4300408 – PIPE CULVERTS
COMMENTS FROM INDUSTRY REVIEW

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David OHagan
414-4283

Comments:

3.1 Why are we still not allowing fiber reinforced pipe under interstates (shouldn't we say "limited access" like we do everywhere else?), yet we apparently will allow unreinforced pipe in these locations? Seems to me the fiber reinforced pipes would be at least as good in this application or is this just an oversight and we should not allow unreinforced pipes in these locations too?

Response:

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Rodney G. Powers (Retiring 08/01/08)
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Comments:
Sec. 4.8.1, second paragraph, next to last sentence: This sentence makes it appear that the specialty engineer has the final say as to disposition. Suggest the following revision, "…..analysis by a Specialty Engineer to assist the Department's Engineer in determining the disposition….."

Response:

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Bob Dion
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Comments:
Suggest you seperate the last paragraph of 430-8.2 into 2 paragraphs to add a paragrpah beginning with "As an excpetion ...." You are saying 2 things in the present paragraph, remove and replace, also as an exception... . Does the Contractor need the Engineers approval of the analysis or is the Engineer limited to approving the use of a Specialty Engineer?
Consider somrthing along this 'As an exception to removal and replacement, when approved by of the Engineer, obtain an engineering analysis by a Specialty Engineer to evaluate the impacts to the drainage system. The engineering analysis must be signed and sealed by a Professional Engineer licensed in the State of Florida. The Engineer will make the final disposition. No additional monetary compensation or time extension will be granted for the impact of any such analysis.' or will reference to 6-4 handle your concern?

Response:

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Pete Kelley
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Comments:
"This spec is calling for an initial and a final (25%) laser inspection of the pipe. This spec was bad and these changes only make it more oppressive. Do you think the FDOT realized how much this is costing them? It is not only the cost per foot of testing, it is the support work that goes with it. Each run has to be dewatered and this often means pumping down a pond, on the final inspection all of the pipe will have to be cleaned spotless or it will throw the laser off. Can we do anything about this?"

The way the spec is currently worded, it adds another layer of uncertainty to the bid process. The final inspection says that at least 25% of the pipe will be inspected after the pavement is completed, but could be more. How is a contractor to factor this into the cost of the project. In addition, the locations to be inspected after pavement is completed are at the discretion of the engineer. This could be pipe that is high and dry or part of a submerged system several hundred feet long that would require extensive dewatering of the system and retention pond to facilitate the inspection. The cost associated with this type of inspection could easily approach/exceed $5-10 per lf.

Response:

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Autry, Alan
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Comments:
430-4.8.1 Initial Pipe Inspection: Upon completion of placement of the pipe and 3 ft. of backfill above the pipe crown or the bottom of the stabilized subgrade, whichever is lower, dewater the pipe and provide the Engineer with videos and reports of the installed pipe prior to resuming backfilling operations. Videos and reports are to be reviewed by the Engineer prior to resuming pipe backfill. For pipe installed within MSE wall embankments, initial inspection is to be conducted when compacted embankment reaches 3 feet above the pipe crown. The submittal, review and resumption requirements stated above apply to pipe in MSE wall locations. The submittal, review and resumption requirements above will not be considered as a basis for granting additional time or as a VECP proposal.

Response:

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Duane Brautigam

Comments:

430-4.8.2 - The second paragraph could be rewritten with better active voice. The reference to "Section" should be clarified, since the Section is 430. The reference should probably be to a subarticle, perhaps, 430-4.8??Also, a Specialty Engineer is, by definition, a Florida P.E., so the last two sentences could be combined and simplified to say signed and sealed by a Specialty Engineer.

Response:

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Kim Spahn, P.E. (TX
American Concrete Pipe Association
www.concrete-pipe.org
(972) 506-7216

Comments:
Per the origination statement for the proposed Section 430 change, the American Concrete Pipe Association (ACPA) understands that the Department desires to detect installation issues at an early stage of construction. We concede that an initial, early inspection can detect random or isolated defects, damage, or errors that occurred during installation. However, time-dependent and design-related performance indicators (e.g., deformation, buckling, and yielding) will not become evident until the full earth load has consolidated above and around the pipe. These factors are global and affect the entire pipe system, not just a percentage of the system.
We believe the proposed specification change will not provide necessary assurance of the pipeline's long term performance. We fully support keeping the requirements as 100% inspected, no sooner than 30 days after final fill.

Past research and technical papers support this position.

Inspect No Sooner Than 30 Days Following Pipe Backfilling
Much like concrete reaches the majority of it's strength over 28 days, the soil-structure interaction of thermoplastic pipes, such as HDPE and ribbed PVC (RPVC) and the soil itself must also be given time to reach stability before long term strength and performance of the culvert can be determined. But, unlike concrete pipe which delivers the majority of the total structure to the site, flexible pipe must first be installed and allowed to deflect into the soil structure and reach stability over an initial period before design strength and performance can be evaluated.

To laser video a thermoplastic pipeline after only a short time with only three feet of fill would be similar to performing a compressive strength test on a concrete cylinder after a day or two while only applying a fraction of the design force. It is impossible to determine the how the product will perform in the future without the appropriate time and load. The ACPA believes that there will be little to no value in the proposed early-stage inspection of the total pipe system at only three feet of cover as there will have been little time for a flexible pipe to react to the earth loads and construction impacts.

Inspection of Thermoplastic Pipe

Various specifications and technical reports all recognize that deflection continues with time. The examples below clearly state that deflection should be measured no sooner than 30 days and it continues into the future.
AASHTO Section 30.5.6 outlines acceptable procedures for pipe inspection of flexible culverts: *Final internal inspections shall be conducted on all buried thermoplastic pipe installation to evaluate issues that may affect long term performance. Final inspections shall be conducted no sooner than 30 days after completion of installation and final fill.*

And in the commentary of the same section of AASHTO Section 30.5.6 for further clarification: *Soil consolidation continues with time after installation of the pipe. While 30 days will not encompass the time frame for complete consolidation of the soil surrounding the pipe, it is intended to give sufficient time to observe some of the effects that this consolidation will have. However, occasionally pavement is placed over the pipe sooner than 30 days. While the 30-day time limit should be maintained, a brief inspection of the pipe prior to paving over it, particularly for the first few joints, may be prudent to ensure that good construction practices are being applied.*

Amster Howard's Pipeline Installation, p. 14-10, 1996:
"Deflection of a non-pressure flexible pipe increases with time after construction is finished. Most of the increase occurs in the first three to six months after backfilling, and the deflection has essentially ceased at the end of three to six years."

ASTM D2321, X1.13:
Deflection Testing—To ensure specified deflection limits are not exceeded, the engineer may require deflection testing of the pipe using specified measuring devices. To allow for stabilization of the pipe soil system, deflection tests should be performed at least 30 days after installation.

Inspection of Reinforced Concrete Pipe
In our professional opinion, the majority of cracking issues in reinforced concrete pipe (RCP) result during installation. The most significant stresses on a concrete pipe occur during the stages of pipe laying and initial backfill.

