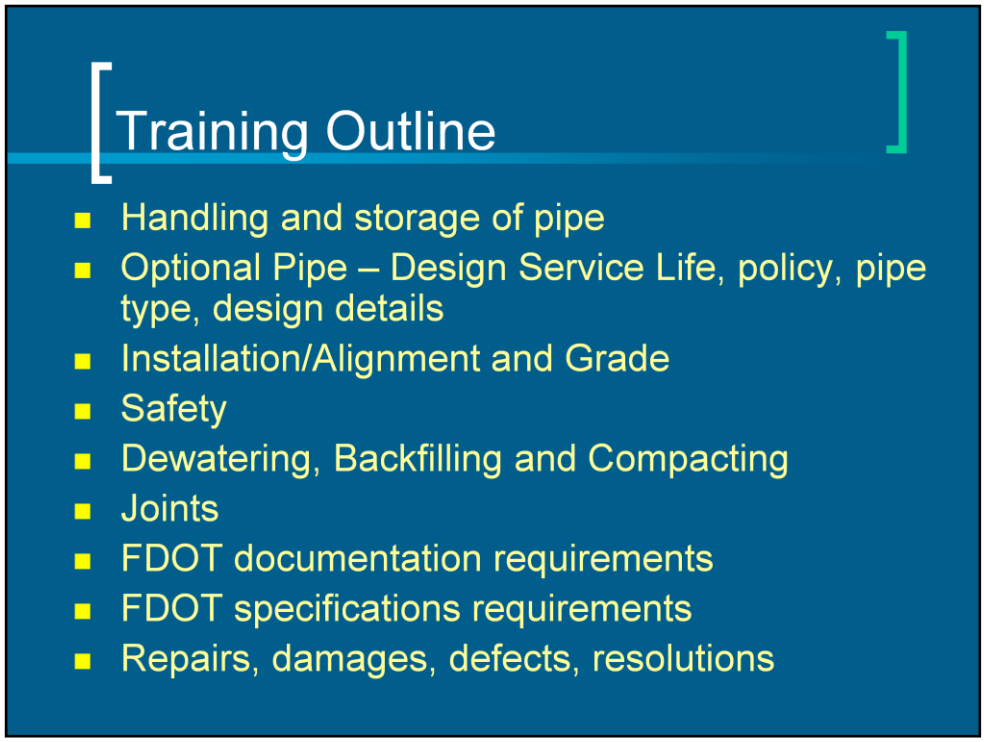
FDOT Drainage Installation

Training course for inspectors overseeing pipe installations on projects using FDOT specifications

June 12, 2008 in D5



Handling and Storage of Pipe – address proper handling by contractor, proper storage on site, storage of gaskets and lubricant if used, use of slings appropriate for the types of pipe, identification requirements (stamps from Producer QC).

Optional Pipe Types – address FDOTs policy of allowing option pipe types for drainage installations. Address Drainage Manual criteria and information shown on contract plans. Ensuring pipe is appropriate type for the intended application – ties to information supplied in the contract plans and how contractor required to identify to FDOT the pipe option selected for the project from choices allowed.

Alignment and Grade – illustrate techniques used by industry to maintain line and grade of the pipe installation.

Safety – address personal safety and FDOT requirements for employees with regard to work around heavy equipment and trench safety.

Backfilling and compaction – discuss spec requirements, equipment used, density testing requirements,

FDOT Documentation requirements – discuss density log book, backfill materials sampling and testing requirements

FDOT Specifications requirements – discuss specs 125, 430, 449, and 948 requirements and how they relate and work together

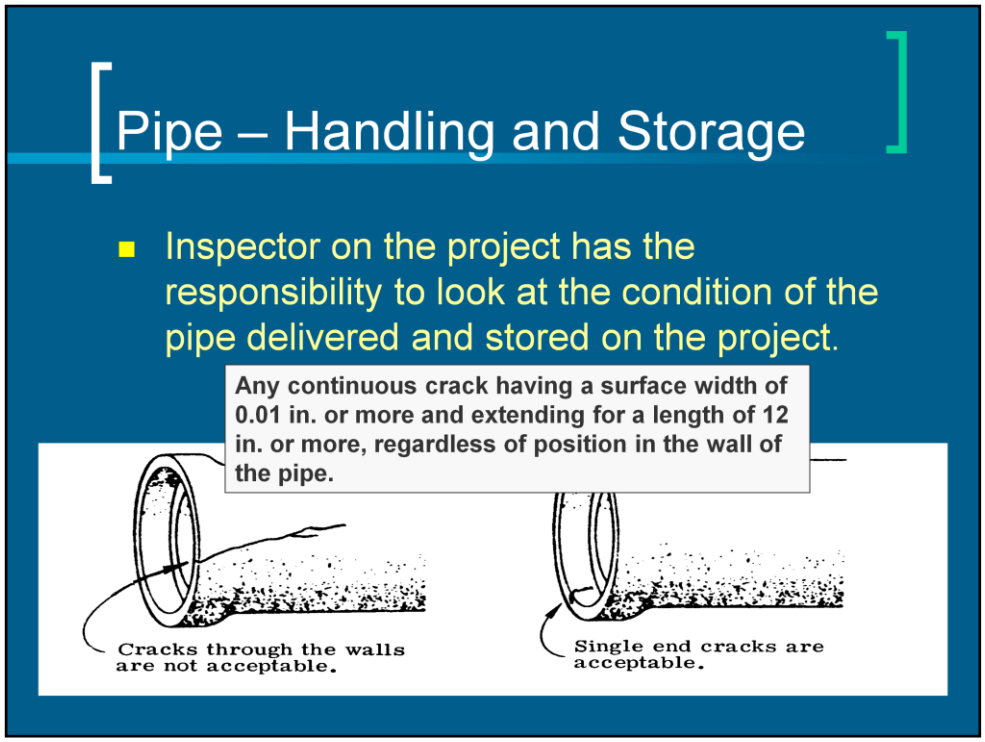
Repairs, damages, defects, resolutions – address some of the common findings on projects, the spec requirements, and how field issues resolved.

We've come a long way with Pipe installation

Pipe – Handling and Storage

Pipe installation inspection begins before the trench is dug or the first section of pipe is laid.

It begins with inspection of the pipe materials delivered and stored on the project.



Inspectors need to check both insides and outsides of pipes prior to the pipe being allowed to be used.

Spec reference for cracking acceptance in concrete pipe is in Section 449. Section 449 refers contractor to ASTM C76 as modified by Section 449-4.2 for pipe requirements. Cracks in pipe in ASTM C76 section 15 state that:

15. Rejection

15.1 Pipe shall be subject to rejection on account of failure to conform to any of the specification requirements. Individual sections of pipe may be rejected because of any of the following:

15.1.1 Fractures or cracks passing through the wall, except for a single end crack that does not exceed the depth of the joint.

15.1.2 Defects that indicate proportioning, mixing, and molding not in compliance with 10.1 or surface defects indicating honeycombed or open texture that would adversely affect the function of the pipe.

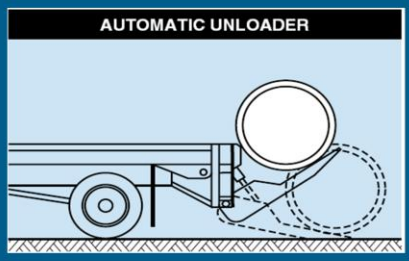
15.1.3 The ends of the pipe are not normal to the walls and center line of the pipe, within the limits of variations given in 12.3 and 12.4.

15.1.4 Damaged or cracked ends where such damage would prevent making a satisfactory joint.

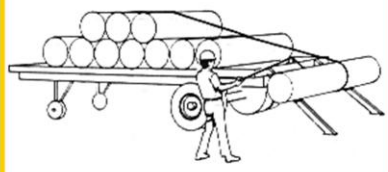
15.1.5 Any continuous crack having a surface width of 0.01 in. or more and extending for a length of 12 in. or more, regardless of position in the wall of the pipe.

Pipe – Handling and Storage

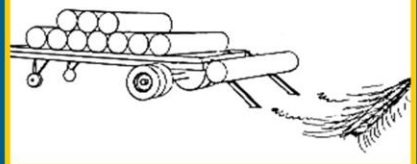
AUTOMATIC UNLOADER



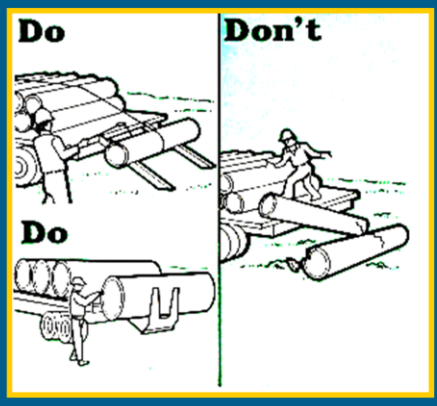
UNLOADING WITH ROPES AND SKIDS

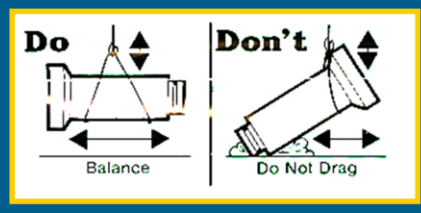


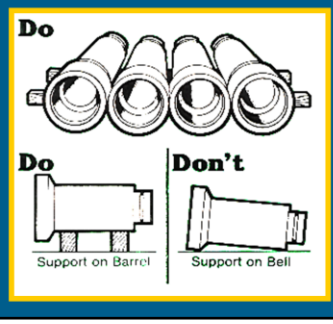
UNLOADING WITH SKIDS AND WINDROWED EARTH



Pipe – Handling and Storage



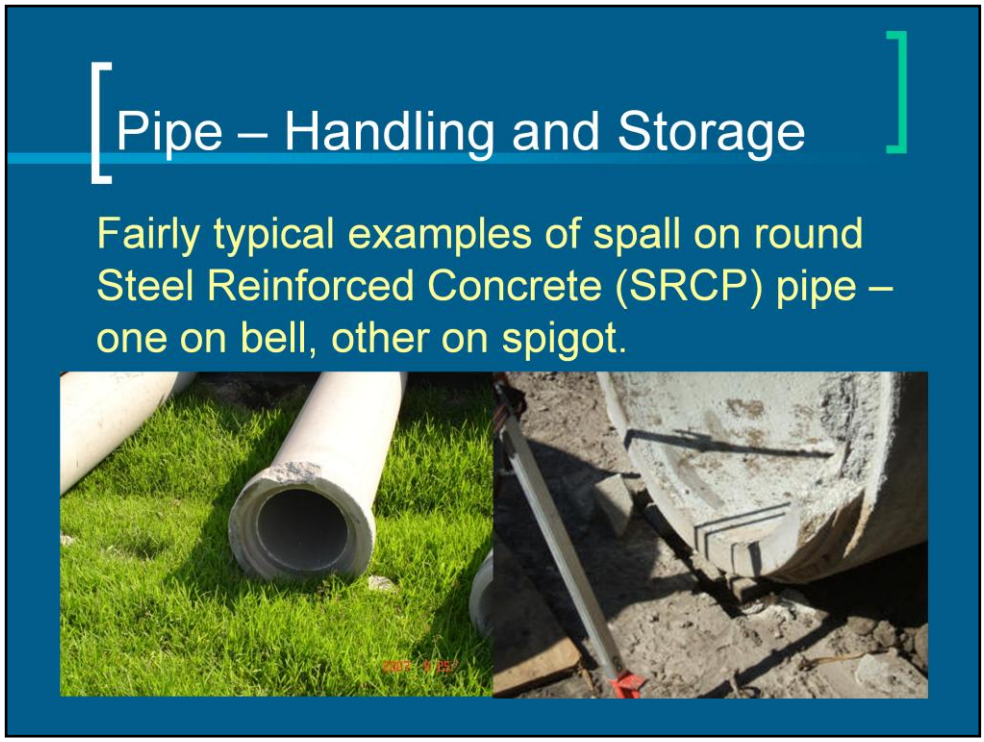




Pipe – Handling and Storage

Things to watch for are cracks, spalls, honeycombing, exposed reinforcement on concrete pipes, bends or dents in metal pipe, breaks in protective coatings, cracks in plastic pipe

Note the small spall (chip) on the center section of pipe. This spall is probably small enough that the pipe could be repaired and used. If not, the section of pipe could be used to come out of or go into a structure so that the entire section would not be lost.



Note that the spall on the bell could possibly be used as it appears that the integrity of the bell is maintained such that the joint would be maintained. If it could not be, consider trying to use the section to start a run from a structure.

The spall on the spigot end as shown on the right picture is so significant that the section of pipe should be rejected for use in the run of pipe. It could be used as a starting section from a structure if the broken end is cut off. In the case of the broken spigot end, this pipe run also had a misalignment so the contractor elected to install a junction box at this location rather than remove and relay the sections of pipe already installed. Because the addition of the junction box did not present any conflict problems, it was acceptable to the engineer.

Pipe – Handling and Storage

- Plant Quality Control stamps required for reinforced and non reinforced pipes.
- Flexible pipes must have a QC stamp

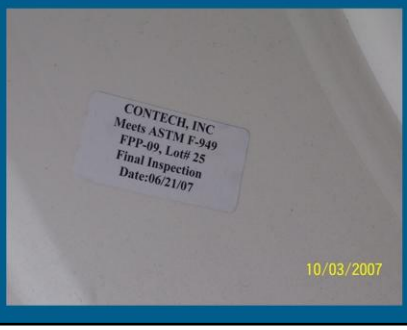
The QC stamp indicates that the Plant certifies that the Pipes are manufactured in conformance with the Plant's Quality Control Plan (QCP). Each shipment of the pipe to the project site shall include the list of the sizes delivered. The Plant shall address its shipping policy as part of the QCP.

Requirements for the QC stamps and QCP can be found in the Materials Manual.

If the pipe is delivered without QC stamps, it should be rejected.

Pipe – Handling and Storage

Pipe identification markings from producers – shown is plastic pipe and aluminized steel pipe.



Section 942 of the 2007 standard specifications state:

“Prior to use, the gasket shall be stored in as cool a place as practicable.”

Typically, the gaskets are stored inside the ends of pipe sections until they are ready to be used. Heat and sunlight can cause the gaskets to crack and split.

When inspecting pipe on the ground, look to ensure pipe has manufacturer QC stamp, is free of cracks, spalls, honeycombing. Ensure that pipe gaskets are stored out of the sunlight – usually placed inside end of pipe. This is necessary to ensure gaskets do not dry out in the sunlight which will diminish their ability to seal the joint.

If the contractor elects to use a lubricant for the joint installation, this will typically be delivered in buckets along with the gaskets. Ensure that the soap product is vegetable based per specification 430-7.1. In either the case of pre-lubricated gaskets or brush applied lubricant, ensure that product used is inert when applied to rubber materials. This requires a certification from the producer and should be delivered with the products.

Lubricants are recommended for ease of installation. Must ensure that the joint is clean. Soap lubricant makes homing up the joint easier.

Pipe – Handling and Storage

Spiral Ribbed Metal Pipe stored on project right-of-way – note that the Mitered End Section (MES) is not coated with bitumen.

Metal pipe in contact with concrete is required to have bituminous coating.

Pipe – Handling and Storage

More spiral ribbed metal pipe stored, again without required bituminous coating.

From Standard Index 272 for MES

6. That portion of corrugated metal pipe in direct contact with the concrete slab and extending 12" beyond shall be bituminous coated prior to placing of the concrete.

Additional to the requirement for bituminous coating of the area that will be in contact with concrete, for corrugated metal pipe, there is also a requirement for the pipe to have anchors as shown in the attached detail from index 272. It is note 4 in Standard Index 273 for Side Drain Mitered End Sections.

Pipe – Handling and Storage

More pipe stored along right-of-way. Pipe type is steel reinforced concrete elliptical with tongue and groove joints

For the aluminized steel pipe, note the change in direction of the spirals at the ends – this is for installing the bands that connect adjacent sections of pipe.

Pipe – Handling and Storage

Handling on projects is typically done with Front End Loaders and Backhoes.

Front end loader in this case has Fork attachment for lifting pipe section. Others will sometimes use a root rake attachment to lift pipe sections. Fork type attachments should not be used for moving/handling plastic or other flexible pipe as this can cause damage to the inside of the pipe.

