Connections

- Provide flexibility and resiliency for movement.
- Provide for expansion and contraction.
- Guard against leakage.
- Connect like materials.
- Transition between unlike materials.
- Transmit or transfer load.
- Reduce stress on the material or structural member.

Joining
Understanding Connections

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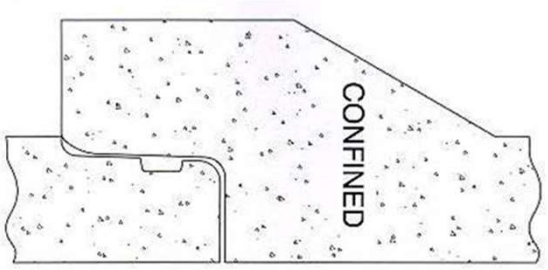
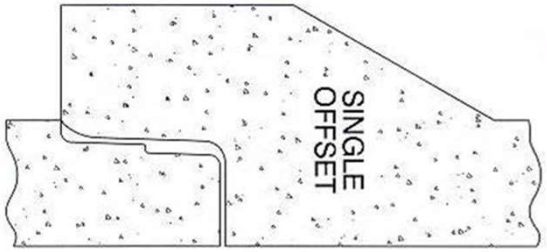
Joining
Understanding Connections

Tongue & Grove, Profile Gasket (Single Offset), Confined O-Ring



Rubber O-Ring



Profile Rubber Gaskets

Butyl Mastic or Mortar

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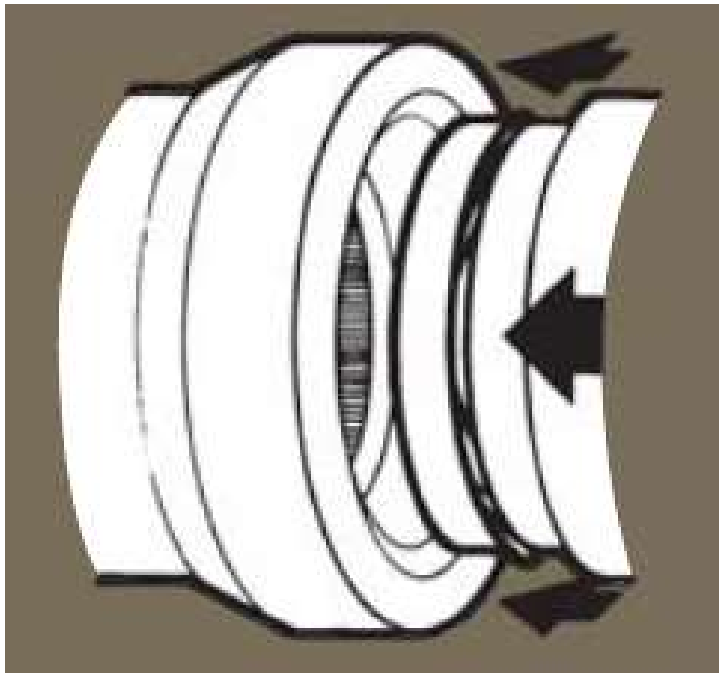
Proper Methods of Joining Pipe