Furthermore, the FDOT Section 125 backfilling specifications compel contractors to aggressively compact the RCP to proctor densities much greater than necessary for RCP haunch support. For example, Section 125 requires that RCP backfill compaction meet 100 percent density to an elevation 12 inches above the pipe crown. These parameters exceed ASTM, ASCE, and AASHTO installation specifications for RCP. These requirement might not only be costing taxpayers more money than necessary for the initial installation, but also causing unnecessary damage to the pipe.

Early-stage inspections of RCP installations would likely reveal the majority of any potential cracking or joint issues since these phenomena typically occur during laying and initial bedding. However, waiting until the final backfill is completed would allow for the full earth load and the potential to see the RCP perform at or near its design load.

AASHTO Section 27.6.1 regarding concrete culvert inspection:
Internal inspections shall be conducted on all buried rigid pipe installations to evaluate issues that may affect long-term performance, such as cracks, joint quality, and alignment. Inspections shall be conducted no sooner than 30 days after completion of installation and final fill.

Consider the Need for Laser Profiling On Rigid Pipe
Laser profiling is a technology that quantifies deformation and deflection, and it indicates whether the pipe-soil system was properly designed and constructed. As mentioned above, a specification should be written to ensure quality performance of any product without needless costs to the owner. Since reinforced concrete pipe is rigid and does not deflect significantly, it seems that requiring contractors to laser profile RCP is an unnecessary expense. Therefore, the ACPA requests that you look at whether the laser profiling component of the overall inspection of concrete pipe has shown any benefit to your agency.

It is assumed the CCTV inspection provides valuable information for both flexible and rigid culverts, but we encourage you to consider the differences in these products when specifying laser profiling in addition to conventional video and other precision measurements. From results we have seen, the laser profiling of RCP seems a needless costs to the agency, and therefore a needless cost to the public.

While the currently adopted Section 430 may not require final inspection several months after installation (when deflection should be stabilizing), it generally results in the final inspection at a point no sooner than 30 days after final backfilling. I fully support keeping the requirements as 100% inspected, no sooner than 30 days after final fill.
Thank you for the opportunity to express our concerns, and please feel free to contact us if you have any questions or concerns of your own.

Response:

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Ken Zinck
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Comments:
1. Based on the below section, I am confused as to the intent of the (or the bottom of the stabilized subgrade if lower) If you can explain this fine if not, it needs clarification. 2. The same below section requires review by the Engineer. It does not state a review time frame. I suggest a reasonable time frame. If no time frame is given, it could lead to interpretation. Eric Jaggers Comments: Section 430-4.8.1 I disagree with putting the burden on the Engineer for allowing the Contractor to resume with pipe backfill after reviewing initial inspection results. Shouldn't the Contractor be responsible for the quality of their product? For the Engineer to be reviewing the videos and reports prior to the Contractor resuming pipe backfill on every run of pipe, will be very excessive (especially on a big drainage project, it will be a full time job for someone). If anyone needs to be reviewing the videos prior to resuming, it should be the Contractor (without some kind of timeframe, the contractor will say we are delaying them). Is the Contractor comfortable with his product prior continuing construction of any certain pipe run? During the

initial inspections the Engineer should still receive all of the videos and reports but whether or not pipe backfill can resume, should be decided by the Contractor. The pipe should be right at Final Inspection, if its not right it should be on the Contractor to fix especially since he reviewed the videos and reports prior to resuming with pipe backfill initially. I think we should still review the videos and reports at Final Inspection, but I think the Contractor should be reviewing and determining whether or not they should resume after the initial inspection. Maybe it should be a QC responsibility to determine acceptability at the initial inspection. There must be an issue with the original spec, due to this revision. I don't see what was wrong with what we had. This new spec just leads to the possibility of the Contractor claiming delay depending on how long it takes to video the specific run of pipe then have the Engineer review and give the OK to continue with pipe backfill. The initial inspection should be a Contractor responsibility.

Response:

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Jerry Botts
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Comments:

After reviewing the proposed changes to the 430 specification I would make the following observations.

430-4.8.1 1. Actual recorded length and width measurements of all cracks within the pipe. Show calibration procedure on screen and recorded on the video Add: Record the video micrometer calibration and measurement procedure for each measurement taken. Evidence must be provided for each measurement that the camera lens and video micrometer is positioned perpendicular to the observation being measured.

8. Deviation in pipe line and grade, joint gaps, and joint misalignment. Provide in reporting graphical representation from structure to structure of the actual line and grade maintained during the installation. Add: Provide a table of punctual slope measurements for each pipeline section.

Paragraph 2 Laser profiling and measurement technology must be certified by an independent accredited laboratory recognized in the field of equipment calibration and measurement certification Add: utilizing a protocol that will demonstrate that the accuracy and the repeatability of the laser profiler will meet or exceed the calibration accuracy and repeatability requirements stated in the calibration procedure along the entire line section being tested. The manufacturer of the technology and the company performing the work Add: must also certify to be within compliance of the calibration criteria posted at: www.dot.state.fl.us/construction/contractorissues/laser.htm

Replace 430-4.8.4 with Laser Profiling Reporting: Provide a high quality DVD in MPEG2 format video with a standard resolution greater than 200 DPSI™ measured in a 10" pipe moving at a rate of one inch per second. Add: 403-4.8.5 Mandrels: etc………

Response:

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Douglas J. Holdener, P.E.
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Comments:

Allow Contractors to Perform Initial Inspection *at Their Discretion*
We agree with the Department's desire for initial inspections, however, we believe that the initial inspection should be performed at the contractor's discretion, not because it is mandated. We believe that the Department should require a single, final pipe inspection at the end of the project on 100 percent of the pipe system. If pipe is subsequently replaced, then that replacement pipe should also be completely inspected. Any initial inspections – such as with only limited backfill - may be performed by the contractor at his or her own discretion as part of their quality assurance.

Inspection Percentages are "Backwards"
Any initial inspections should be at the contractor's discretion. However, if the Department insists upon mandating both initial and final inspection phases, then the inspection percentages should be reversed. In other words, the initial inspection phase should be conducted on a smaller percentage, such as 25 percent including all cross drains. The final inspection phase should then be conducted on 100 percent of the pipe system at the end of the project.

The objective of the initial inspection should be to conduct a quality control check to verify that the Engineer's design is being met and that the installation process is sufficient. Pending the initial inspection review, then appropriate adjustments can be made to the design, selection of pipe material, or backfill procedures before proceeding. Since the Department is investing in the finished product, then the final, installed product should be 100 percent inspected.