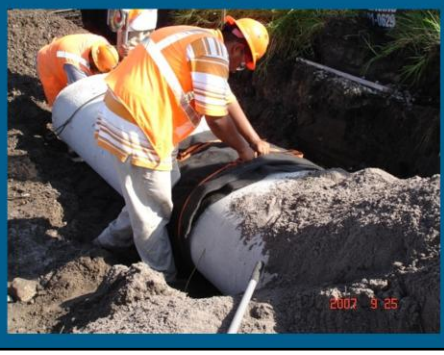
Backhoes buckets will typically be fitted with a hook on its back for connecting the sling used to lift the pipe section.

Pipe – Handling and Storage

Worker installing restraints for filter fabric.

Clean joint on elliptical pipe with gasket.

More on joints and wrapping later.



Large diameter concrete pipe typically will be fabricated with a lifting hole in the pipe through which the sling cable is lower so that a bar can be inserted into the sling to allow the backhoe to lift the pipe. After the pipe is installed, the lifting hole must be patched prior to backfilling operations. Spec section 430-4.1 states, “Do not use concrete pipe with lift holes except round pipe which has a inside diameter in excess of 54 inches or any elliptical pipe. Repair lift holes, if present, by use of a hand-placed, stiff, non-shrink, 1-to-1 mortar of cement and fine sand, after first washing out the hole with water. Completely fill the void created by the lift hole with mortar. Cover the repaired area with a 24 by 24 inches piece of filter fabric secured to the pipe. Use a Class D filter fabric meeting the requirements shown on Design Standards, Index No. 199. Secure the filter fabric to the pipe using a method that holds the fabric in place until the backfill is placed and compacted. Use a grout mixtures, mastics, or strapping devices to secure the fabric to the pipe.”

The large diameter flexible pipe are generally still handled with a sling. One thing to be watchful of is when the flexible pipe is coated with bitumen that the sling used does not damage the coating. Wide slings, not cables or chains, are needed to handle coated pipe.

Optional Pipe Types – Design Service Life (DSL)

- DSL: Target Life of Pipe Installation
  - 25 DSL for Side Drains
  - 50 Year DSL for Low ADT
  - 100-year DSL for Most Pipes
- Value of Installation
  - Capital Investment
  - What if this pipe fails…

Optional Pipe Types – Optional Pipe Policy

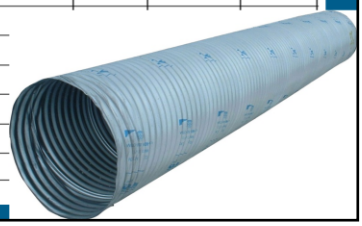
From FDOT Drainage Design Manual:

"Optional culvert materials shall be considered for all culvert applications including, but not limited to, storm drains, cross drains, side drains, gutter drains, and French drains. All culvert materials shown in Table 6-1 for the application being designed shall be evaluated. The evaluation shall consider functionally equivalent performance in three areas: durability, structural capacity, hydraulic capacity."

Optional Pipe Types – Table 6-1 Excerpt

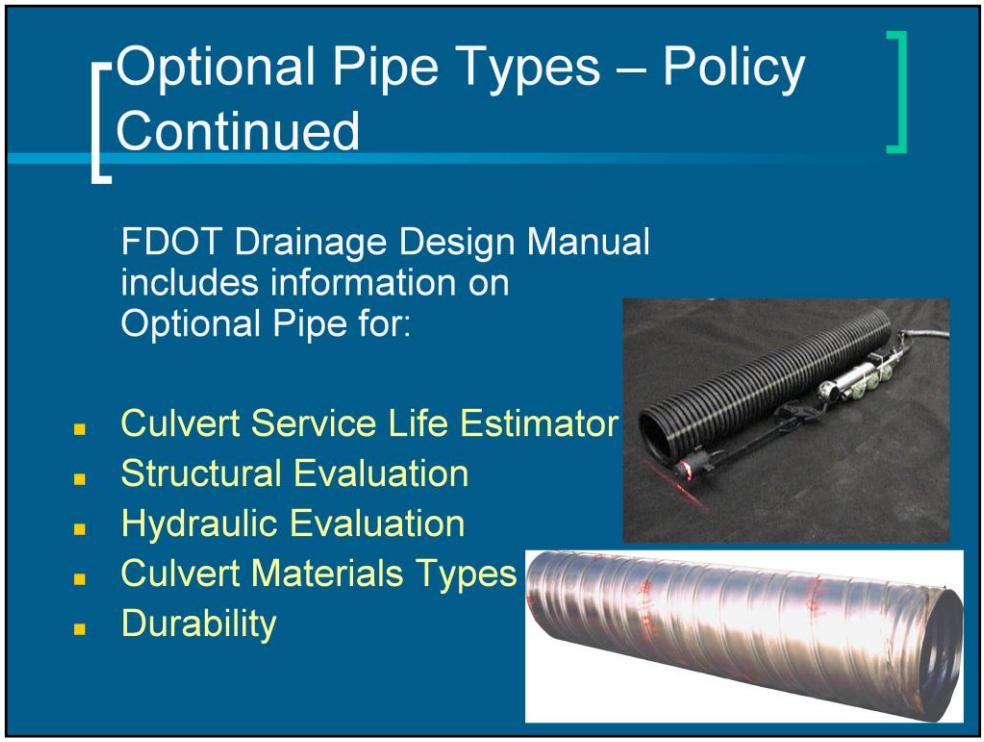
TABLE 6-1 CULVERT MATERIAL APPLICATIONS AND DESIGN SERVICE LIFE

Application		Storm Drain		Cross Drain		Side Drain[4]	Gutter Drain	French Drain		
Highway Facility (see notes)		Minor	Major	Minor	Major	All	All	Replacement will Impact the Roadway[5]		Other
								Minor	Major	All
Design Service Life →		50	100	50	100	25	25[6]	50	100	50
Culvert Material		An * indicates suitable for further evaluation.								
PIPE	Corrugated Aluminum Pipe CAP	*	*	*	*	*	*	*	*	*
	Corrugated Steel Pipe CSP	*	*	*	*	*	*	*	*	*
	Corrugated Aluminized Steel Pipe CASP	*	*	*	*	*	*	*	*	*
	Spiral Rib Aluminum Pipe SRAP	*	*	*	*	*		*	*	*
	Spiral Rib Steel Pipe SRSP	*	*	*	*	*		*	*	*
	Spiral Rib Aluminized Steel Pipe SRASP	*	*	*	*	*				
	Steel Reinforced Concrete Pipe SRCP	*	*	*	*	*				
	Non-reinforced Concrete Pipe NRCP	*	*	*	*	*				
	Fiber Reinforced Concrete Pipe FRCP	*	*	*	*	*				
	Polyethylene Pipe – Class I HPEP-I	*		*		*				
	Polyethylene Pipe – Class II HDEP-II	*	*	*	*	*				
	Polyvinyl-Chloride Pipe PVC	*	F949	*	F949	*				



Excerpt above is from Drainage Design Manual.

The indicates pipe is suitable for further evaluation note means that the drainage designer should evaluate each of the pipe types and allow in the contract use of any that will fulfill the design service life requirements.

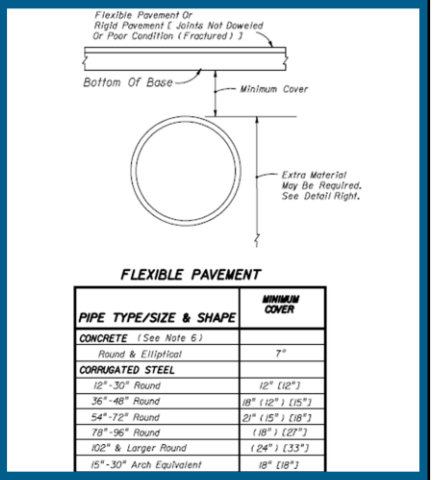


Drainage designers will follow the FDOT Drainage Design Manual when determining which pipe types to allow. Those that satisfy the evaluations noted on the slide can be used and therefore available to the contractors to bid.

Optional Pipe Types – Structural Evaluations

FDOT Design Standards provide structural details such as:

- Minimum cover over pipe
- Maximum cover
- Dimensions of pipes
- Sectional properties



FLEXIBLE PAVEMENT

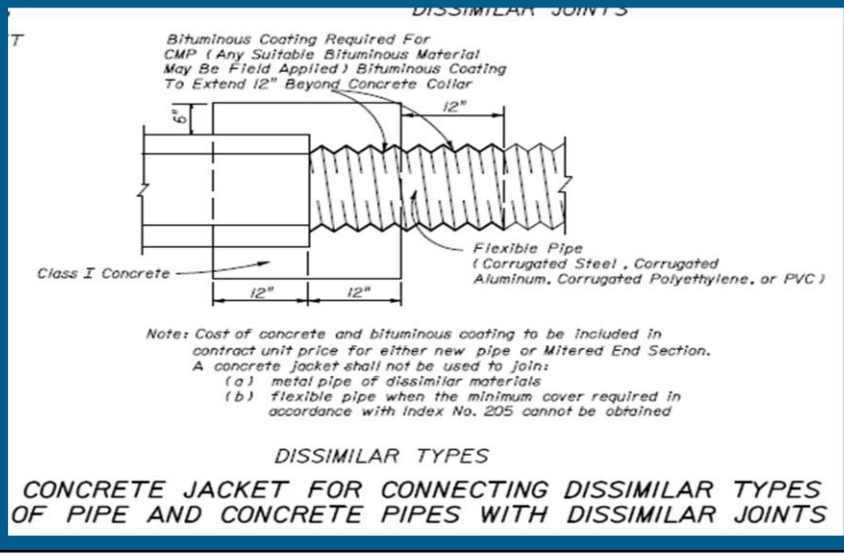
PIPE TYPE/SIZE & SHAPE	MINIMUM COVER
CONCRETE (See Note 6)	
Round & Elliptical	7"
CORRUGATED STEEL	
12"-30" Round	12" (12")
36"-48" Round	18" (12") (15")
54"-72" Round	21" (15") (18")
78"-96" Round	(18") (27")
102" & Larger Round	(24") (33")
15"-30" Arch Equivalent	18" (18")

Structural evaluations will include determinations of the minimum and maximum cover over the pipe, what size pipe is required to carry the design flow, and the section properties of the pipe intending to be used.

The illustration is from Design Standard 205 that addresses cover height over pipe. In this index, design minimum and maximum cover for different pipe types are tabulated.

As an inspector overseeing installation of drainage pipe, it is important for you to be familiar with the requirements of the design standards as you will often be confronted with field conditions that do not match exactly those shown by the Designer in the plans. When you find things in the field that do not match what is shown in the plans, it is important to notify the Project Engineer or Project Administrator and to document the findings and resolution.

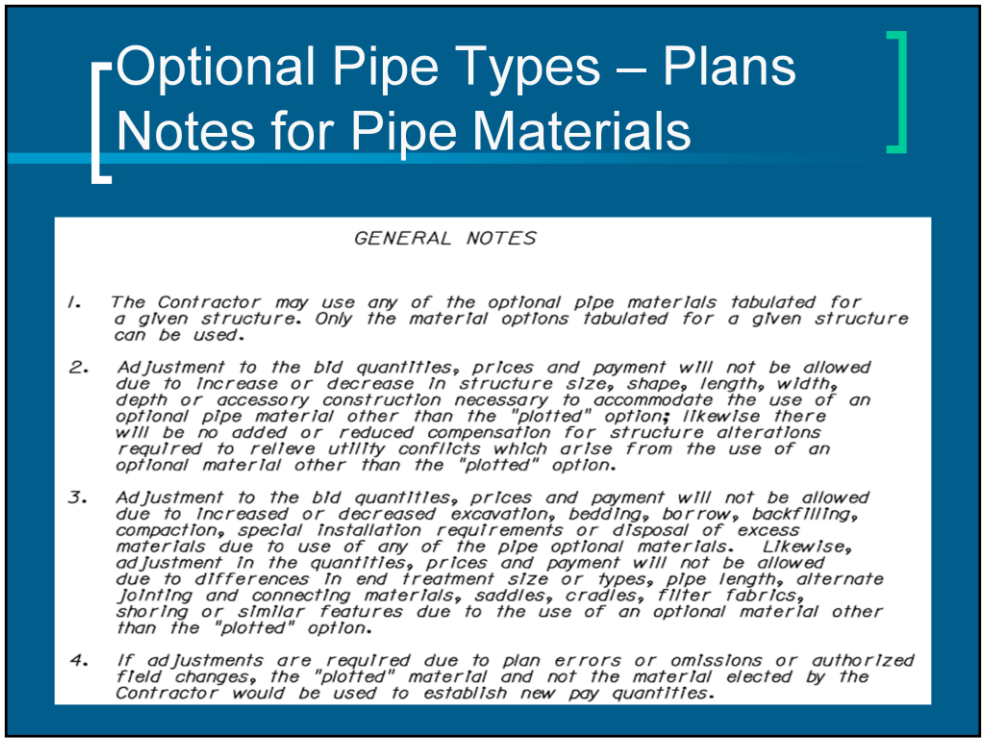
Optional Pipe Types – Design Standard Details



The illustration above depicts a concrete collar that could be used to join two dissimilar pipe types together. Note the requirement for the bituminous coating applied to the corrugated metal pipe.

As an inspector, you will sometimes encounter pipe types found in the field that do not match those shown in the plans. When this occurs, notify your Project Engineer or Project Administrator and see how they want the pipe to be addressed.

Optional Pipe Types – Plans Notes for Pipe Materials



GENERAL NOTES

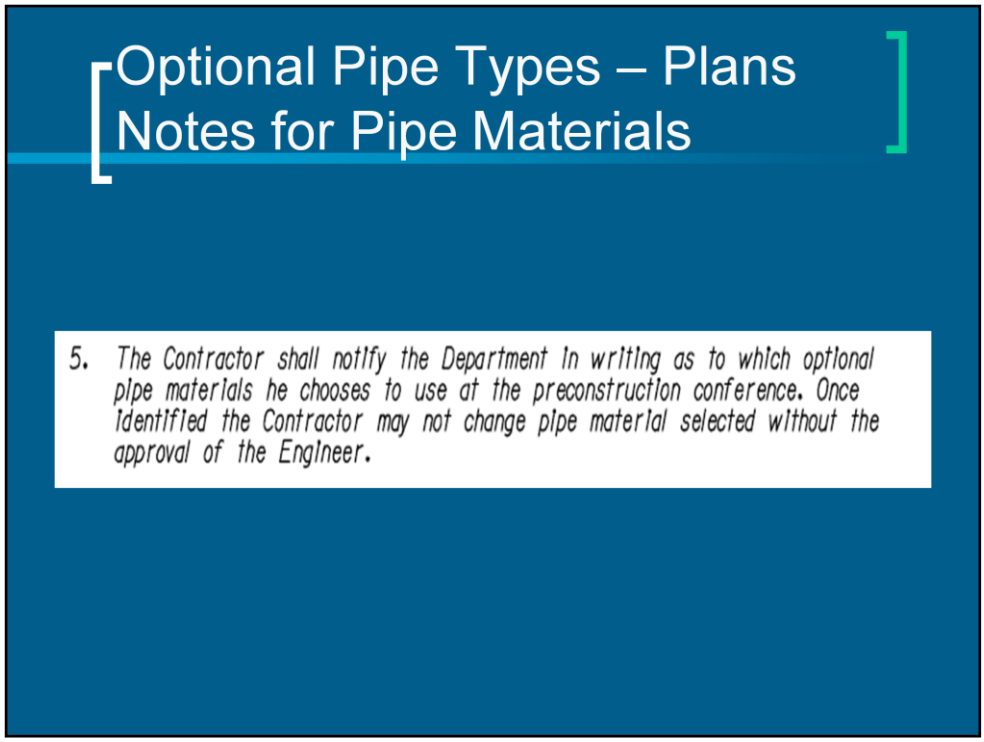
1. The Contractor may use any of the optional pipe materials tabulated for a given structure. Only the material options tabulated for a given structure can be used.

2. Adjustment to the bid quantities, prices and payment will not be allowed due to increase or decrease in structure size, shape, length, width, depth or accessory construction necessary to accommodate the use of an optional pipe material other than the "plotted" option; likewise there will be no added or reduced compensation for structure alterations required to relieve utility conflicts which arise from the use of an optional material other than the "plotted" option.

3. Adjustment to the bid quantities, prices and payment will not be allowed due to increased or decreased excavation, bedding, borrow, backfilling, compaction, special installation requirements or disposal of excess materials due to use of any of the pipe optional materials. Likewise, adjustment in the quantities, prices and payment will not be allowed due to differences in end treatment size or types, pipe length, alternate jointing and connecting materials, saddles, cradles, filter fabrics, shoring or similar features due to the use of an optional material other than the "plotted" option.