O-Ring Gaskets

Brush or wipe bell clean

Brush or wipe spigot clean

Lubricate spigot surface and gasket groove

Mount gasket on spigot

Equalize gasket stretch

Lubricate exterior surface of gasket

Lubricate bell surface

Carefully draw or push spigot into bell

Profile Gaskets – Single Offset Joint

Brush or wipe bell clean

Brush or wipe spigot clean

Mount gasket on dry spigot

Equalize gasket stretch

Lubricate the bell

Align spigot with bell

Carefully draw or push spigot into bell

T&G Joints – Mastic Gaskets

Brush or wipe bell clean

Brush or wipe spigot clean

Remove cover from one side of
Preformed Mastic Gasket piece

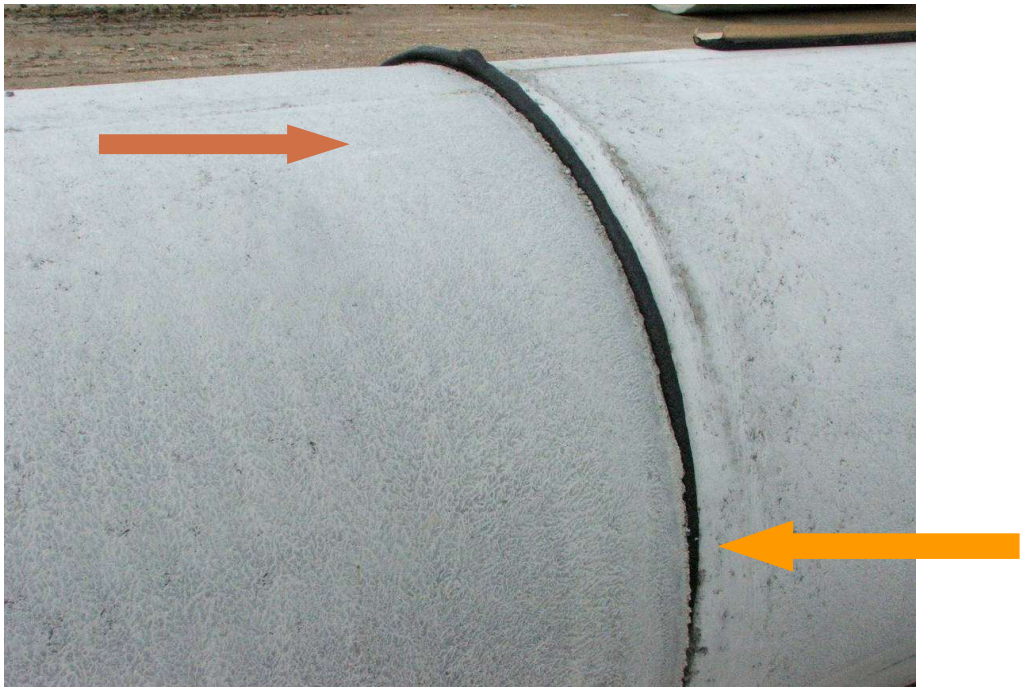
Place Mastic on top half of spigot,
remove paper backing

Butt Mastic pieces to splice

Place Mastic on bottom half of bell
& remove paper backing

The reason not to put Mastic on bottom of spigot

Carefully draw or push spigot into bell



Some mastic may squeeze out of the joint

T&G or RG Pipe – This will
keep joints from closing evenly

Joints may be primed or unprimed

RAM-NEK Brand joint sealant will perform equally with or without the use of primer. To say that our product will not perform it's intended use without priming the surface of the concrete would be incorrect.

Be advised that the quality and consistency of our product allows me to make this assessment and in no way am I speaking for any other sealant manufacturers.

Please let me know if I can be of any further assistance regarding your concerns.

Sincerely,

Pat G. Voinis
Sales Manager

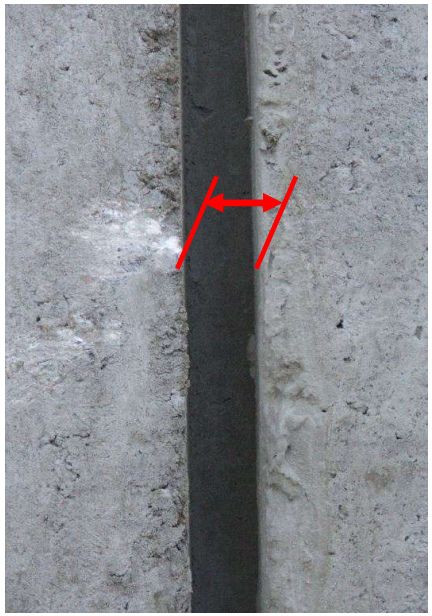
When using bulk mastic, apply liberally to bell of pipe only.