Initial Inspection Timeframe Insufficient for Acceptance Determination
In our review of pipe installation and inspection resources, we find overwhelming evidence that supports inspecting the entire pipe system after all backfill has been placed for final acceptance. The Department's desire to inspect 100 percent of the system at only three feet of backfill will not allow sufficient duration for consolidation of the pipe-soil system

Please consider the following excerpts taken from flexible pipe design resources – which due to flexible pipe's time-dependent load responsiveness - that support the need to conduct a complete inspection at the end of the project "…deflection may increase with time because of consolidation of the embedment material and the in-situ soil caused by the horizontal earth pressure at the pipe's springline." (PE Pipe – Design and Installation, *AWWA Manual M55, First Edition*, American Water Works Association, 2006, Page 58) "The maximum load on the pipe does not occur until three to six months (or longer) after completion of backfilling." (Amster Howard, The Reclamation E' Table, 25 Years Later, Presented at PLASTICS PIPE XIII INTERNATIONAL CONFERENCE, Washington, D.C., October 2006.) "Spangler observed an increase in ring deflection with time. Settlement of the backfill and consolidation of the embedment under the lateral pressure from the pipe continue to occur after initial installation. To account for this, he recommended applying a lag factor to the Iowa Formula in the range of from 1.25 to 1.5. Lag occurs in installations of both plastic and metal pipes." (*Handbook of Polyethylene Pipe*, Chapter 6 Design of Polyethylene Piping Systems, http://plasticpipe.org/publications/pe_handbook.html, Page 213)
The "acceptance deflection" is the maximum vertical pipe deflection permitted following installation. Typically, measurements are made only after most of the initial soil consolidation occurs, usually at least 30 days after installation." (*Handbook of Polyethylene Pipe*, Chapter 7 Underground Installation of Polyethylene Piping, http://plasticpipe.org/publications/pe_handbook.html, Page 265)

Engineer/CEI will Not be in Responsible Charge of Final Acceptance
The Department proposes to curtail the final inspection to 25 percent or perhaps even less than 25 percent. The decision to reduce the inspection to 25 percent or even less is risky. In practice, we presume this might be exercised if - for example - 10 or 15 percent of the pipe system were to be inspected and determined acceptable, and the Engineer/CEI were to then reduce the percentage under the assumption that the remainder of the system will also be acceptable. Obviously, the Engineer/CEI risks making an incorrect assumption.

The Department also places the Engineer at risk in the statement, "locations are to be determined by the Engineer based on results of the initial pipe inspection." Underground utility installations can be impacted by many unknown factors, such as soil consolidation, compaction consistency, deleterious materials, equipment damage, material defects, and other factors. The Engineer/CEI will be encouraged, if not compelled, to ignore these unknown factors in order to conduct a reduced inspection (i.e., 25% or less).

We believe that these risks to the Engineer and CEIs can be mitigated, if not avoided, by requiring one final inspection of 100 percent of the storm pipe system.

Provide Guidance on Crack Width Measurements
We propose the following language in the section regarding crack width measurement: "For steel-reinforced concrete pipe, measure and record the width, length, and location of all cracks greater than 0.01 inch in width. For all other pipe materials, measure and record the width, length, and location of all cracks.

What is the Value of Laser Profiling Rigid Pipe?
Does the Department intend to continue requiring the laser profile inspection of rigid pipe? Rigid pipe, such as reinforced concrete pipe (RCP), does not appreciably deflect under common applications. Our experience with reviewing laser profile reports for RCP indicates "flat line" deflection/deformation measurements that indicate negligible deflection or deformation and seemingly offer little to no value to the Department.

Measurement of All Pipe Joint Gaps
It appears that the Department intends to continue requiring that pipe joint gaps are measured for all pipe types (e.g., RCP, CMP, PVC, and HDPE). Our review of the Departments specifications reveal that a joint gap tolerance exists only for RCP. No other pipe material has an FDOT-specified joint gap tolerance. To illustrate that joint gaps and joint dimensions are not inconsequential other pipe materials, consider a corrugated metal pipe, which has corrugation dimensional tolerances and specific coupler band dimensions. The coupler band must nestle inside of the metal pipe's annular corrugations for a proper seal. Since the dimensions of the pipe corrugations and the coupler band width are known, fixed dimensions, it seems that the acceptable joint gap should be readily determinable. Our conversations with contractors and CEIs suggests that joint gap measurements are not performed nor verified with pipe joint designs for pipe materials except for RCP.

Specialty Engineer Analysis Requirement
We have the following comments regarding the requirement that a "…Specialty Engineer to determine the disposition of the material. The engineering analysis must be signed and sealed by a Professional Engineer licensed in the State of Florida."

- What "specialty" (e.g., geotech) will be required? The Department does not specify a "pipe design" specialty. It appears that the Department specifies several concrete-related specialties; however, there are no storm pipe-related specialties.

- Storm pipe materials include concrete, steel-reinforced concrete, ribbed PVC (RPVC), HDPE, galvanized steel, aluminum spiral rib, aluminized steel, and fiber cement. How will engineering specialties address each material?

- Can the Specialty Engineer be an employee of a pipe manufacturer?

- The current specifications do not emphasize the structural design of the pipe-soil system on the "front end." It seems that the requirement of an engineering analysis after installation will be complicated without an initial design benchmark beyond Index 205.

Additional Comments on the Current Adopted Specification

Emphasize the need for dewatering - We repeatedly hear that FDOT storm pipe systems – primarily in southern Florida – are not inspected with video, laser profiling, or even mandrels because the pipes are either (a) submerged or (b) solid wall pipe systems adjacent to French drain systems. It seems that a significant, if not majority, portion of new storm pipes southern Districts are not inspected using the required technologies. If the pipe was too saturated to conduct a proper inspection, then it suggests that the pipe-soil system design, pipe buoyancy, and installation quality were likewise challenged by installation in wet or submerged conditions. We suggest further emphasizing the need to dewater all solid wall pipes.
Do not waive inspection of cross and side drains - The current specification waives inspection of cross drains that are short enough to inspect from each pipe end. Regardless of pipe length, it is not practical to inspect for flexible pipe deformation, for defects along the internal wall, or at joints by either lamping or un-aided visual inspection from the pipe end. Deflection cannot be detected at the 5 percent limit reliably without a laser profile inspection or mandrel. Likewise, cracks cannot be observed without the use of video equipment. Since cross drains and side drains are critical sections that lie beneath roadways, it seems reasonable to require full inspection of these pipe systems, too.

Closing
The current, adopted Section 430 requires a thorough inspection at the end of the project and allows for time-dependent factors to take effect. The proposed "initial inspection" change will inadvertently compel engineers, inspectors, and contractors to jeopardize long-term performance. However, long-term performance is precisely the Department's goal. Therefore, we urge the Department to reconsider the proposed initial inspection changes and to not overly-complicate an inspection process that is already working. If the Department decides to maintain the current practice of final inspection of 100 percent of the pipe system, then we request consideration of the other specification topics mentioned above, namely crack width measurements, the need for laser profiling rigid pipe, joint gap criteria, specialty engineer designations, emphasis on dewatering, inspection of cross drains and side drains.

Response:

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Douglas J. Holdener, P.E.
Florida Concrete Pipe Institute
407-895-9333

Comments:
The Florida Concrete Pipe Institute (FCPI) appreciates the opportunity to review the proposed Section 430 modifications. The FCPI members support the currently adopted requirement of inspecting the total storm pipe system at the near completion (prior to final friction course) of the roadway project. The FCPI believes that the Florida Department of Transportation (FDOT) should focus on the quality of the finished product, which, in this case, is the fully backfilled and consolidated pipe system. Additionally, we request that the Department be cognizant of any apparent proprietary laser profiling inspection equipment terminology and certification requirement methodology.