4. If adjustments are required due to plan errors or omissions or authorized field changes, the "plotted" material and not the material elected by the Contractor would be used to establish new pay quantities.

When the project is let, the construction plans will identify which types of pipe can be used for which locations. The above represent some of the general notes that will be provided in the plans notifying the contractor of its options.



The contractor is to notify the Department in writing of its choice of optional pipe types allowed by the contract. This is typically done at the Preconstruction Conference.

Optional Pipe Types – Plans Notes for Pipe Materials

STR. NO.	DSL YEARS	SIZE (Inches)	PLOTTED	MATERIAL & THICKNESS	FL	FL	AS BUILT	
1	100	18	X	SRCP CLASS II				
2	100	18	X	SRCP CLASS II				
3	100	15	X	SRCP CLASS II	7.0			
				SRAP				
4	100	36	X	SRCP CLASS II	5.7			
				SRSP, 12 GA.				
				SRAP, 12 GA.				
				SRASP, 16 GA.				
5	100	15	X	SRCP CLASS II	7.7			
				SRAP				
6	100	36	X	SRCP CLASS II	6.4	5.7		
				SRSP, 12 GA.				
				SRAP, 12 GA.				
				SRASP, 16 GA.				
7	100	36	X	SRCP CLASS II	6.5	6.4		
8	100	42	X	SRCP CLASS II	7.9	7.7		
				SRAP				
				SRSP				

After receiving notification of the optional pipe type chosen, it is important that the submittal be compared to the contract plans to ensure that the chosen option is allowed for the locations identified. Shown in the Material & Thickness column above is some of the pipe types allowed by FDOT.

Optional Pipe Types – Plans Notes for Pipe Materials

QUANTITY	STR. NO.	STATION	SIDE		BARRELS	CROSS DRAIN OPTIONAL TYPE								STOR OPTIO		
						ROUND SHAPE						OTHER SHAPE				
						15"	18"	24"	30"	48"	60"	24"	30"	15"	18"	2
P	1	146+50	RT	Pipe	1										12'	
F																
P	2	146+54.12	LT	Pipe	1										103'	
F																
P	3	147+33.80	RT	Inlet, Pipe	1									89'		
F																
P	4	147+61	LT	Inlet, Pipe	1											
F																
P	5	148+15.96	LT	Inlet, Pipe	1									93'		
F																
P	6	148+45.30	RT	MH, Pipe	1											
F																
P	7	148+77.55	LT	Inlet, Pipe	1											
F																
P	8	148+77.55	RT	EW, Pipe	1											
F																
P	9	149+35	RT	Inlet, Pipe	1											
F																
P	10	149+35	LT	Inlet, Pipe	1										53'	

From the Contract plans, you'll find Summary of Drainage Structure sheets that provide the bidder more details on the pipe and drainage structures as well as stationing for placement. This also provides you as inspector, a location to record actual quantities used for future as-built plans preparation and payment purposes.

The illustrated stakes provide information to the contractor on the location (station) of the structure, the structure number (S-18), the offset distance of the stake to the centerline of the structure (15 feet), and the cut depth to the flowline of the pipe (cut 6 feet). For example, if the nail shown on the side of the stake were at elevation 103, the flowline of the pipe would be at elevation 97 feet. Surveyors will sometimes use a permanent marker on the stake instead of a nail.

Installation/Alignment and Grade

Shown in this photograph is stake set to locate the end of the mitered end section for this run of pipe.

Surveyors will typically provide a series of stakes identifying the station, cut depth, and offset from the stake so the pipe layers can correctly locate the structure and pipe.

Shows location stakes that were illustrated in previous slide.

Installation/Alignment and Grade

After the pipe foreman has determined the location for the structure based on the surveyor's staking and the pit for the box is excavated, the structure will be set in place.

The drainage structure shown in this slide is a box precast to receive multiple pipes. The black circular inserts are rubber resilient connectors that eliminate the need for grouting the pipe into the structure. This type connection does take more precision in setting the structures as the resilient connectors are not as forgiving as the typical blockout cast in precast structures.

Illustrated in these two photographs is a typical laser setup inside a drainage structure and a laser target inside the end of the pipe. The worker installing the pipe must ensure that the laser beam is centered in the target to ensure that the line and grade is maintained.

Contractors used to use batter board and stringlines for controlling line and grade but that method has been replaced almost entirely with use of the laser system. This required the use of plumb bobs and a level rod to check elevation as the pipe was being laid.

From Section 430-4, “Do not allow departure from and return to plan alignment and grade to exceed 1/16 inch per foot of nominal pipe length, with a total of not more than 1 inch departure from theoretical line and grade. Take up and relay any pipe that is not in true alignment or which shows any settlement after laying at no additional expense to the Department.”

Typical pipe installation operation consists of starting the pipe run from a drainage structure and excavating the trench with a backhoe as it backs its way away from the structure. The pipe sections are then delivered to the trench, typically by a front end loader, and placed in a location accessible by the backhoe. An employee of the contractor will ready the pipe for pickup by the backhoe. This preparation can include cleaning the joint bell and spigot ends (depends on the pipe type), installing the gasket (lubricating is a good practice), hooking up sling. The backhoe operator will then swing the section into the trench where the worker in the trench will home up the joint.

After several sections of pipe have been placed, the joints wrapped and secured, the front end loader will deposit loose soil into the trench as backfill. The workers in the trench will spread the backfill material into loose lifts approximately 8” thick and ready it for compaction.

Installation/Alignment and Grade

Pipe section being swung into position by backhoe. Workers in the trench have the filter fabric wrap ready after the pipe placed.

Skilled crews can efficiently install several hundreds of feet of pipe per shift, depending on the depth of cut and size of pipe being handled.

Installation/Alignment and Grade

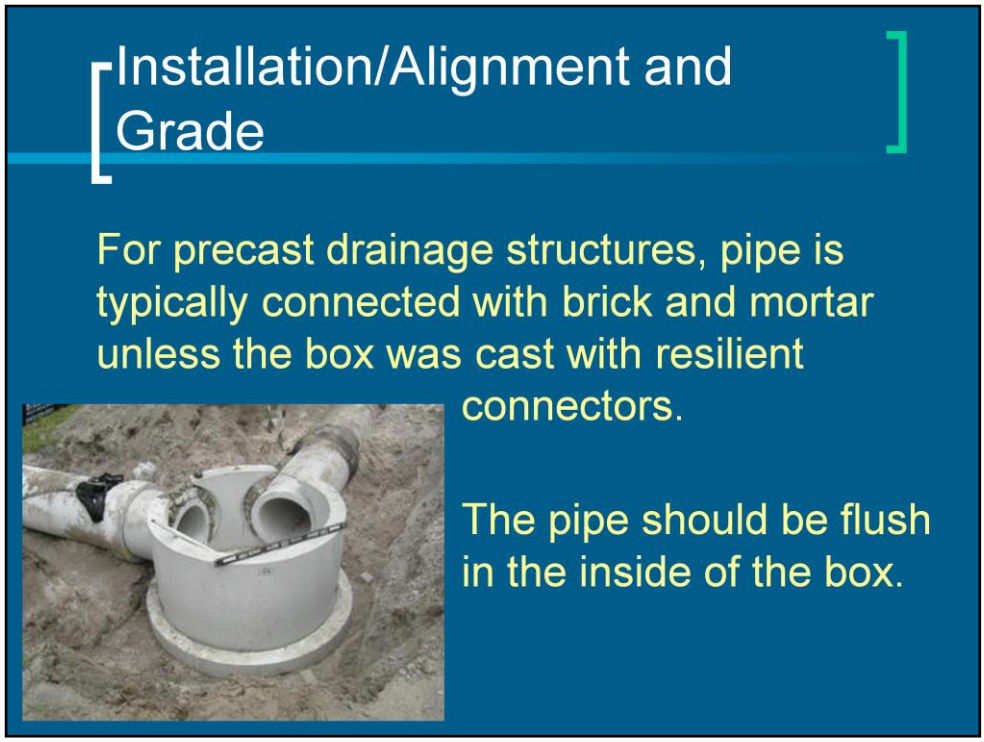
Even with use of laser systems for line and grade, sometimes misalignments still occur. As shown in the picture, the pipes missed in alignment and the contractor was faced with two options – relay the pipe or install a box

In this case, the contractor was able to install a junction box at its expense because it did not conflict with other work.

Installation/Alignment and Grade

There will be cases where due to size or complexity, drainage structure cast in place as shown

Depicts a cast in place drainage structure. Also, has well point system installed in background of picture. Also, note the depth of fill over the pipe where the bull dozer is parked.



Operation shown in slide is bricking and mortar installation of the joint.

Regarding time for placement of backfill adjacent to drainage structures, Section 125 of the Standard Specs states:

125-8.1.5 Time of Placing Backfill: Do not place backfill against any masonry or concrete abutment, wingwall, or culvert until the Engineer has given permission to do so, and in no case until the masonry or concrete has been in place seven days or until the specified 28-day compressive strength occurs.

Section 425 of the Standard Specifications address the requirements for bricking and mortaring of drainage structures. Bricks are required to be saturated before using. This is to ensure that moisture in the mortar needed for hydration is not absorbed into the brick instead.

Section 430 addresses the requirements for the mortar to be used to brick structures.

Section 902 addresses the requirements for sand used in the mortar. Silica sand shall be uniformly graded coarse to fine and pass the No. 8 sieve.

Section 921 addresses the requirements for Portland Cement used for the mortar.

Installation/Alignment and Grade

Photograph of large diameter pipe being installed. Note the use of timber to protect pipe during homing of joint.

Also, note that fill not placed prior to installation of pipe FDOT requires fill prior to laying pipe.

Included photo of large diameter pipe to show how timber was used to home up the pipe so that pipe was not damaged. FDOT specs would require that the embankment fill be placed prior to installation of the pipe.

Installation/Alignment and Grade – Curb Inlet Top

Next series of slides depicts how the curb inlet top is set and aligned using a stringline. Must ensure that the top is set in line with the curb which may, or may not, be level. Stringline should ensure proper alignment of the top grade.

Installation/Alignment and Grade – Curb Inlet Top

Installation/Alignment and Grade – Curb Inlet Top

Inlet top is being set and grouted to the top of the previously set drainage box.

Curb inlet top is set and is pretty close to line and grade.

For gutter inlets set in line with drop curb, must ensure that the structure is set so the top is in line with the curb. Often, you will set boxes set with the top level while the drop curb is on a vertical curve.

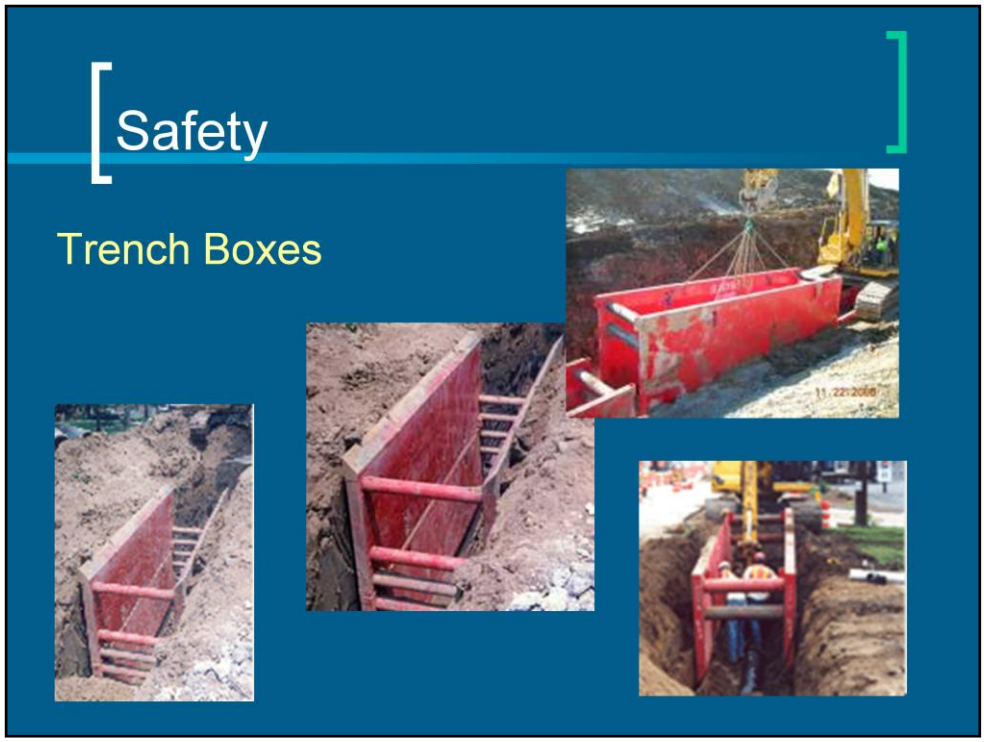
While FDOT personnel do not act as an enforcement arm of OSHA, it is important for our own safety to understand the requirements for a safe trench. Trench collapses have been the cause of many crushing and suffocation deaths and can be avoided by not putting yourself in jeopardy.

If you are a FDOT employee working around construction projects, take the FDOT's OSHA Awareness Training and other available classes to improve your knowledge of the risks on construction sites. FDOT's Loss Prevention Manual also provides guidance for FDOT employee safety.

If you are a consultant employee doing work for FDOT, you need to follow the requirements of your employer with regard to safety training requirements.

Whenever trenches are excavated, you should be sure that they are safe. The sides must be sloped outward to the natural ground line and heavy equipment should not operate near the edges. Also, excavated material must be stockpiled at safe distances away from trench edges.

If the trench is deep -- more than 5ft -- shoring, sheeting or other bracing may be required to hold the sides. The Occupational Safety and Health Administration -- OSHA -- publishes a manual on safety requirements. Consult this manual for specific requirements.



Ensure that trench boxes are sufficiently wide to allow for the compaction equipment and density testing equipment.

Submission of bid and subsequent execution of the Contract will serve as certification that all trench excavation in excess of 5 feet in depth will be in compliance with Section 553.62, Florida Statutes which states, "**553.63 Trench excavations in excess of 5 feet deep; required information.**--On all specific contracts for trench excavation in which such excavation will exceed a depth of 5 feet:

(1) The contract bid submitted by the contractor who will perform such excavation shall include:

(a) A reference to the trench safety standards that will be in effect during the period of construction of the project.

(b) Written assurance by the contractor performing the trench excavation that such contractor will comply with the applicable trench safety standards.

(c) A separate item identifying the cost of compliance with the applicable trench safety standards.

(2) A contractor performing trench excavation shall:

(a) As a minimum, comply with the excavation safety standards which are applicable to a project.

(b) Adhere to any special shoring requirements, if any, of the state or other political subdivisions which may be applicable to such a project.

(c) If any geotechnical information is available from the owner, the contractor, or otherwise, the contractor performing trench excavation shall consider this information in the contractor's design of the trench safety system which it will employ on the project. This paragraph shall not require the owner to obtain geotechnical information."

Standard Specification 125, Excavation for Structures and Pipe, require the contractor:

125-1.1 Trench Excavation Safety System and Shoring, Special (Trench Excavation): When performing trench excavation in excess of 5 feet in depth, comply with the Occupational Safety and Health Administration's (OSHA) trench safety standards, 29 C.F.R., s. 1926.650, Subpart P, and all subsequent revisions or updates adopted by the Department of Labor and Employment Security. Ensure that trench boxes are wide enough to accommodate compaction and density testing.