Placement/Joining

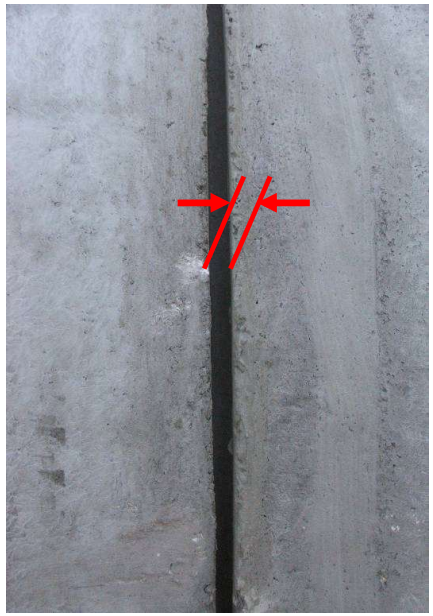
- Begin at the downstream end (bell faces upstream)
- Ensure spigot and bell are clean and free of debris
  - The gasket sealing surface must be carefully inspected
- Lubricate joint as recommended
- Remember, max insertion angle!
- Fully insert pipe.
- Moving pipe around after joining may cause pipe joint to work apart

ACPA

3. **Joints Using Rubber Gaskets.** Make the joint assembly according to the recommendations of the gasket manufacturer. When using rubber gaskets, make joints watertight. Backfill after the joint has been inspected and approved.



No



Yes

Best Practices

Keep Pipe off Bedding

Avoid Pushing Down to Set Grade ASTM C-1479

10.3 The bedding grade under the middle third of the pipe outside diameter shall be prepared before laying the pipe section. Making adjustments in grade by exerting force on the barrel of the pipe with excavating equipment, by lifting and dropping the pipe, or by lifting the pipe and packing bedding material under it shall be prohibited. If the installed pipe section is not on grade, the pipe section shall be completely unjoined, the grade corrected, and the pipe then rejoined.

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Compact Outer 1/3 Bedding

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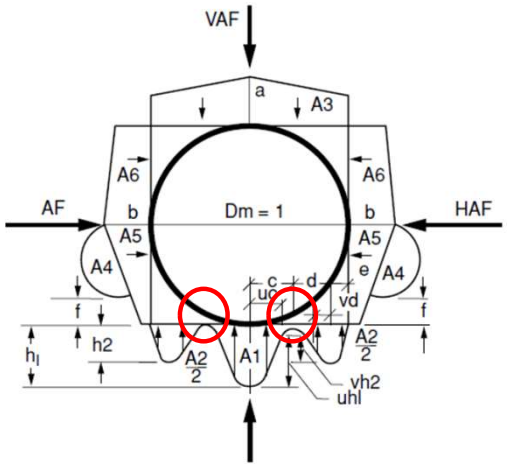
Structural Backfill

Embedment
Placing Backfill Materials



National Clay Pipe Institute Youtube Video

Heger Pressure Distribution:

Dr Frank Heger evaluated SPIDA results and created the Heger Soil Pressure Distribution diagram widely used today.

SPIDA research found that embedment materials within 40 degrees of the invert cannot be compacted.

Rigid Pipe Standard Installations, Types 1-4, take this lack of compaction into account.

ACPA

Initial Backfill

Manual compactors allow contractor to get up close to the pipe without damaging it.

Hoe packs, and other large compaction equipment can do damage to a pipe if there is not enough soil cushion over or around the pipe.

ACPA

Create Proper Trench Width

Proper Material for Backfill

Compact Each Lift

Crew Task

Proper Material Placement
Create Proper Trench Width
Compact
Alternate Side/Side

The lack of settlement of the bedding and/or backfill when a jumping jack is operating is an indicator that proper compaction is achieved.

Based on what we have discussed, what do you think about this installation?

Questions