Is It Necessary To *Mandate* Initial Inspection?
We are aware of contractors conducting initial inspections of storm pipe at their own discretion and without the imposition of a specification mandate. In these instances, the contractor typically

inspects a percentage of the pipe system. For example, the contractor may initially inspect the cross drains, pipe laid in sections with a higher baseline water elevation, or the pipe located in high construction traffic zones. The benefit of this selfimposed inspection at select areas is feedback on installation means and methods and "insurance" in the event of future construction damage by others. We have identified a growing list of pipe contractors that have purchased and are using their own inspection equipment for these purposes. According to our discussions with pipe utility contractors, we believe that self-imposed initial inspections are becoming common practice.

We request that the Department simply allow initial pipe inspections of select areas to evolve naturally as part of contractors' own quality assurance practices. We also request that FDOT continue to enforce its currently adopted requirement to inspect the total storm pipe system at the near completion of the roadway project.

Potential For Disparity In Flexible Pipe Vs. **Rigid Pipe Inspections.**
Consider an installation of HDPE pipe, corrugated metal pipe, or ribbed PVC pipe with only three feet of backfill. At this point of installation, there is insufficient loading on the flexible pipe to substantiate an Engineer's assessment long-term performance or pipe-soil design. The only justifiable assessment at that time would be a cursory evaluation of isolated construction damage.

At the point of final inspection, the Department proposes to inspect only 25 percent of the storm pipe system. It seems counter-intuitive to inspect only a small percentage of the system at a point at which the entire flexible pipe system is beginning to experience its greatest potential stress. At the point of final inspection, flexible pipe systems will have experienced consolidation of the soil structure, and time-dependent failure modes such as deflection and buckling will have potentially occurred. However, the Department's proposal to inspect only 25 percent of the system will have reduced the odds of identifying these failure modes in the entire system.

Furthermore, the propensity at the point of final inspection will be to focus on repair versus replacement. The cost of replacing a deformed or buckled flexible pipe under a partially paved roadway will far exceed the cost of repairing that same pipe. At the point of greatest vulnerability in a roadway system comprised of flexible pipe at final backfill, the Department's proposal will result in patched, mended, grouted, lined, and otherwise repaired flexible pipes. Alternately, consider a rigid pipe installation, such as reinforced concrete pipe (RCP). Please note that it is unlikely to have structurally significant cracking issues in a RCP storm pipe system. However, in those cases where cracks occur, the majority of the cracking - whether hairline cracks or other - occurs during pipe laying and initial backfill. If rigid pipe were to be inspected at the proposed stage of three feet of backfill, then most, if not all, of any potential rigid pipe issues - significant or insignificant - will have already occurred.

At the point of initial inspection, a propensity will exist to error on the side of extreme caution because - at that point of limited backfill - the cost to replace pipe is considered minimally consequential. The result could be needless replacement of rigid pipe. At the point of the fmal inspection, rigid pipe structural performance is less time dependent. The initial inspection phase should, therefore, provide sufficient and reasonable representation of its long term performance. Proposal Reduces Risk of Using Flexible Pipe, Increases Risk of Using Rigid Pipe.

The proposed Section 430 modification will reduce the contractor's perceived risk of using flexible pipe and will increase the perceived risk of using rigid pipe. Because of the propensity to repair described above, contractors will assume the risk of using flexible pipe because they will expect the propensity for repairing a deflected or otherwise defective installation after final inspection to prevail. To the contrary, because of the propensity to replace during the initial inspection, the use of rigid pipe will be perceived as a higher risk due to the potential added costs of needless replacements. Engineer Lacks Critical Information with Proposed Modification.

The proposal to inspect 100 percent of the storm pipe system at three feet of backfill has only limited benefit. Early inspection offers useful information to the contractors on their performance. However, early inspection provides little to no useful information to the Engineer with regards to long-term pipe performance and proof of design of a flexible pipe. Further, an Engineer's assessment based on the final inspection will be limited since only 25 percent of the system is proposed to be inspected. "In shallow installations, the full value of the E' given in Table 2-7 may not develop. This is due to the lack of "soil confining pressure" to hold individual soil grains tightly together and stiffen the embedment. Increased weight or equivalently, depth, increases the confining pressure and, thus, the E'." *(Handbook of Polyethylene Pipe*, Chapter 6 Design of Polyethylene Piping Systems, http://plasticpipe.org/publications/pe handbook.html, page 210) "The maximum load on the pipe does not occur until three to six months (or longer) after completion of backfilling." (Amster Howard, *The Reclamation E' Table*, 25 *Years Later*, Presented at PLASTICS PIPE XIII INTERNATIONAL CONFERENCE, Washington, D.C., October 2006). "Internal inspections shall be conducted on all buried rigid pipe installations to evaluate issues that may affect long-term performance, such as cracks, joint quality, and alignment. Inspections shall be conducted no sooner than 30 days after completion installation and final fill." (AASHTO LRFD Bridge Design Specifications, Section 27.6.1, 2006)

Avoid Proprietary Inspection Technology Terminology

We are concerned that the proposed requirements on inspection technologies could be construed as proprietary and thus unintentionally restrictive on current, successful camera and profile products. We are not experts in inspection technology, but we -like the Department - desire reliable and accurate data. Our understanding of the various inspection products used in Florida causes some concern about potentially proprietary terms referenced in the proposed specification, such as "continuous laser ring," calibration terminology, and certification terminology. We request that the Department thoroughly vet these and possibly other seemingly proprietary inspection terms.

Summary

It is not necessary to mandate initial inspection when it appears that the construction industry is naturally evolving this self-imposed practice. The proposed two-part inspection process will create a disparity in the inspection assessment of rigid pipe versus flexible pipe. An initial pipe inspection would be beneficial only in the case ofRCP installations, whereas flexible pipe should be completely inspected at the fmal inspection.

The Department's proposal to inspect 100 percent of all pipes at the initial phase yet inspect only 25 percent or less of all pipes at the final phase is counter-intuitive and lacks engineering justification. The early inspection provides little to no useful information to the Engineer with regards to long-term pipe performance and proof of design of a flexible pipe. Further, the Engineer's assessment based on the final inspection will be incomplete since only 25 percent of the system or less is proposed to be inspected. There will be a great propensity to replace pipe - perhaps needlessly - during the initial phase inspections. However, there will alternatively be a great propensity to simply repair - instead of replace - pipe during the final phase inspections. We are, therefore, pipe concerned that the proposed inspection process will increase the perceived risk of using RCP while reducing the perceived risk of using flexible pipe.

Conclusion

We share the Department's desire for long-term performance and the ability to detect and adjust issues during the initial construction stages. We request that (1) the Department maintain its currently adopted practice of inspecting 100 percent of the storm pipe system at the near-completion of the roadway project and (2) promote - as opposed to mandate - initial inspection of a percentage of the pipe system or of select areas.

The FCPI values the opportunity to share our professional opinions and coordinate with the FDOT on this proposed specification change, as well as on all other issues.