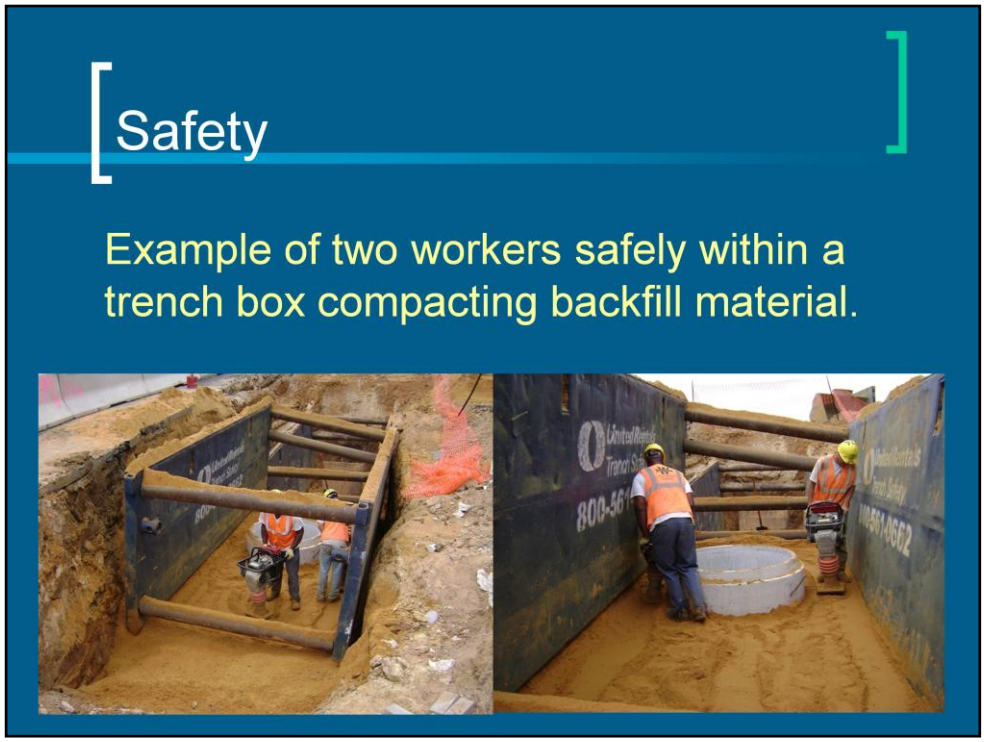
Submission of bid and subsequent execution of the Contract will serve as certification that all trench excavation in excess of 5 feet in depth will be in compliance with Section 553.62, Florida Statutes.

Consider all available geotechnical information available when designing the trench excavation safety system.

Consider these and any more stringent trench safety standards as minimum Contract requirements.

Safety

Examples of wider trench boxes stored on project site between use.



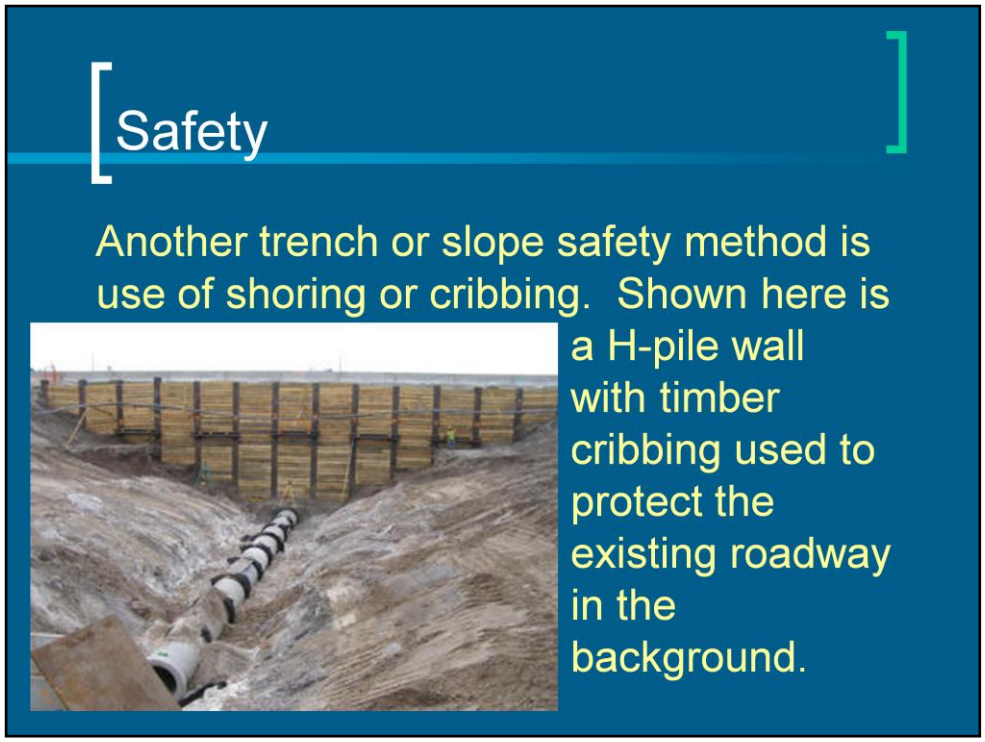
Note the second trench box in the background. The pipe backfill is being compacted in the second box.

Also, note the top of the precast drainage structure. This box will receive a riser to extend the height of the box up to finished grade.

Safety

Depicts use of multiple trench boxes for installation of water main. Typically, only 1 or 2 boxes would be used.

Use of multiple trench boxes would cut down on the number of density lots that would be required. Contractor in this case used several trench boxes to speed up the backfill operations.



H-pile with cribbing installed to secure roadway in the background behind the temporary barrier wall.

Dewatering, Backfilling and Compacting

Using soils that have been sampled and the proctor determined, the contractor will begin backfilling of the pipe trench. Shown is a trench that did not require dewatering.

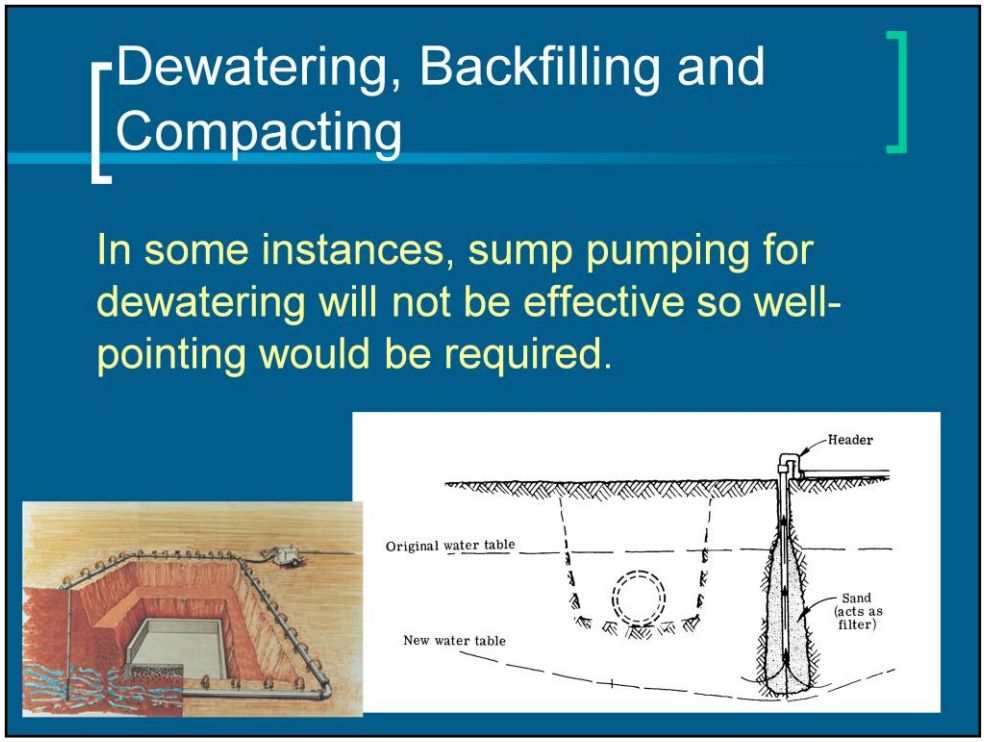
This is an ideal situation where the trench material is acceptable and dewatering is not needed.

Soils to be used by contractor require sampling and testing to determine the proctor used for density testing. Check to ensure that soil being used as backfill matches the description on the soils sample results. Also, verification density testing is required to validate the contractor's QC density test results.

This is the most common method of dewatering. A lower cut is made on one side or at one end of the trench and the water flows to a sump located there. The water is then pumped through a pipe and away from the trench area. The Inspector must be sure that the flow of water to the sump does not erode the pipe bedding or undermine the pipe previously laid.

A caution when a contractor uses a sump pump method for dewatering is the quality of the water being discharged. Often this water is muddy and would fail to meet water quality standards so a treatment, such as a settlement basin, may be required. Direct discharge into a receiving water body would not be acceptable. Small photograph in left of slide shows one product available that can help with filtering muddy discharge from mudhog pump.

Also, if contamination found in trenches, notify Project Engineer or Project Administrator who will contact the Contamination Assessment/Remediation (CAR) contractor. It is important that contaminated water remain on the project or be disposed of properly as FDOT can't become a conveyor of the contaminates from the present locations. When/if contaminated soils are found during trench excavations, the specifications require the contractor to stop and FDOT activates one of its CAR contractors to clean up and remove the hazardous materials. An important function of the drainage pipe being installed is the conveyance of water through the pipe. The importance of the joint tightness is that FDOT can not be a conveyor of hazardous materials that may be in the adjacent ground via its drainage pipe.



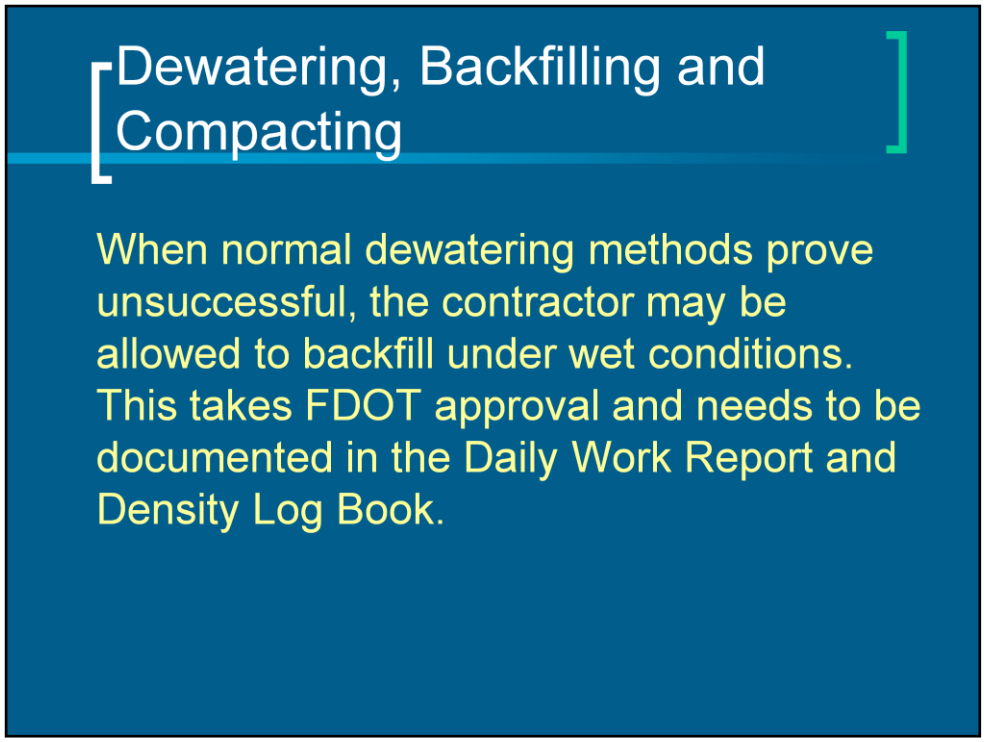
In some cases, sump pumping will not be effective and it will be necessary to use wellpoints. This is shown below. In this process, the well points are jetted into the ground and a sand filter is placed at the tips. The wellpoint risers are connected to a main pipe that is connected to the wellpoint pump. When the pump is running, the well points draw the water into the pipe and, over a period of time, the water table is lowered.

Wellpoints are effectively as series of very shallow wells that lower the water table below the trench excavation elevation to enable placement of the pipe and backfilling of the trench in dry conditions.

Section 125-8 addresses requirements for dewatering equipment and methods.

Color illustration is set up for dewatering a foundation. Black and white illustration is a typical set up for pipe trench excavation.

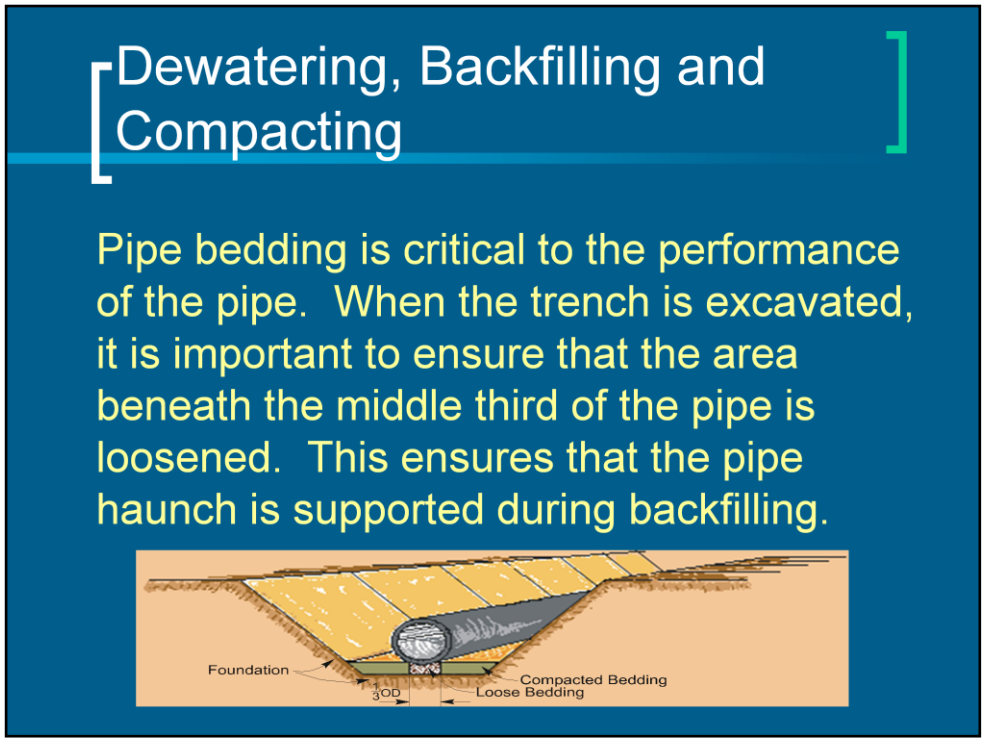
A pump hose would be attached to the wellpoint header. The water removed by wellpointing is typically very and discharge into a holding area (pond for example) should not be an issue.



125-8.3.4 Backfill Under Wet Conditions: Where wet conditions are such that dewatering by normal pumping methods would not be effective, the procedure outlined below may be used when specifically authorized by the Engineer in writing. The Department will pay for any select material which is not available from the grading as Unforeseeable Work. The Department will not pay for select material that might be used by the Contractor for his own convenience instead of dewatering.

The Department will permit the use of granular material below the elevation at which mechanical tampers would be effective, but only material classified as A-3. Place and compact the material using timbers or hand tampers until the backfill reaches an elevation such that it's moisture content will permit the use of mechanical tampers. When the backfill has reached such elevation, use normally acceptable backfill material. Compact the material using mechanical tampers in such manner and to such extent as to transfer the compacting force into the material previously tamped by hand.

The Department will permit the use of coarse aggregate below the elevation at which mechanical tampers would be effective. Use coarse aggregate as specified in Section 901 for Aggregate Size Number 89, 8, 78, 7, 68, 6, or 57. Place the coarse aggregate such that it will be stable and firm. Fully wrap the aggregate with a layer of Type D-4 filter fabric, as specified on Design Standard, Index No. 199. Do not place coarse aggregate within 4 feet of the ends of the trench or ditch. Use normally accepted backfill material at the ends.



Often, the teeth on the backhoe bucket will sufficiently loosen the material beneath the middle third of the pipe such that the pipe haunch will be supported. The areas outside this middle third will also be loosen by the backhoe teeth but will be compacted when the backfill material is compacted.

If the material in the bottom of the trench is unyielding, then the trench would need to be undercut and suitable backfill placed beneath the pipe.

The foundation and bedding for a pipe culvert should be constructed to provide uniform support throughout the length of the pipe.

After the pipe trench has been excavated to the level required to place the pipe, it is necessary to inspect the exposed soil. If the material is rock or extremely hard, or if the material seems unusually wet or yielding, consult with the Project Engineer to determine the amount of undercut necessary. Soft material below the pipe can cause the pipe to settle, often unevenly. Hard material can increase the stress in the pipe wall.

The bedding zone normally extends 4" below the pipe. If rock or hard material must be removed, the bedding zone will extend to 12" below the pipe. The material in the bedding zone should meet the specifications for backfill around the pipe.

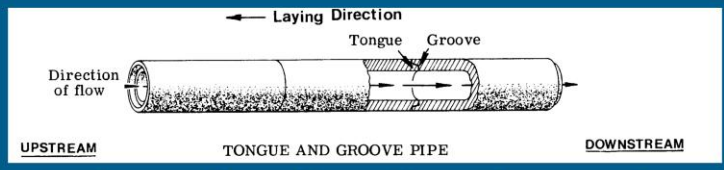
If the trench is undercut to remove undesirable foundation material, the undercut must be filled and compacted to the level of the bedding zone of the pipe. Next, the bedding material must be placed. The bedding material should meet the specifications for backfill around the pipe. The bedding material must be compacted except below the middle third of the outside diameter of the pipe. This will be accomplished after the pipe has been laid during backfill compaction. Loosely placed, uncompacted bedding directly below the invert of the pipe significantly reduces stresses in the pipe wall. The pipe can nestle into the bedding and form a continuous, uniform contact. When unstable conditions are encountered and when specifically authorized by the Engineer in writing, select material on granular material may be used for backfilling.

If the trench was not undercut, the soil below the middle third of the pipe must be loosened.

Once the bed is prepared, the pipe can be placed. The Contractor must excavate for pipe bells before laying the pipe.

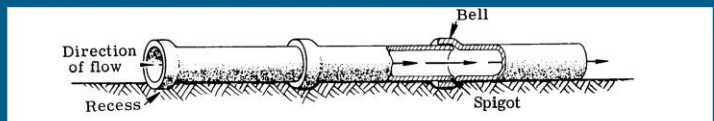
The pipe is placed and material is compacted under the haunches of the pipe. A small mechanical tamper or a hand tamp is generally used. Be sure that the pipe is not moved or damaged during compaction. If the pipe is flexible be sure the pipe does not deflect excessively.

Dewatering, Backfilling and Compacting



TONGUE AND GROOVE PIPE

Illustrations show how the pipe sections should be laid with regard to direction of flow and joint. Also, note that bells need to be recessed in the trench.



BELL AND SPIGOT PIPE

Pipe should be laid from the outlet end to the inlet end (uphill).

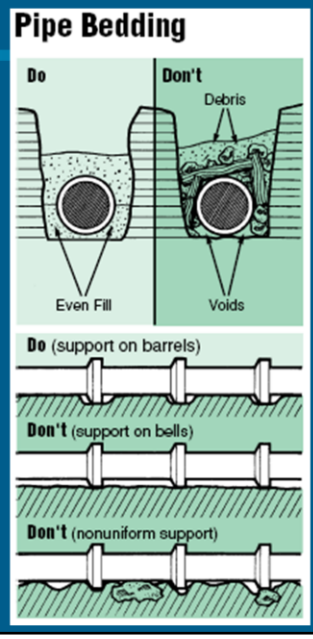
Pipe up to approximately 24 in. in diameter can be pushed into place by a bar and wood block, as shown at the right. Trench excavation equipment may be used. Often you will see the pipe being pushed into position with the assistance of the backhoe, either with the sling or by pushing the bell or groove end of the pipe. Must be mindful of possible damage with use of backhoe.

Whenever <u>any</u> pipe is being pushed into place by heavy equipment, wood blocks should be used as cushions.

If placing a large diameter pipe that has lifting holes, ensure that the lifting holes are at the top of the pipe and that the lifting holes are properly patched.

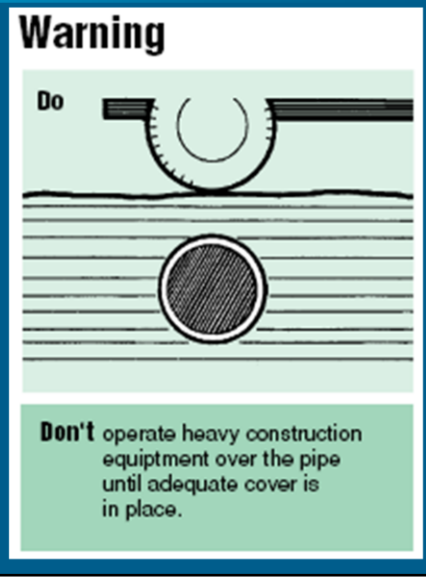
Dewatering, Backfilling and Compacting

- Watch for debris in trench
- Ensure barrel and spigots supported
- Watch for non-uniform support



Dewatering, Backfilling and Compacting

- Something that is often overlooked during pipe installation

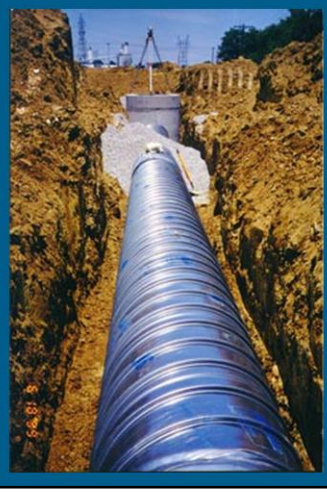


Include diagram of lifts for pipe backfill.

Dewatering, Backfilling and Compacting

Illustrates a trench that is too narrow to allow testing and compaction equipment

This trench could be back-filled with flowable fill.



Dewatering, Backfilling and Compacting

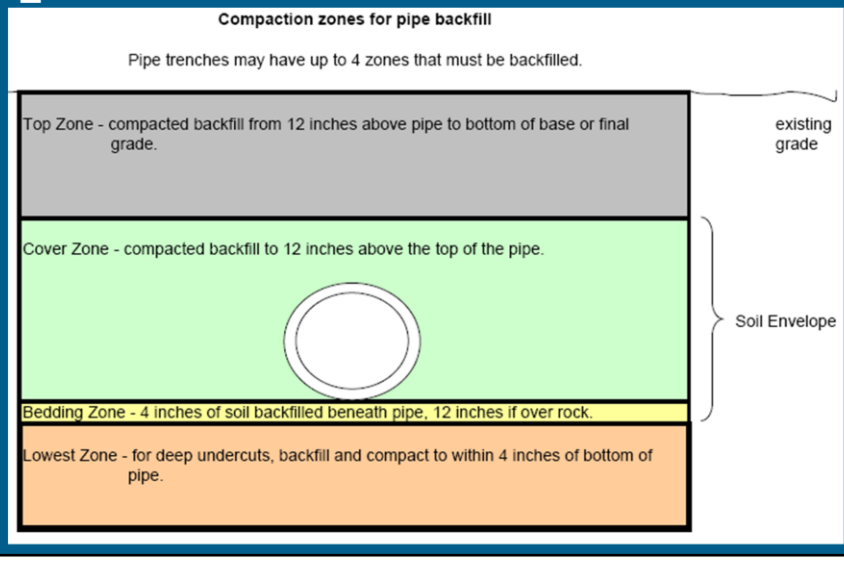
Photos illustrate properly wrapped joints, required bituminous coating applied to the exterior

of the box and filter fabric applied to the bituminous coating.

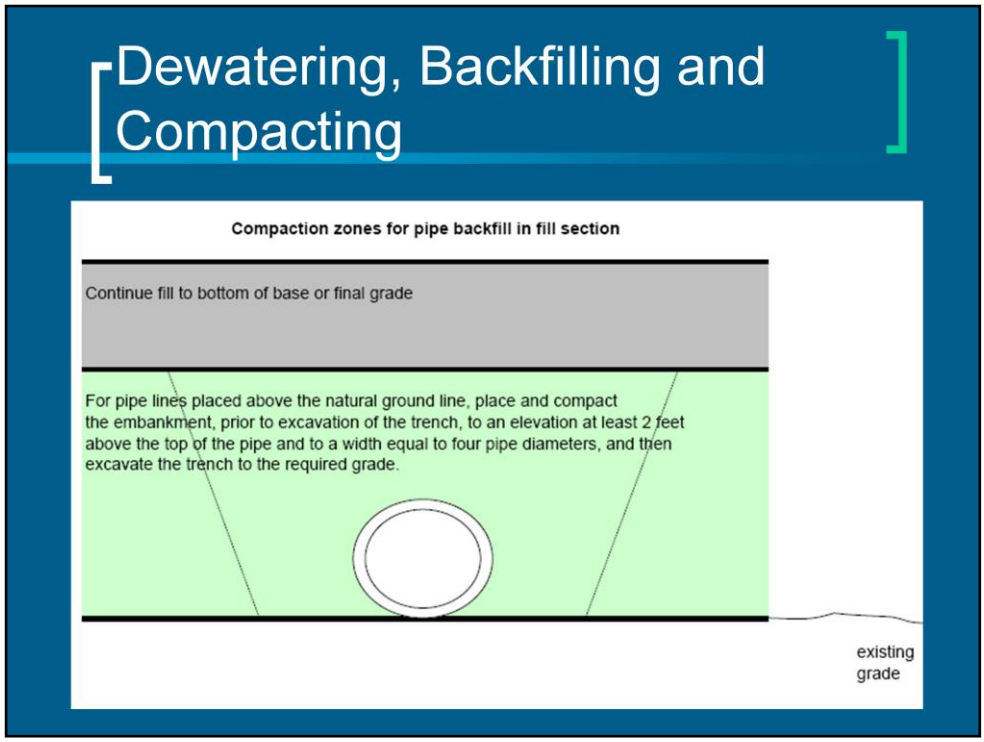
Dewatering, Backfilling and Compacting

Example of plastic pipe being backfilled in trench using jumping jacks for compaction. Also, note the brick and mortar operations being performed. Bricks on top of structure would need to be soaked prior to use.

Dewatering, Backfilling and Compacting



From Standard Specification 125-8.3.1

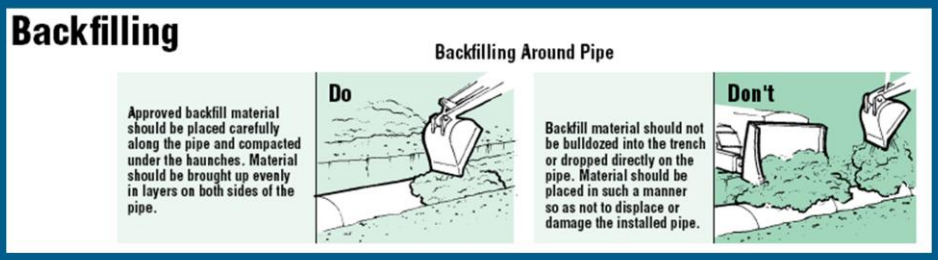


From Section 125-4.4, “For pipe lines placed above the natural ground line, place and compact the embankment, prior to excavation of the trench, to an elevation at least 2 feet above the top of the pipe and to a width equal to four pipe diameters, and then excavate the trench to the required grade.”

The reason for this requirement is to prevent lateral displacement of the pipe. If it were installed on the existing grade and then backfill placed along side of the pipe, the pipe can move laterally.

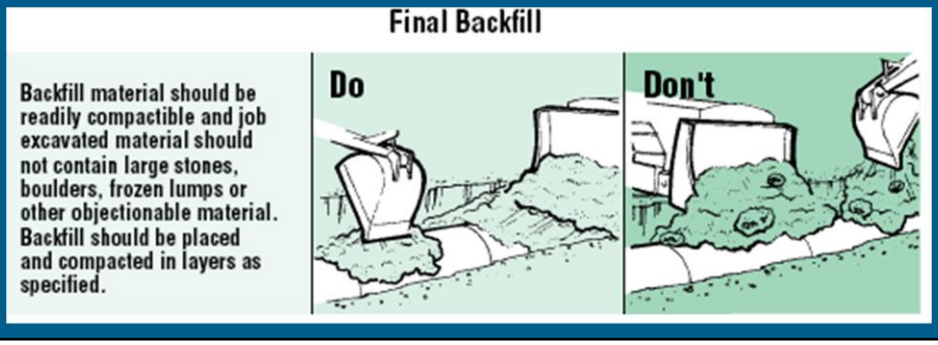
Dewatering, Backfilling and Compacting

Slide shows proper and improper methods of distributing backfill materials into the pipe trench.



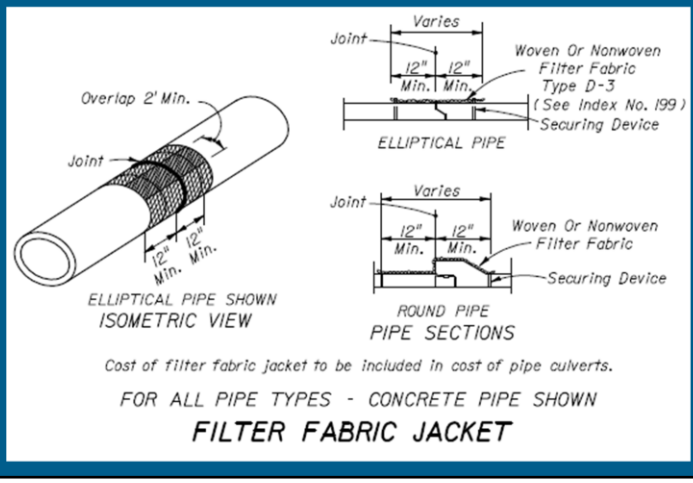
Dewatering, Backfilling and Compacting

Slide shows dos and don’ts for quality of backfill material – shows debris, stones, frozen lumps



Joints

Standard Index detail of filter fabric for pipe



concrete pipe shown.

The 2004 standard specs require side-drains, cross-drains, and storm-drains to use soil tight joints. The spec definition of soil-tight is that these same joints are to be water-tight to 2 psi. So, if you are seeing leaking joints in side-drain, cross-drain, or storm-drain pipes, it needs to be determined if the if the hydrostatic groundwater head exceeds that which would cause the joint to leak at 2 psi.

A quick determination of this is as follows:

Using the hydraulic equation, $p = wh$

where p is the pressure
w is the specific weight of water, 62.4 pcf
h is the head, or in this case, the depth below the water surface

Then solving for h gives you $h = p/w$

$= (2 \text{ psi} \times 144 \text{ in}^2/\text{ft}^2)/62.4 \text{ pcf}$
$= 4.61 \text{ ft}$

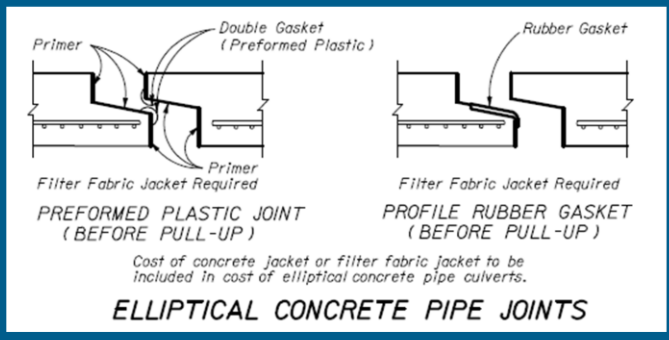
So if the pipe that is installed is less than 4.61 feet below the water table, you should not have any leaking joints for the 2 psi required water tightness. If the joints are leaking and your project has this condition, then the joints are either defective or not installed correctly.

Something to keep in mind is that the ASTM requirement for the testing of these pipe joints at the manufacturers facility is to test them to 10 psi so field installed joints to 2 psi for soil tight joints or 5 psi for water tight joints is achievable. Beginning with projects let in January 2007, all pipe joints except for side drain joints target 5 psi water tight joints. Side drains will retain the 2 psi water tight joint requirement.

Importance of filter fabric on joint is to minimize intrusion of soils into joints should a joint leak.

Joints

A key to successfully performing joints is the gasket installation. Shown here is two types of gaskets used for elliptical pipe – the more common being the profile rubber gasket.



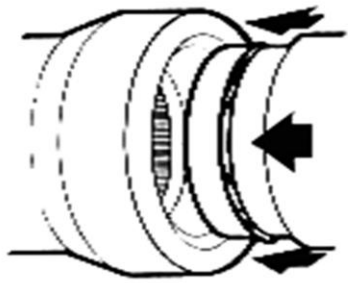
Joints

Lubricate bell jointing surface liberally. Use a brush, cloth, sponge or gloves to cover entire inside surface. Only approved lubricant should be used.

Lubricate the spigot or tongue end of pipe, especially the gasket recess.

Lubricate the gasket thoroughly before it is placed on the spigot or tongue.

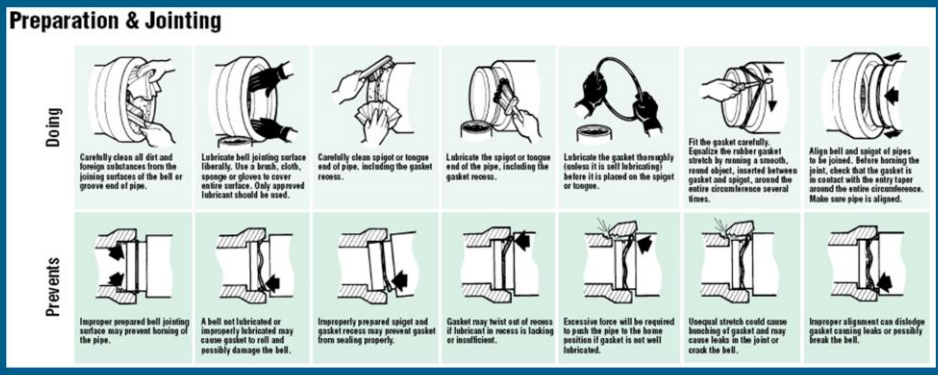
Fit the gasket carefully. Equalize the rubber gasket stretch by running a smooth, round object, inserted between gasket and spigot, around the entire circumference several times.