Response:

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Comments:

430-4.8.1 Initial Pipe Inspection: Upon completion of placement of the pipe and 3 ft. of backfill above the pipe crown (or the bottom of the stabilized subgrade if lower), but prior to continued placement of backfill or embankment or placement of stabilized subgrade or base, dewater and pressure clean installed pipe and provide the Engineer with pipe videos and reports of the installed pipe. Submitted videos and reports are to be reviewed by the Engineer prior to resuming pipe backfill or embankment placement or placement of subgrade or base. For pipe installed within MSE wall embankments, initial inspection is to be conducted when compacted embankment reaches 3 feet above the pipe crown. The submittal, review and resumption requirements stated above also apply for pipe in MSE wall locations.

The line should be dewatered and pressure cleaned prior to recording cracks or defects to assure full defect recognition and measurement accuracy when performing the CCTV and laser profiling inspection.

For pipe 48 inches or less in diameter, provide the Engineer a video DVD and report using low barrel distortion video equipment with laser profile technology with continuous laser ring, non-contact video micrometer and associated software that provides:

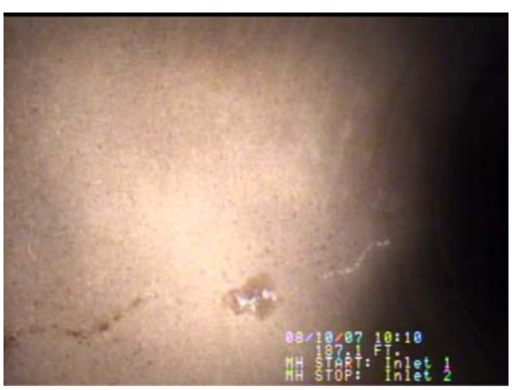
1. Actual recorded length and width measurements of all cracks within the pipe. Show calibration procedure on screen and recorded on the video for each measurement recorded. Evidence must be provided for each measurement that the camera lens and video micrometer is positioned perpendicular to the observation being measured. We believe this is too general a statement with regard to crack measurement. Our survey experience has found that many new concrete pipes have a multitude of “spider” and other insignificant cracks. Published studies by the concrete pipe industry and universities, both nationally and internationally have stated that

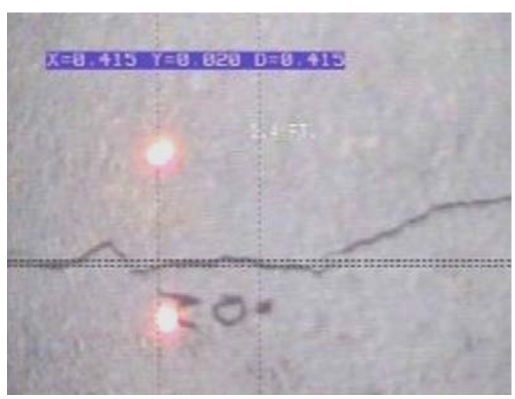
such cracks have no impact on the service life of the pipe. There appears to be some agreement that a crack that is less than 0.019 inches does not affect the durability of a concrete pipe. We believe the following measurement requirement would be more appropriate, when considering the underground pipe environment, the capability of present pipeline CCTV inspection hardware (Camera Resolution) and the cost to the contractor and State of Florida to perform the required inspection.

We would propose the following: “Actually record length and width of all significant cracks that exceed 0.02 “or greater in diameter or exhibit moisture, staining or other potential failure modes.”

The requirement for the proof of perpendicular camera imager position would require replacement of all current pipe inspection cameras and be very expensive as no pipeline inspection camera presently offers this capability. This also may not be technically possible, with any high level of assurance or justify the additional inspection costs, do to the underground pipe environment. The pipe would need to be totally clean with no silt, debris or flow. The camera would always have to be positioned on the horizontal and vertical centerline of the pipe. Today’s pipeline inspection cameras use precision aligned laser dots or lines projected onto the pipe wall within the area to be measured. These calibration references allow for the calibration of the Video Micrometer measurement cursers to account for the varying distance position of the camera from the C/L of the pipe. The camera is seldom on the C/L of the pipe due to silt, debris and other materials remaining within the pipe.

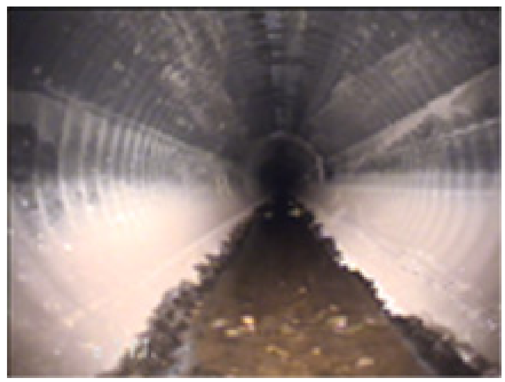
SPIDER CRACKS **INSIGNIFICANT CRACKS**



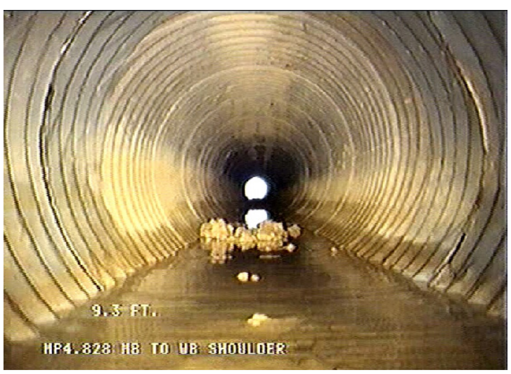


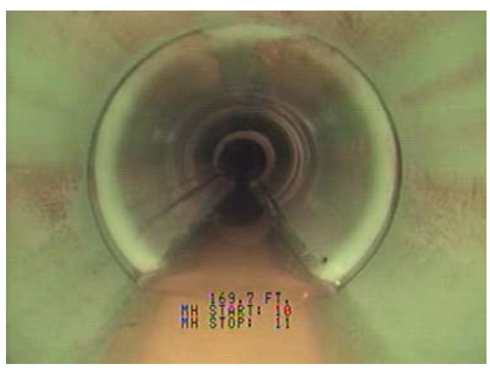
SIGNIFICANT CRACK CALIBRATION DOTS

2. Actual recorded separation measurement of all pipe joints gaps. Record in the video and report the locations along the pipe joint four measurement locations separated by 90° beginning at the widest observed joint gap location on the pipe section. If the widest gap is at 3 – 9 or 12 o'clock it may be impossible to measure at the 6 o'clock position due to silt, flow or debris in the joint. We recommend the following "All joints shall be measured at their widest visible separation. If the joint gap exceeds the pipe manufactures specification it shall then be measured at three additional locations approximately 90^0 apart. The inspection report shall record all joints that exceed manufacturers specification with video still frames of all bad or damaged seals and/or external infiltration including their distance location within the pipe".