Align bell and spigot of pipes to be jointed. Before homing the joint, check that the gasket is in contact with the entry taper around the entire circumference. Make sure pipe is aligned.

Joints

Illustrates what can happen with gaskets and joints not properly prepared

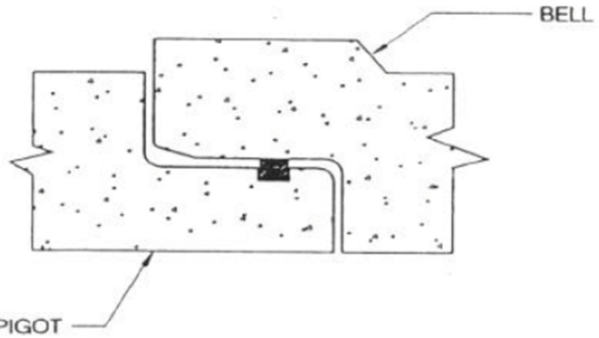


Joints – Round Rubber Gaskets

PROBLEM	POSSIBLE CAUSE	SOLUTION
JOINT WILL NOT GO HOME	1. DIRT IN BELL 2. UNEVEN GASKET TENSION 3. POOR ALIGNMENT OF PIPE BEING LAID 4. IMPROPER GASKET 5. INCOMPATIBLE JOINT 6. IMPROPER LUBRICANT	1. CLEAN & LUBRICATE BELL 2. SEAT GASKET USING SCREWDRIVER 3. REALIGN PIPE BEING LAID BEFORE BARRING. DO NOT "DIVE" PIPE WHEN MAKING JOINT 4. CHECK GASKET FOR PROPER SIZE AND DIAMETER 5. MAKE SURE PIPE IS FROM SAME MFG. OR HAS COMPATIBLE JOIN 6. RE-LUBRICATE GASKET, GROOVE AND BELL
JOINT IS LOOSE	1. IMPROPER GASKET 2. INCOMPATIBLE JOINT	1. CHECK GASKET FOR PROPER SIZE AND DIAMETER 2. MAKE SURE PIPE IS FROM SAME MFG. OR HAS COMPATIBLE JOINT
JOINT WILL NOT STAY "HOME"	1 GASKET IS NOT ROTATING 2. UNEVEN GASKET TENSION	1. CHECK SPIGOT GROOVE FOR ROUGH SPOTS OR DIRT. CLEAN AND LUBRICATE SPIGOT GROOVE. 2. SEAT GASKET USING SCREWDRIVER

Joints

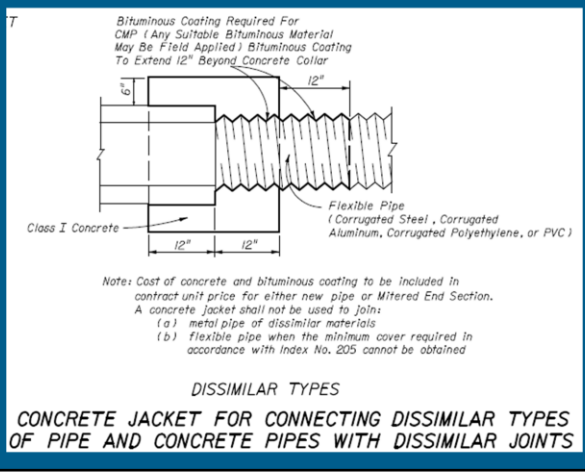
Step 4: Place the gasket in the lubricated groove. A well-lubricated groove will automatically equalize the tension in the gasket. For proper jointing, it is imperative that the tension in the gasket be equalized.



The equalizing of the tension in the gasket is often accomplished by running a screwdriver under the gasket after it has been placed on the joint. This was illustrated on a previous slide.

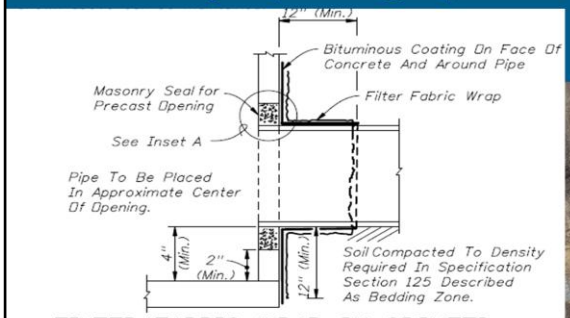
Joints

There are times when dissimilar pipe types are connected. This is done with a concrete collar. Detail here is from Design Standard 280.



Joints

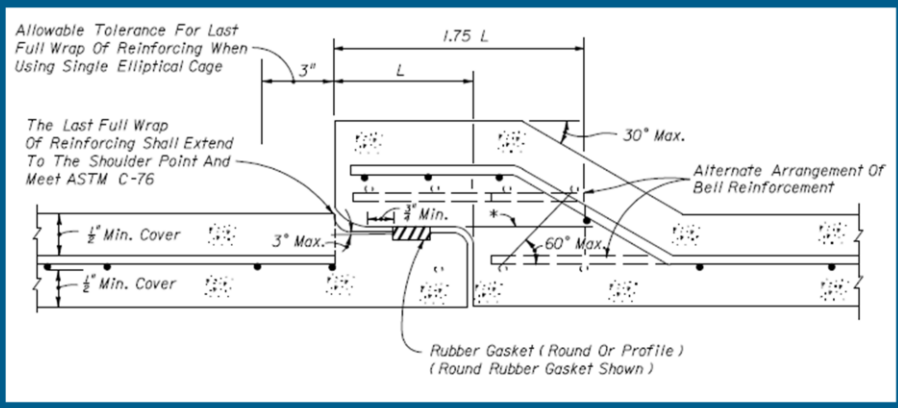
Design Standard shows area on outside of drainage structure that requires bituminous coating – photograph shows field example.



FILTER FABRIC WRAP ON GROUTED PIPE TO STRUCTURE JOINT

Joints

Typical Bell/Spigot joint for Round Steel Reinforced Concrete Pipe



Joints

Standard Specification 430-7.2 addresses gap tolerances for concrete pipe with rubber gaskets:

5/8” for 12 to 18 inch diameter pipe

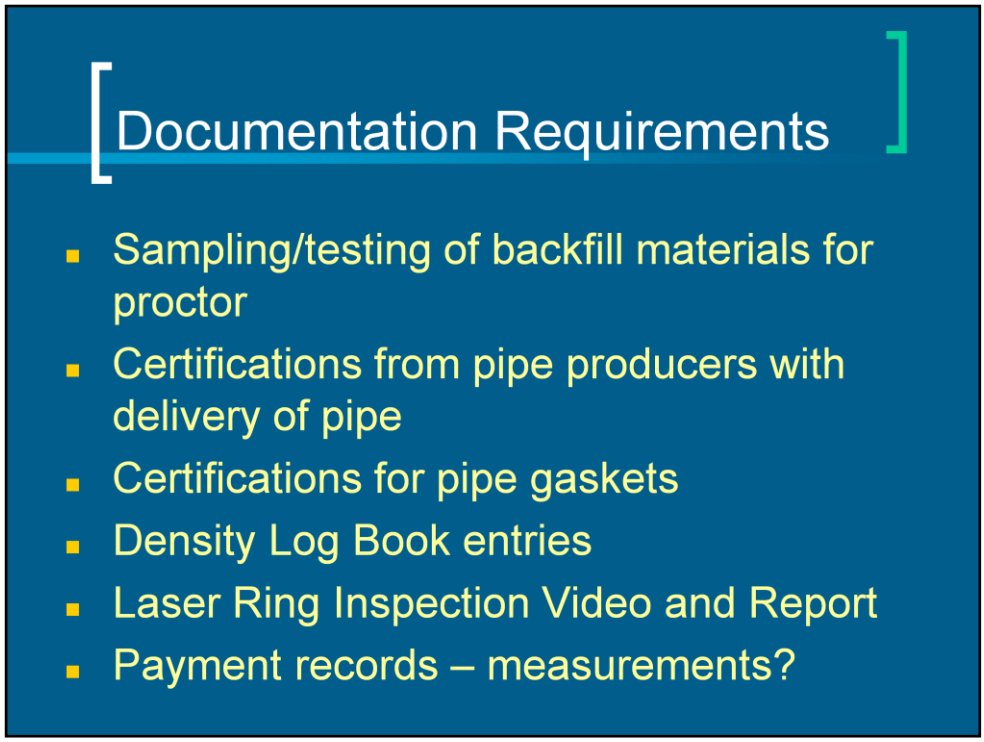
7/8” for 24 to 66 inch diameter pipe

1” for pipe diameters 72 inch or greater

Joints

Section 430-7.2 also allows for minor manufacturing imperfections in the pipe joint:

Imperfection that does not exceed 1/3 the circumference of the pipe and the rubber gasket is 1/4 inch or more past the joint entrance taper can be accepted.



Soil materials used for pipe trench backfill requires sampling and testing to determine suitability for use as backfill. Contract Documents identify that the materials excavated for pipe trenches is unclassified so the contractor will have to collect samples and have them tested to determine suitability and proctor. These results need to be made available as part of the contractor quality control process. Inspection of the pipe backfilling operations will require that the soils being used match the descriptions provided with the test reports.

Certifications are required from the manufacturer of the pipe stating that the pipe has been fabricated to FDOT specifications.

Additionally, certifications are required for the gaskets indicating that they are fabricated in accordance with the specifications section 942.

When the pipe is being installed and backfilled, the contractor's QC representative is required to test backfill compaction per Section 125 of the standard specs. The Department's representative is required to take comparison tests randomly to verify the contractor's QC results. If they verify, FDOT will accept the contractor's QC results.

New to the specs, since May of 2006, the Department requires pipe 48 inches or less in diameter to be video taped and laser profiled to determine quality of the installation workmanship. The laser profiling of the pipe generates a report identifying lengths and widths of cracks, pipe ovality, deflection measurements, representative diameter of the pipe, deviations from line and grade, joint gaps and misalignments, leaks, debris, or other damages.

Payment records for pipe are fairly simple as the pay items for pipe are plan quantity items. Because of this, the specs do not require measurement of the installed pipe. However, it is necessary for the inspector to keep up with the numbers of pipe sections used between structures to do comparisons to the quantity provided in the plans. Unless the Engineer makes field adjustments or on error in the plan quantity is discovered that exceed threshold of difference between plan quantity and final quantity of >5% or change in quantity that changes the amount payable by more than $5,000, the contractor would be paid the plan quantity amount.

Documentation Requirements

Typical report of Proctor results for backfill

STATE OF FLORIDA DEPARTMENT OF TRANSPORTATION 8-15-07

COMPACTION TEST (STANDARD) WORKSHEE

JOB NUMBER : 20973345201 LINE ITEM N

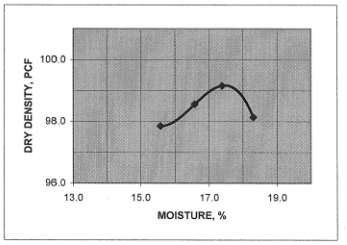
SAMPLE NO : 00001R LAB. NO : 0379-S TESTED BY

STATION LIMITS/ LOCATION :

% RETAINED # 4 SIE

MOLD VOLUME : (1/30 OR 1/13.33 C.F.) % PASSING # 4 SIE

MOLD NO.			375	4			
WATER (C.C.)							
WET WEIGHT + MOLD (GM)							
WET WEIGHT + MOLD (LBS)	12.84	12.89	12.95				
WEIGHT OF MOLD (LBS)	9.12	9.12	9.12	9.			
WET WEIGHT (LBS)	3.72	3.77	3.83	3.			
WET UNIT WEIGHT (LBS / C.F.)	111.6	113.1	114.9	116.4	116.1		
DRY UNIT WEIGHT (LBS / C.F.)	97.4	97.9	98.6	99.2	98.1		



$Y = -0.4053x^3 + 20.102x^2 - 331.25x + 1912.1$

Ymax = 99.3 @ 17.5

Documentation Requirements

Typical Certification Header

"USE ON MANUFACTURER'S LETTERHEAD"

MATERIAL CERTIFICATION

FLORIDA D.O.T.

MANUFACTURED PRECAST CONCRETE PRODUCTS
MATERIAL NUMBER* (206)

Contractor:

F.D.O.T. Project Number:

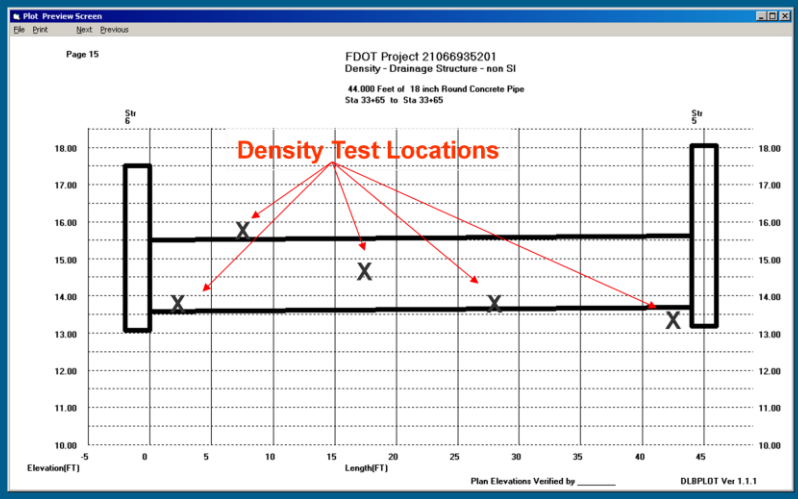
F.D.O.T. Contract Number:

Project Location:

Description of Products:

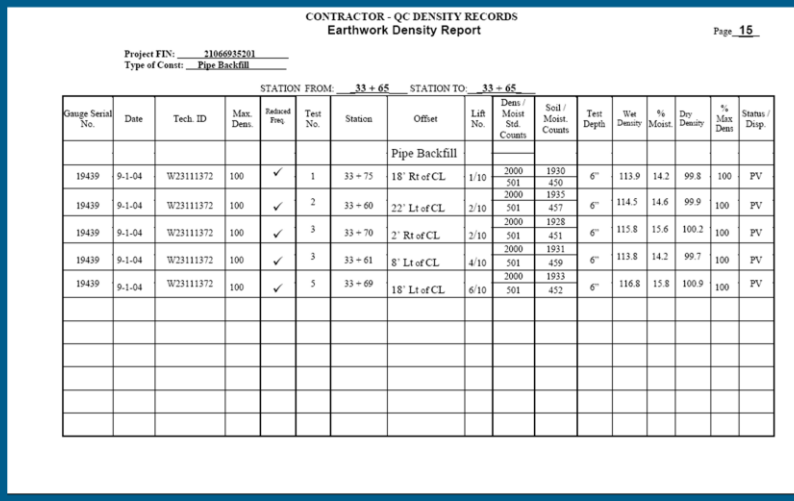
Certification language that is provided by State Materials Office for manufacturers to use in their certifications to the Department that their products meet the requirements of the specifications.

Documentation Requirements



Depicts typical density log book sheet for pipe structures. X's represent test locations that are logged on the following slide.