BAD SEAL WITH INFILTRATION TYPICAL DRAIN LINE ENVIRONMENT





TYPICAL DRAIN LINE ENVIRONMENT

3. Pipe ovality report.

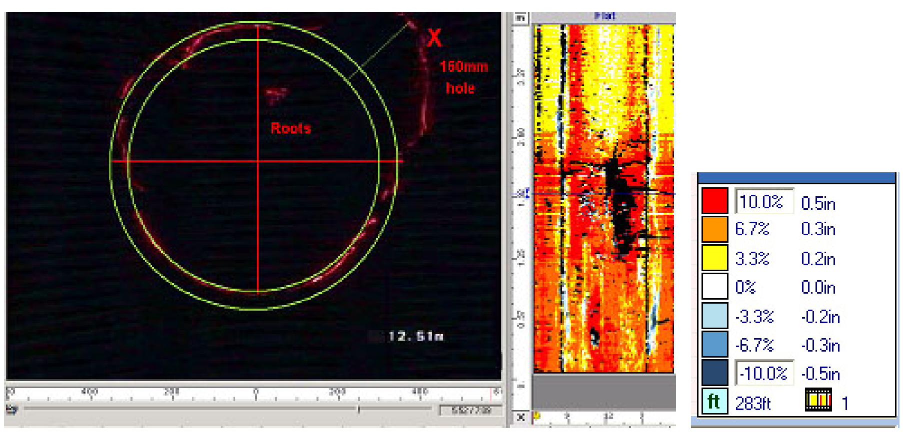
There are a number of formulas that have been used by the pipe industry to calculate ovality. For uniformity and accuracy of reporting, the formula (or formulas) should be included in the specification. The flexible pipe industry divides the horizontal axis by the vertical axis to establish percentage of deformation. This does not work when a pipe has a size change within a line. The ovality formula, recognized by the majority of pipe authorities, is the ovality formula as specified in ASTM 1216. This formula provides an accurate ovality percentage regardless of the diameter of the pipe from entry to exit, and regardless of pipe type, or internal size change. The ASTM 1216 ovality formula is the most accepted and universally used standard throughout the world.

The ovality forulas to be used should be specified and the hardware and software then independently tested to an approved standard.

We suggest he following statement " Ovality measurement and graphical reports shall be calculated using the q-factor formula as specified in ASTM 1216, paragraph X1.2.1 or approved equal"

4. Deflection measurements and graphical diameter analysis report in Terms of x and y-axis. Identify location within the run of pipe for each measurement recorded.

5. Flat analysis report. Identify in this report as an asset-to-asset listing of the location and type of observation recorded. We believe the full value of this report is when it is displayed in an adjustable color-coded report that highlights pipe problems or lack of problems in a clear color-coded flat graphical display. "We suggest the following " The flat analysis report shall include the capability to adjust the color encoding and graphical display through the selection of color by percentage. The report shall coordinate the pipe location position with the graphics color display".



FLAT DISPLAY WITH ADJUSTABLE COLOR BY PERCENTAGE

6. Record the actual diameter of the pipe along the entire pipeline being measured. We suggest the following addition "The report shall coordinate the surveyed distance position with the corisponding pipe diameter."

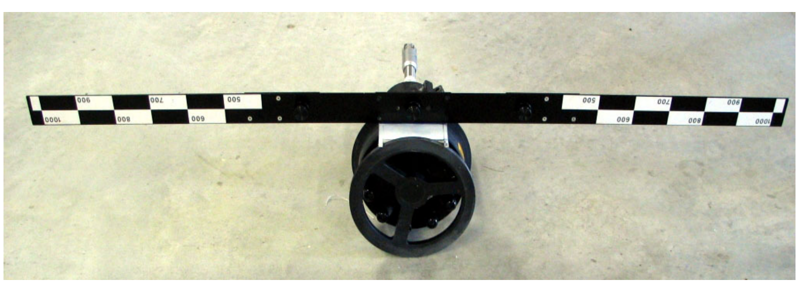
7. Pipe deformation measurements, leaks, debris, or other damage or defects. Identify and record the observation details of the damage or defect such that the Engineer can determine from the report and video any needed further actions.

8. Deviation in pipe line and grade. Provide in the reporting a graphical representation from structure to structure of the actual line and grade maintained during installation. We believe this needs further clarification. There are many instruments from pipe laying lasers, to special 3 axis geophysical units, surveying equipment and inclinometers built into CCTV cameras available to measure line grade. The cost of the inspection instrumentation, time to inspect and the resulting cost of inspection will depend on the accuracy required by the specification. The

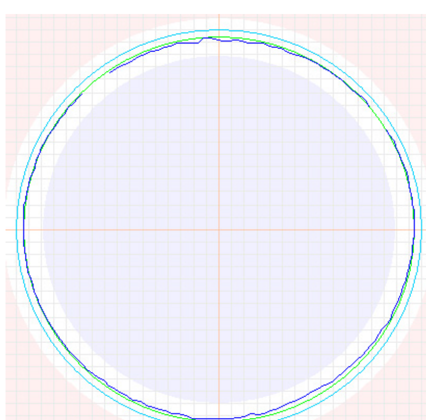
most inexpensive instrument would be an inclinometer built into a CCTV inspection camera system. Today CCTV inspection camera’s inclination system accuracy is usually specified as +/- 0.2^0 and range of +/- 5^0.

9. Record in the video the actual speed at which the camera is traveling ensuring that the rate of travel does not exceed that limit defined in 430-4.8.3 below. The aforementioned report may be submitted in electronic media if approved by the Engineer. This requirement, if it requires the transporter speed be shown within the video image, potentially violates a single manufactures patent. We recommend that the recording of the distance and time be inserted into the video image and recorded. From this data, speed can easily be calculated or verified. This technique is not patent. Laser profiling and measurement technology must be certified by an independent accredited laboratory recognized in the field of equipment calibration and measurement certification, the manufacturer of the technology and the company performing the work to be in compliance with the calibration criteria posted at: www.dot.state.fl.us/construction/contractorissues/laser.htm . These certifications must be provided to the Engineer prior to performing any laser profiling of pipe. If the specification requires certification by an independent party then a test procedure should be issued by the FDOT thereby requiring all certified equipment to be tested and certified to the same specification and under the same conditions. A certification test can be conduct in a laboratory under controlled conditions. That does not mean that it can perform to the certified accuracy in an underground pipe inspection environment. Presently an internationally recognized specification, for light ring technology in underground pipes, is that as published by the WRc of the UK. The WRc specification “WRc Specification for Lightring Technology” takes into account the limitations imposed by the underground pipe environment.

A major reason to have verification of calibration of each surveyed line is in a situation where legal action or large construction replacement expense may be involved. We believe the court will demand proof of calibration “**at the time of that inspection**”. We do not believe an annual only certification, by an independent laboratory, will satisfy the Courts. We would recommend that a calibration calibrator be recorded and verified on each inspection video recording and profiling report.