Documentation Requirements



CONTRACTOR - QC DENSITY RECORDS
Earthwork Density Report

Page 15

Project FIN: 21066935201
Type of Const: Pipe Backfill

STATION FROM: 33 + 65 STATION TO: 33 + 65

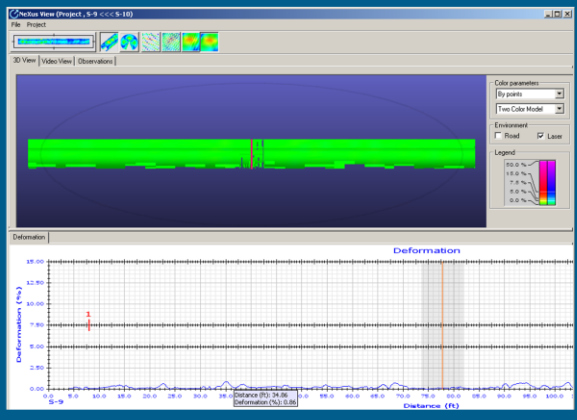
Gauge Serial No.	Date	Tech. ID	Max. Dens.	Reduced Freq.	Test No.	Station	Offset	Lift No.	Dens / Moist Std. Counts	Soil / Moist. Counts	Test Depth	Wet Density	% Moist.	Dry Density	% Max Dens	Status / Disp.
							Pipe Backfill									
19439	9-1-04	W23111372	100	✓	1	33 + 75	18' Rt of CL	1/10	2000 501	1930 450	6"	113.9	14.2	99.8	100	PV
19439	9-1-04	W23111372	100	✓	2	33 + 60	22' Lt of CL	2/10	2000 501	1935 457	6"	114.5	14.6	99.9	100	PV
19439	9-1-04	W23111372	100	✓	3	33 + 70	2' Rt of CL	2/10	2000 501	1928 451	6"	115.8	15.6	100.2	100	PV
19439	9-1-04	W23111372	100	✓	3	33 + 61	8' Lt of CL	4/10	2000 501	1931 459	6"	113.8	14.2	99.7	100	PV
19439	9-1-04	W23111372	100	✓	5	33 + 69	18' Lt of CL	6/10	2000 501	1933 452	6"	116.8	15.8	100.9	100	PV

Reporting of the Density tests are logged into the Density Log book on Earthwork Density Report Sheets. This is the Contractor's QC Record that FDOT inspectors will need to ensure is being performed correctly and that data is being logged.

Documentation Requirements

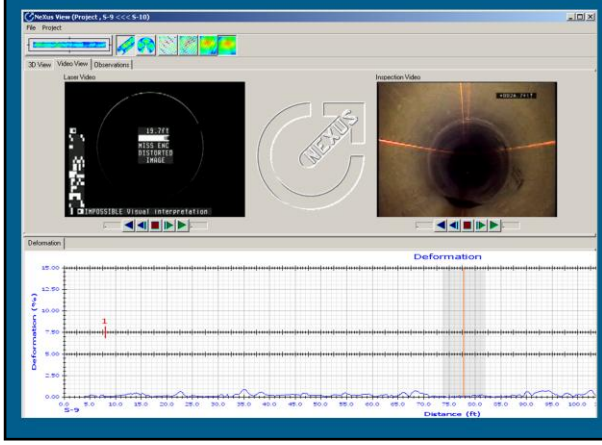
Example of one product's output for laser ring inspection.

Slide shows deflections along bottom of graph.



Documentation Requirements

Continuation of output from laser profiler.



When animated, the video on the left will show the laser ring projection for deflection. The right is laser for crack and joint measurements.

Documentation Requirements

Output from another Laser Ring Inspection

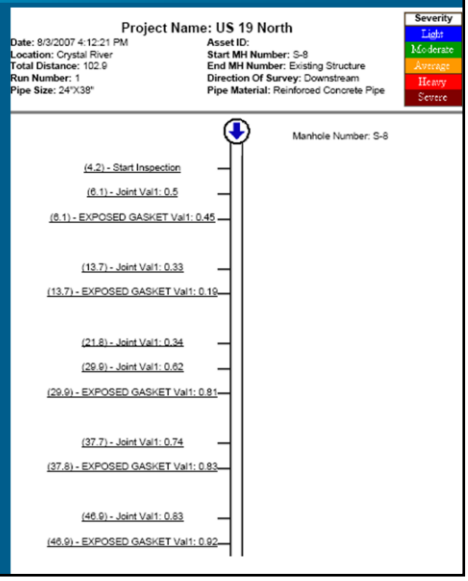
PIPELINE OBSERVATION SYSTEM MANAGEMENT

Session Name	Date	Location	Manhole Numbers	Size
- US 19 North	08/03/2007 01:24:46 PM	Crystal River	S-9 To Mitered End	282 MB
- US 19 North	08/03/2007 01:42:38 PM	Crystal River	S-9 To Mitered End	304 MB
- US 19 North	08/03/2007 02:33:54 PM	Crystal River	Mitered End South To Mitered End 43A	382 MB
- US 19 North	08/03/2007 03:02:21 PM	Crystal River	S-4 To S-3	355 MB
- US 19 North	08/03/2007 04:12:21 PM	Crystal River	S-8 To Existing Structure	708 MB
- US 19 North	08/03/2007 05:45:22 PM	Crystal River	S-8 To Mitered End South	850 MB
- US 19 North	08/03/2007 06:45:37 PM	Crystal River	Mitered End North To S-7	295 MB
- US 19 North	08/03/2007 07:05:46 PM	Crystal River	Mitered End South To S-6	340 MB

You may need to download Divx to view Video clips
http://www.divx.com

Documentation Requirements

Continuation of previous report – provides plot of pipe showing defects and locations.



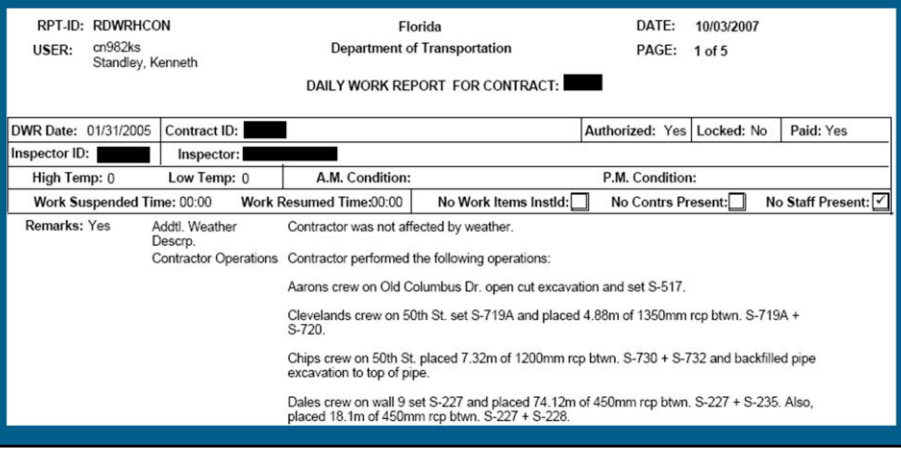
Documentation Requirements

More data from previous report – joints gaps.

46.9	Joint Measurement: 0.83	11:44	
46.9	EXPOSED GASKET Measurement: 0.92	12:15	

Documentation Requirements

Excerpt for SiteManager Daily Work Report



RPT-ID: RDWRHCON | Florida | DATE: 10/03/2007
USER: cn982ks Standley, Kenneth | Department of Transportation | PAGE: 1 of 5

DAILY WORK REPORT FOR CONTRACT: [redacted]

DWR Date: 01/31/2005	Contract ID: [redacted]	Authorized: Yes	Locked: No	Paid: Yes
Inspector ID: [redacted]	Inspector: [redacted]			
High Temp: 0	Low Temp: 0	A.M. Condition:	P.M. Condition:	
Work Suspended Time: 00:00	Work Resumed Time:00:00	No Work Items Instld: ☐	No Contrs Present: ☐	No Staff Present: ☑

Remarks: Yes

Addtl. Weather Descrp.: Contractor was not affected by weather.

Contractor Operations: Contractor performed the following operations:

Aarons crew on Old Columbus Dr. open cut excavation and set S-517.

Clevelands crew on 50th St. set S-719A and placed 4.88m of 1350mm rcp btwn. S-719A + S-720.

Chips crew on 50th St. placed 7.32m of 1200mm rcp btwn. S-730 + S-732 and backfilled pipe excavation to top of pipe.

Dales crew on wall 9 set S-227 and placed 74.12m of 450mm rcp btwn. S-227 + S-235. Also, placed 18.1m of 450mm rcp btwn. S-227 + S-228.

This is a typical Daily Work Report from SiteManager – project or personnel information has been redacted. DWR's need to provide information sufficient to allow Project Engineer or Project Administrator follow progress on the project and quantities of work performed.

Documentation Requirements

Excerpt from same Daily Work Report showing quantities of work being performed. In this case, shown is P-7 Manholes.

Work Item Information

Item Code: 2425 2 41 **Description:** MANHOLES (P-7) (<3M)

Supp Desc 1:

Supp Desc 2:

Project Nbr	Line Item Nbr	Category	Plan Pg Nbr	Place Qty	Units	Contractor ID / Contractor Name	Measured / Installed Qty
25840115201	2230	0200	0	.850	EA	[redacted]	49.50

Location: S-227-partial

	Station	Offset	Distance		Station	Offset	Distance
From:	+ 0.000		0.000	To:	+ 0.000		0.000

Documentation Requirements

This excerpt shows stationing and quantity of optional pipe installed. In this case, pipe is round, 0-24” used for cross drain.

Item Code: 0430173101 **Description:** PIPE CULVERT OPTIONAL MATERIAL, ROUND - SHAPE, 0-24",
Supp Desc 1:
Supp Desc 2:

Project Nbr	Line Item Nbr	Category	Plan Pg Nbr	Place Qty	Units	Contractor ID / Contractor Name	Measured / Installed Qty
23026255201	0795	0200	0	80.000	LF	[redacted]	80.00

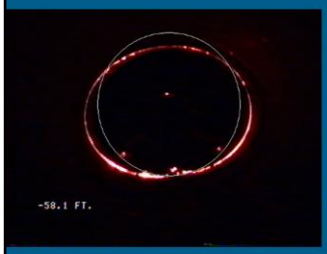
Location: cross Drain across midway rt rdwy

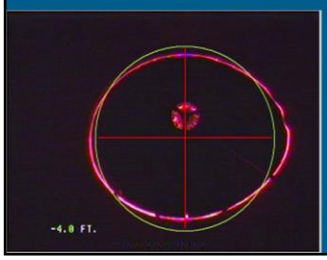
	Station	Offset	Distance		Station	Offset	Distance
From:	33 + 50.000	rt	5.000	To:	33 + 50.000	rt	85.000

S289-290

Specification Requirements

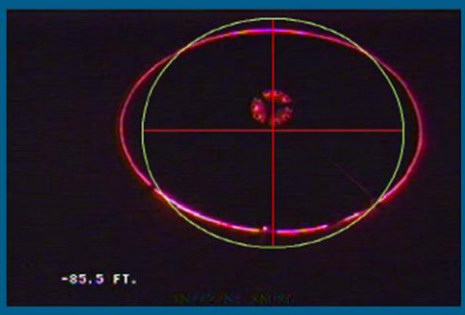
Laser Ring Images – New in Specifications

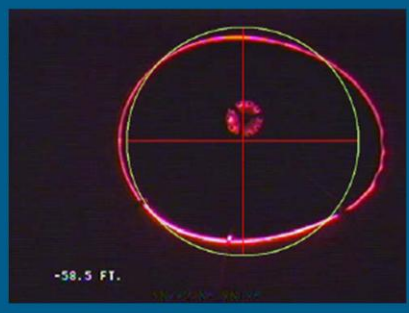




Specification Requirements

Video images showing 15.8% and 14.0% deflection



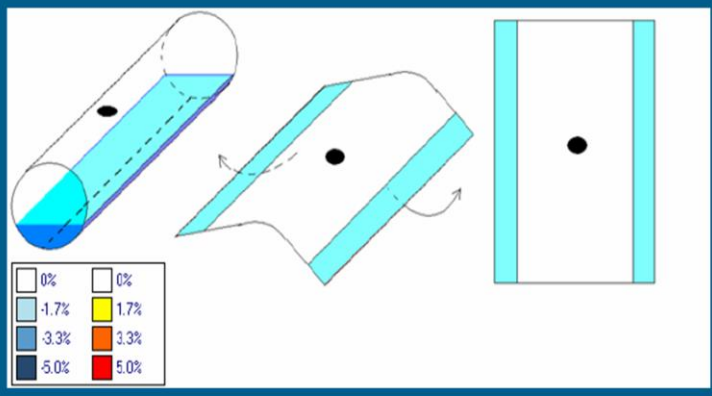


One of the laser profiling devices uses this type of barrel distortion test target for calibrating the camera. Others have different means of calibrating before videoing.

Affect of distortions in the videoing is providing inaccurate views and incorrect measurements.

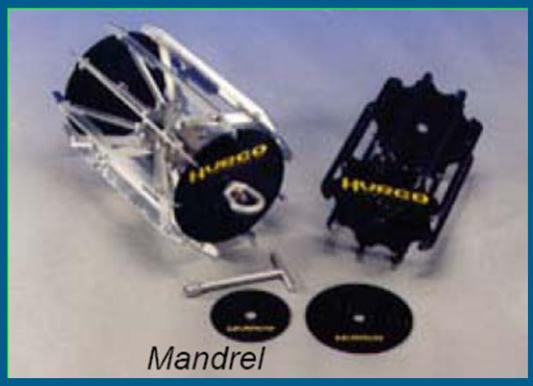
Specification Requirements

Diagram of profiler flat graph display



Specification Requirements

Example of mandrels that could be used to check pipe for excessive deflection



Mandrel

Specification Requirements

Specifications for pipe installation begin with section 125, Excavation for Structures and Pipe.

Section 125 provides specs for trench safety and shoring, soil classification in trench (unclassified), trench excavation, backfilling LOT's, dewatering, compaction, QC and VT

Specification Requirements

Section 425 provides specifications for inlets, manholes and junction boxes.

425 provides requirements for mortar, precast and cast-in-place structures, backfilling specs.

Specification Requirements

Section 430 provides specifications for pipe culverts and storm sewers.

430 provides requirements for optional pipe types, laying, line and grade, final pipe inspection, video reports, mandrels, joints, gaskets, tolerances, deflection limits for flexible pipe types.

Specification Requirements

Section 449 provides specifications for precast concrete drainage products.

449 provides requirements for concrete pipe, drainage structures, joint designs, rejection causes.

Specification Requirements

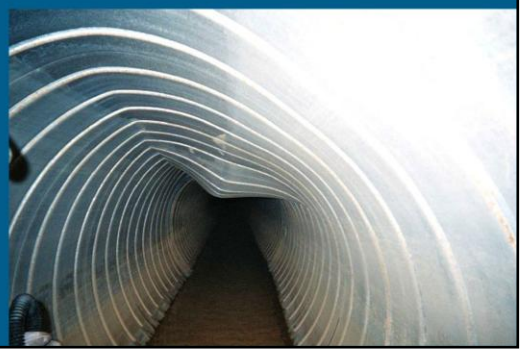
Division III specifications are primarily concerned with materials properties and manufacturing requirements.

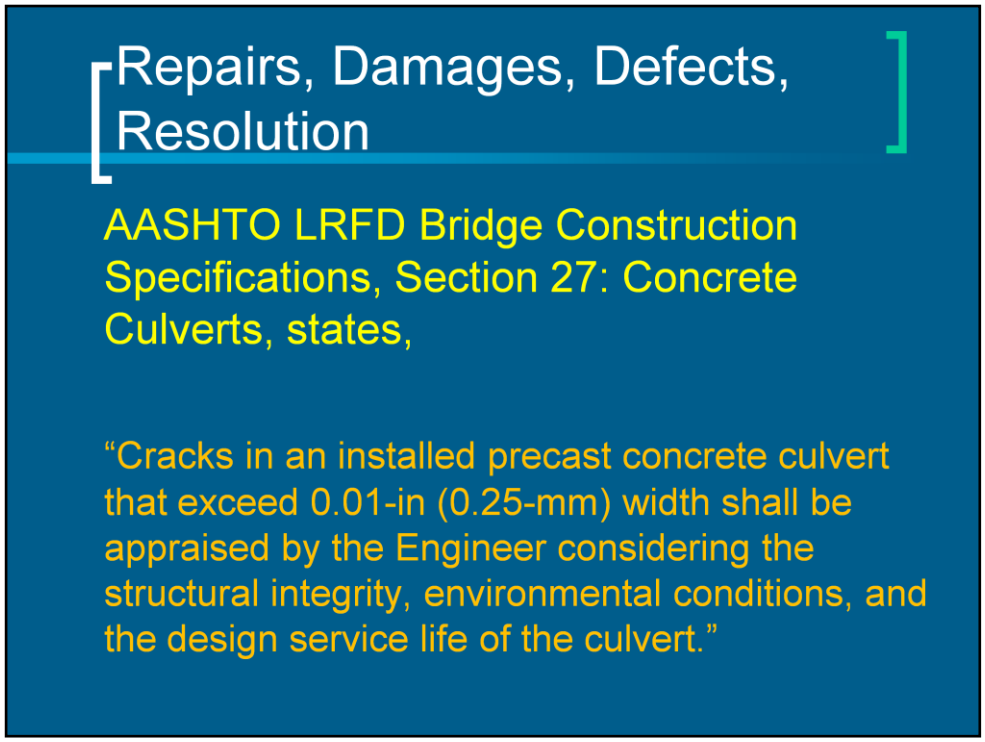
Sections 921, 923, 942, 943, 945, 946, 948, 949, 962 provide specifications for cement for mortar, water, pipe gaskets, steel and aluminum pipes, cast iron pipe, misc pipe, brick.