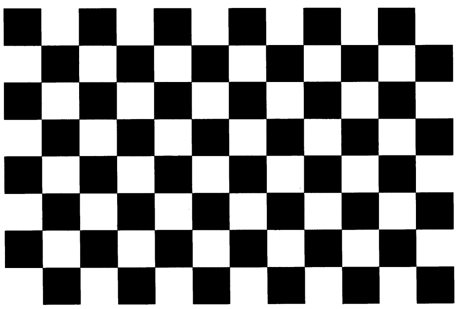


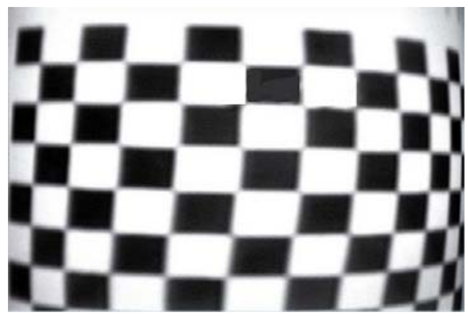
Calibrator Recorded On Each Inspection Video



Software Report Verification On Each Report

Another form, of potentially required software calibration, is called barrel distortion correction. All CCTV cameras have some barrel distortion. This needs to be corrected, in the prcessing software, if the data will be submitted to a court of law. We recommend that the specification state “The software processing shall include barrel distortion correction of the camera as used for the inspection, and fully state in the inspection report that barrel correction has been applied.





BARREL DISTORTION TEST CHART **CAMERA BARREL DISTORTION**

For video recorded, laser profiled pipe that indicates deflection that appears to be In excess of that allowed by Specification, the Engineer might require further testing of the pipe. If directed by the Engineer, test pipe using a mandrel. The mandrel shall be pulled by hand and be approved by the Engineer prior to use. If use of a mandrel is selected as the means of further Testing, the mandrel’s diameter, length, and other requirements shall conform to 430-4.8.2. Remove, replace, and retest pipe failing to meet the specific deflection requirements for the type Of pipe installed, at no cost to the Department. Should the deflection test prove that the pipe met? Specifications, the Department will bear the cost of the deflection testing.

The Engineer may waive this requirement for side drains and cross drains which Are short enough to inspect from each end of the pipe.

430-4.8.2 Final Pipe Inspection: Based on the Contract pavement type, upon Completion of concrete pavement or the placement of structural asphalt, but prior to placement Of asphalt friction course, dewater installed pipe and conduct pipe inspection as defined in 430-4.8.1 for 25% of the initial inspection locations. Locations are to be determined by the Engineer based on results of the initial pipe inspection. The Engineer and can may be reduced the final inspection locations to a lesser percentage provided initial results of the final pipe inspection indicated installed pipe meets specification indicate the installed pipe meets the requirements of this

Section and final pipe inspection confirms initial pipe inspection results. Should final pipe inspections find damages or defects not noted in the initial inspections, 100% of the pipe will be re-inspected as defined in 430-4.8.1 at the contractor's expense. Pipes not meeting specification the requirement of this Section are to be removed and replaced at the contractor's expense. As an exception to removal and replacement and upon approval of the Engineer, obtain an engineering analysis by a Specialty Engineer (as approved by the Engineer) to determine the disposition of the material. The engineering analysis must be signed and sealed by a Professional Engineer licensed in the State of Florida.

430-4.8.13 Video Report: Provide a high quality DVD in a MPEG2 format video with a standard resolution of 720 x 480. Use a camera with lighting suitable to allow a clear picture of the entire periphery of the pipe. Center the camera in the pipe both vertically and horizontally and be able to pan and tilt to a 90 degree angle with the axis of the pipe and rotating 360 degrees. Use equipment to move the camera through the pipe that will not obstruct the camera's view or interfere with proper documentation of the pipe's condition. The video image shall be clear, focused, and relatively free from roll, static, or other image distortion qualities that would prevent the reviewer from evaluating the condition of the pipe. The video will include identification before each section of pipe filmed. The identification will include the project number, the structure number corresponding to the structure number on the set of plans for the project, size of pipe, the date and time, and indicate which pipe is being filmed if multiple pipes are connected to the structure. Notes should be taken during the video recording process. Provide the Engineer with copies of these notes along with the video.

Move the camera through the pipe at a speed not greater than 30 feet per minute. Mark the video with the distance down the pipe. The distance shall have an accuracy of one foot per 100 feet. Film the entire circumference at each joint. Stop the camera and pan when necessary to document and measure defects.

430-4.8.24 Mandrels: Use mandrels, which are rigid, nonadjustable, odd-numbered, legged (minimum 9 legs) having a length not less than its nominal diameter. The diameter at any point shall not be less than the allowed percent deflection of the certified actual mean diameter of the pipe being tested. The mandrel shall be fabricated of metal, fitted with pulling rings at each end, stamped or engraved on some segment other than a runner with the nominal pipe size and mandrel outside diameter.

LASER PROFILING, JOINT AND CRACK MEASUREMENT (PRELIMINARY)

For maximum data and measurement accuracy it is important that the recorded laser profile, joint and crack measurement survey be done according to the following procedure:

A. CLEAN LINE

The profile survey is a measurement of the internal pipe surfaces. If there is a lot of debris, obstructions, water, etc. then the measurement accuracy can be affected. The pipeline should be reasonably clean of debris prior to inspection and survey. No present laser profiling system can look below the flow or through debris, silt, tow bar, chain etc to get an actual measurement. The measurement system must assume that the diameter of the pipe, were hidden, is twice the opposing radiuses.

B. WATER LEVEL
Standing or flow level should not exceed 10% in 6" through 24" and 5% in lines over 24"

C. PLACE CCTV CAMERA, (470 LINE MINIMUM HORIZONTAL RESOLUTION) WITH DUAL PARALLEL LASER CALIBRATION SPOT BEAMS & CAMERA TRANSPORTER INTO THE PIPELINE

D. POSITON CAMERA AS CLOSE TO THE CENTERLINE, OF THE PIPE, AS POSSIBLE

E. TURN ON CCTV SYSTEM AND INSERT THE FOLLOWING SURVEY DATA

1. Asset Number
2. Project ID
3. Date
4. Survey Direction (Upstream or Downstream)
5. Upstream & Downstream Manhole Numbers
6. Pipe Internal Size
7. Pipe External Size
8. Pipe Material
9. Pipe Shape
10. CCTV Camera Manufacturer and Model Number

F. RECORD 30 SECONDS OF THE SURVEY DATA (ABOVE) ON CD or DVD

1. **<u>PAUSE</u>** recorder

G. VIDEO INSPECT AND **<u>RECORD</u>** THE PIPELINE FROM ENTRY TO EXIT

1. Set cable distance to "0" or "preset" distance
2. Set Camera lighting to proper intensity
3. Center the camera head
4. Start CD/DVD Recording
5. Move down the line at approximately, but not more than 30' per minute
6. Note and record each visible defect or problem with description, its clock position and survey distance.