Repairs, Damages, Defects, Resolution

Any and all pipe types are subject to some kind of damage during installation or defects during manufacture.

This is metal pipe that was impacted by guardrail post. Fix was remove and replace.





This is the approach that FDOT takes when it is discovered that the installed pipe has cracking. The Department will, in these cases, alert the contractor of the cracking and request an evaluation be done by the contractor to address a remedy. These factors must be taken into account when evaluating the pipe.

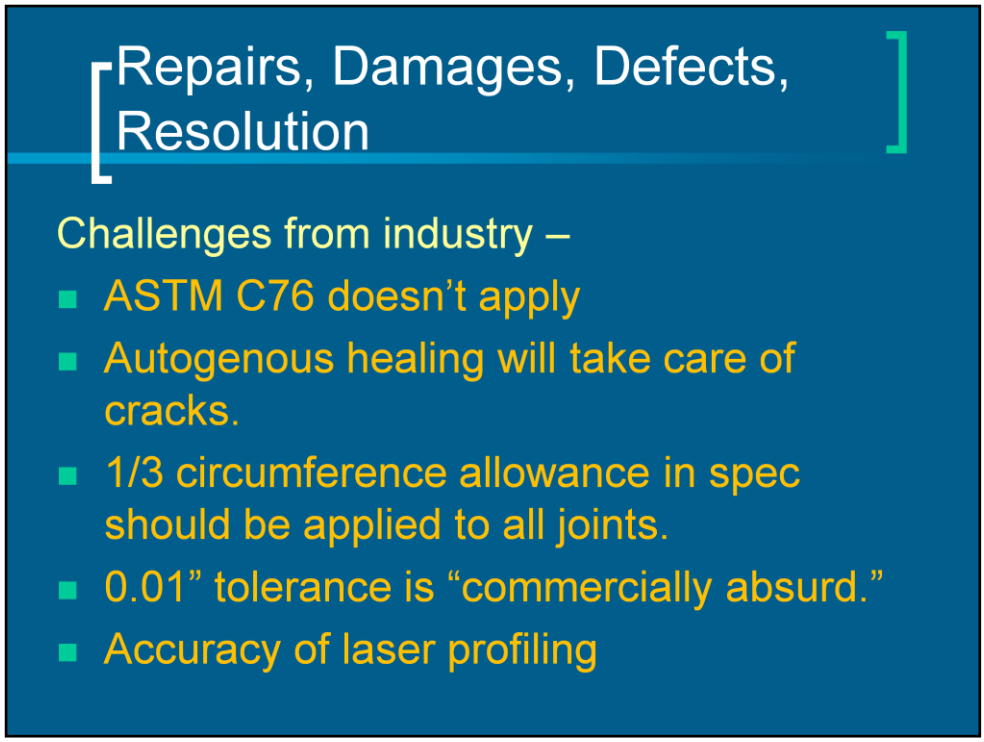
FDOT expectation here is that the Contractor will propose a sealing method for review and approval of the Department.

Repairs, Damages, Defects, Resolution

AASHTO LRFD Bridge Construction Specifications, Section 27: Concrete Culverts, further states,

"Generally, in non-corrosive environments, cracks 0.10 in. (2.5 mm) or less in width are considered acceptable; in corrosive environments, cracks 0.01 in. (0.25 mm) or less in width are considered acceptable without repair."

Environmental conditions must be considered when evaluating the performance of pipe with cracks.



ASTM C76 - argument from industry is that this is a manufacturing and purchasing spec and does not apply to installed pipe. The ASTM states, "NOTE 1—This specification is a manufacturing and purchase specification only, and does not include requirements for bedding, backfill, or the relationship between field load condition and the strength classification of pipe." FDOT spec 449 states, "**449-4.6 Rejection of Concrete Pipe:** Specific causes for rejection of concrete pipe, in addition to any failure to meet the general requirements specified in the Contract Documents, are as follows:

(a) Failure to meet the requirements listed in ASTM C 76 for permissible variations in dimensions with the modifications outlined in 449-4.1 and 449-4.2.

(b) Occurrence of defects listed in ASTM C 76. "

Rather than restate the crack criteria in the FDOT specifications, it has chosen to use the ASTM by reference as modified within its specs.

Autogenous Healing – industry argues that cracks in pipes will heal themselves by virtue of autogenous healing. This is the formation of calcium carbonate crystals that can seal a crack in concrete. Environmental conditions need to be conducive for this "healing" to occur.

"Autogenous healing depends on the crack width, leakage velocity and concrete mix. Wider cracks will take much longer (up to forever beyond about 0.3mm) to heal, excessive leakage velocity will prevent healing, some mixes tend not to heal (lacking unhydrated cement)." Dave Minter, Structural Engineer

1/3 circumferential tolerance in 430 specification – Section 430-7.2 states, "Where minor imperfections in the manufacture of the pipe create an apparent gap in excess of the tabulated gap, the Engineer will accept the joint provided that the imperfection does not exceed 1/3 the circumference of the pipe, and the rubber gasket is 1/4 inch or more past the pipe joint entrance taper. Where concrete pipes are outside of these tolerances, replace them at no expense to the Department." Industry argues that pursuant to ASTM C76, that the permissible variations of the manufacture of the pipe would lead to exceeding the joint gap tolerances in the spec. From ASTM C76, it states, "12.3 *Length of Two Opposite Sides—Variations in the laying* length of two opposite sides of the pipe shall not be more than 1⁄4 in. for all sizes through 24-in. internal diameter, and not more than 1⁄8 in./ft for all sizes larger with a maximum of 5⁄8 in. in any length of pipe through 84-in. internal diameter,…."

0.01" tolerance is "commerically absurd" – again basis for this argument is ASTM C76 being a manufacturing and purchasing spec.

Accuracy of laser profiling – industry has made some comments challenging the accuracy of the results provided by laser profiler operators – challenges have been that the operator did not have camera positioned correctly, was not skilled, did not indicate on video how/when operator calibrated laser, etc.

Repairs, Damages, Defects, Resolution

"The appearance of a crack, or crack(s) in an installed pipe can reasonably be assumed to be due to trench, site handling or from loading during the backfilling process."

Concrete Pipe Insights – Sherman Dixie

Repairs, Damages, Defects, Resolution

"Severe cracking, over 0.02-inch (0.508mm), or slabbing of the concrete cover over the reinforcing should be investigated as to cause. Poor bedding under the pipe, under-designed pipe (wrong strength), excessive loading from construction equipment are some causes of pipe overstressing. Once a cause is determined, a decision as to repair or replacement can be made."

Concrete Pipe Insights – Sherman Dixie

Repairs, Damages, Defects, Resolution

Photograph shows Spiral Ribbed Aluminized Steel Pipe with manufacturing defect that led to premature corrosion.

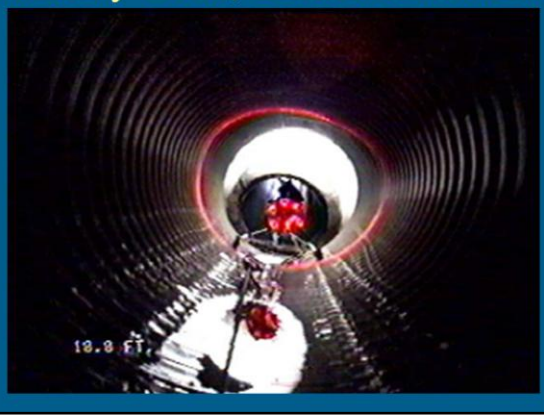
Fix was remove and replace.

Repairs, Damages, Defects, Resolution

Shown in this photograph is a Steel Reinforced Concrete pipe with 0.04 inch cracking in the walls. These were either undetected defects from manufacturing or damages during installation.

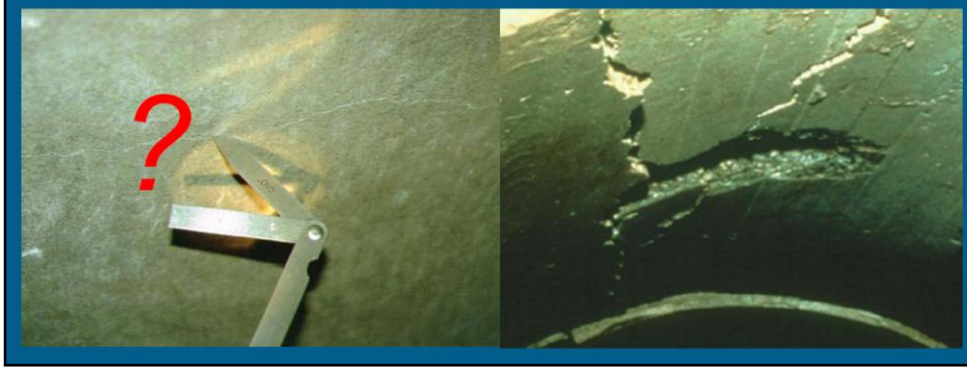
Repairs, Damages, Defects, Resolution

Laser showing severe crown deflection approximately 11%, settlement near drop inlet.



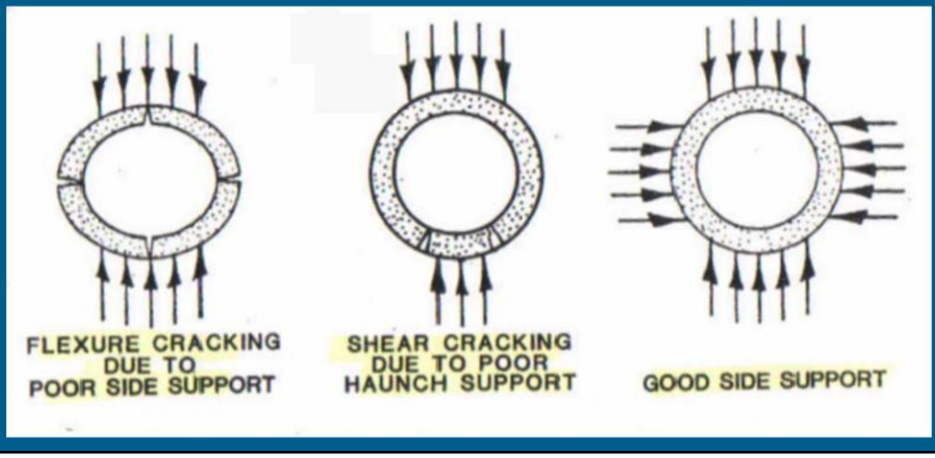
Repairs, Damages, Defects, Resolution

Examples of cracking and fractures in Steel Reinforced Concrete Pipe.



Repairs, Damages, Defects, Resolution

Illustrations of possible causes of damage

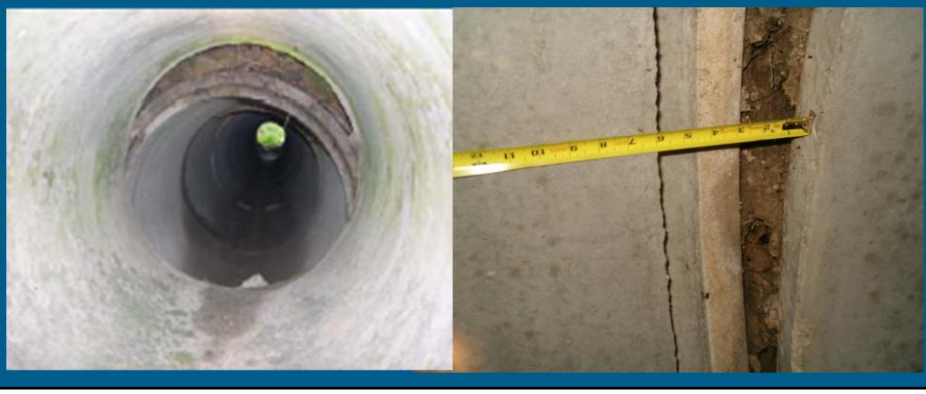


Repairs, Damages, Defects, Resolution

If this is what is found during post installation inspection, there are serious problems

Repairs, Damages, Defects, Resolution

Examples of joint separation in Steel Reinforced Concrete Pipe



Repairs, Damages, Defects, Resolution

Shown is Steel Reinforced Concrete pipe with break at spigot end. This particular pipe end was cut off and a structure placed at this location.

Repairs, Damages, Defects, Resolution

More metal pipe with guardrail post damage. Pipe was removed and replaced.

Repairs, Damages, Defects, Resolution

Misaligned joint in Fiber Reinforced Concrete pipe.

Repairs, Damages, Defects, Resolution

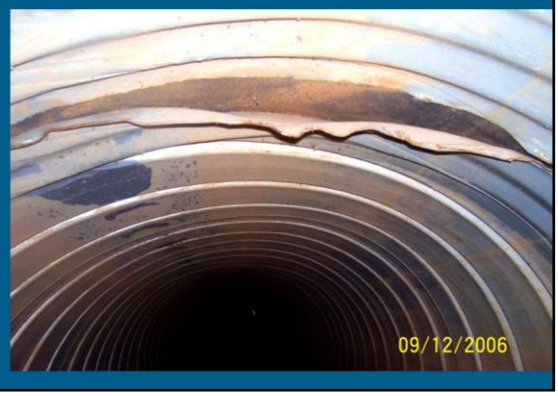
Circumferential cracking of Fiber Reinforced Concrete pipe.

Repairs, Damages, Defects, Resolution

Impact damage to Fiber Reinforced Concrete pipe.

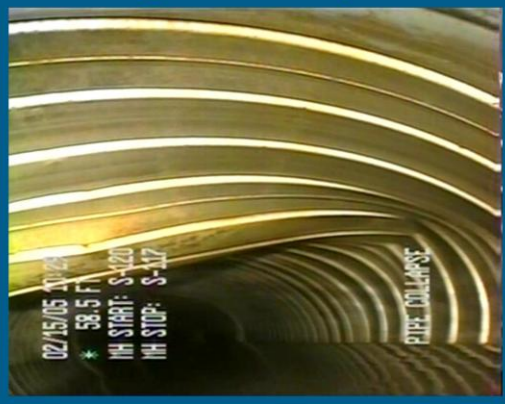
Repairs, Damages, Defects, Resolution

Tear in metal pipe joint that can lead to soil intrusion and potential damage to roadway above.



Repairs, Damages, Defects, Resolution

Metal pipe with significant damage on the verge of collapse. Risks to roadway above if pipe collapses.



Repairs, Damages, Defects, Resolution

Metal pipe with impingement.

Appears that pipe was laid over rock or other unyielding protrusion.

Repairs, Damages, Defects, Resolution

Pipe on left has bend that has damaged galvanizing and led to corrosion. Right picture has damaged joint with corrosion.

Repairs, Damages, Defects, Resolution

Poorly constructed joint in metal pipe that has led to soil intrusion. Risk of soil intrusion is settlement of roadway above, conveyance of contaminated water if it is present.

Repairs, Damages, Defects, Resolution

Because all pipe types have the risk of damage during installation, FDOT encourages pipe producers to take a “Parental Involvement” with the purchasers and installers of their products. After all, the reputations of their products is at stake.

Repairs, Damages, Defects, Resolution

FDOT is encouraging the construction contracting industry to video inspect the pipe it installs earlier during the project rather than waiting until the specified timeframe. This would allow repairs, if any, to be addressed before too much else is constructed above the pipe.

We are also considering specification revisions that would require earlier video inspection with possibility of reduced final videoing prior to Friction Course.

Repairs, Damages, Defects, Resolution

FDOT is working with Industry via a Pipe Installation Task Group to develop a guide or handbook to address common deficiencies, damages, or defects and how to resolve them. All of the pipe types allowed by FDOT are represented on the Team.

Repairs, Damages, Defects, Resolution

For the time being, when confronted with pipe that is not according to specification – from cracks, joint gaps, leaks, spalls, buckling, fractures, whatever damage or defect – the Project Engineer or Project Administrator needs to contact State Construction Office for resolution.

FDOT Drainage Installation

Special Thanks for Photographs to:

Donnie Autry: D1

Don Rauch: D2

Brian Pickard & Lori Palumbo: D7

Tony Manos: RS&HCS

Paul Harkins: Hardie Pipe


Now which way out of here?
09/12/2006