I. AT EACH PIPE JOINT (Procedure not defined in FL.DOT specification 2007)

1 Pause and Pan Camera 90^0
2 Rotate the Camera head to the 4 o'clock pipe position
3 Set the Digital Micrometer cursers on the center of each calibration laser dot. <u>Micrometer should have a minimum accuracy of 1/1250</u>
4 Calibrate the micrometer to the laser dots calibrated separation distance
5 Move the coursers to each side of the joint
6 Note and hard copy record the joint measurement
7 Note and hard copy record the cable distance joint position

8. Rotate the camera to 12 o'clock
9. Repeat steps 4,5, 6, 7
10. Rotate the camera to 8 o'clock
11. Repeat steps 4,5, 6, 7

J. AT EACH PIPE CRACK _ (Procedure not defined in FL. DOT specification 2007)

1. Pause Camera at the start of each crack
2. Pan the camera head $90^{0,}$.
3. Note cable distance at start of crack
4. Rotate the camera head so it is horizontally perpendicular to the apparent widest separation and center the crack between the calibration dots
5. Set the calibration cursers on the center of each laser calibration dot
6. Calibrate the cursers to the calibrate separation distance
7. Move the cursers to each side of the crack
8. Record the crack width.
9. Use the cable distance counter to record the crack length.
10. **PAUSE camera and RECORDER** at end of the video inspection
11. **Note the (end of line) cable distance for this will be the laser profile survey starting point reset distance**

K. OPEN FAR ENTRY PORT (MANHOLE OR CATCH BASIN))

L. TURN OFF THE AUTO FOCUS FUNCTION ON CAMERA CONTROLLER

M. CONNECT LASER PROFILE ASSEMBLY TO CCTV CAMERA/TRASNPORTER

For Pipes over 12" a CCTV camera skid with proper extenders and long runners should be used to maximize the laser alignment with the C/L of the pipe.

1 Connect profiler skid to the transporter with a chain or cable. The distance from laser ring to the camera face (should be approximately 2.3 X pipe diameter for the Cues Oz II camera). Skids should position the laser projection head on the centerline of the pipe and skids should ride along the sidewalls of the pipe.

2. Power on the laser profile light head

3. Place laser in pipeline and move transporter so that the laser ring is projected at the intended laser survey starting point (J 11 above)

4. Check that **laser ring fills 5/8 to 3/4** of the video monitor screen (adjust chain length if necessary)

5. Center Camera Head

6. Set cable distance to the video inspection "**end of pipe distance**" (J11)

7. Cover manhole or far pipeline entry point **(must be dark)**

8. Check that the laser image circle, on the monitor, is **fully visible and distinct**. It should not bloom. Adjust camera iris and/or image strobe if needed

N. DO NOT TOUCH OR MOVE THE CAMERA CONTROLS DURING THE PROFILE RECORDING.

O. RECORDING LASER PROFILE SURVEY

1. Switch CD/DVD recorder from **PAUSE** to **RECORD**
2. Retract the camera; transporter, profiler and skid slowly back to the entry point (manhole), using the mainline cable reel rewind to prevent meandering and to keep the laser profiler in the center of the pipeline. The tow cable **shall remain taut** during the entire retraction of the Profiler. **Use of rear tag line is recommended.**
3. **PAUSE** the CD/DVD Recorder
4. Remove all CCTV and Laser Profile equipment from the line

P. RECORDING CALIBRATION TARGET (THIS CAN BE DONE AT THE START OR END OF THE SURVEY AT THE OPTION OF THE OPERATOR)

1. Place camera/transporter and laser profiler on the ground and separate them to the **exact distance** that they were or will be separated during the laser survey. (In bright sun) place under survey vehicle and position with rear tag line.
2. Attach calibration target to the laser assembly by removing the laser head (1, 3, or 6 head laser) and attaching the target in the exact position as the laser using the adapter provided. **BE SURE YOU CAN READ THE CALIBRATOR ON THE VIDEO MONITOR.**
2. **RECORD** 30 seconds of the calibrator image in the horizontal position.
3. Rotate the camera Head 90^0 to the vertical position and **RECORD** 30 seconds
4. **PAUSE** the recorder.

NOTE: THE CALIBRATION PROCEEDURE IS THE SAME FOR ALL PIPE SIZES. THE DISTANCE BETWEEN THE CAMERA FACE AND RED LASER RING MUST BE THE SAME DISTANCE AS IT WAS WHEN PROFILING THAT PARTICULAR LINE

Q. RECORD BARREL DISTORTION CHART

a. Place Barrel Distortion Target in front of camera so that it fills the monitor screen when in focus
b. Check camera focus
c. **RECORD** 30 seconds on CD/DVD
d. **STOP RECORDING**

MOVE THE RECORDED CD/DVD TO A COMPUTER FOR SOFTWARE PROCESSING

Response:

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Megan Arasteh, P.E
813-975-6162

ARTICLE 430-2 (of the Supplemental Specifications) is deleted and the following substituted:

430-2 Materials.

430-2.1 Pipe: Meet the following requirements:

Concrete Pipe	Section 449
Round Rubber Gaskets	Section 942
Corrugated Steel Pipe and Pipe Arch	Section 943
Corrugated Aluminum Pipe and Pipe Arch	Section 945
Corrugated Polyethylene Pipe	Section 948
Polyvinyl Chloride (PVC) Pipe	Section 948

430-2.2 Joint Materials: Use joint materials specified in 430-7 through 430-~~910~~ according to type of pipe and conditions of usage.

430-2.3 Mortar: Use mortar composed of one part ~~p~~Portland cement and two parts of clean, sharp sand, to which mixture the Contractor may add hydrated lime in an amount not to exceed 15% of the cement content. Use mortar within 30 minutes after its preparation.

SUBARTICLE 430-3.1 (of the Supplemental Specifications) is deleted and the following substituted:

430-3.1 General: When the plans designate a type (or types) of pipe, use only the type (or choose from the types) designated. As an exception, when the plans designate reinforced concrete pipe as Class S, Class I, Class II, Class III and Class IV, the Contractor may use nonreinforced *or fiber reinforced* concrete pipe up to and including 36 inch in diameter.~~-or fiber reinforced concrete pipe up to and including 48 inch in diameter.~~ Do not use fiber reinforced concrete pipe beneath the main travel lanes of interstate highways.

SUBARTICLE 430-4.8 (of the Supplemental Specifications) is deleted and the following substituted:

430-4.8 ~~Final~~ Pipe Inspection:

430-4.8.1 Initial Pipe Inspection: ~~Based on contract pavement type, u~~*U*pon completion of placement of ~~concrete pavement or the placement of structural asphalt~~ *the pipe and 3 ft. of backfill above the pipe crown (or the bottom of the stabilized subgrade if lower)*~~backfill~~, but prior to *continued* placement of *backfill or embankment or placement of* ~~asphalt friction course~~*stabilized subgrade or base*, dewater installed pipe and provide the Engineer with ~~a video recording schedule allowing for~~ pipe video*s*~~ing~~ and reports *of the installed pipe.* ~~to be completed and s~~Submitted ~~to the Department and~~*videos and reports are to be* reviewed *by the* ~~*Department*~~ *Engineer* prior to ~~continuation~~ *resuming pipe backfill or embankment placement or placement* of *subgrade or base*~~pavement~~. *For pipe installed within MSE wall embankments, initial inspection is to be conducted when compacted embankment reaches 3 feet above the pipe crown. The submittal, review and resumption requirements stated above also apply for pipe in MSE wall locations.*

or to a depth of 4' above the crown if heavy equipment is to cross over the pipe (Section 125-8.1.3)