



RIGID RUGGED RESILIENT



SR 9B (209294-1-52-01)

5-7-7-5-7-8

Post Installation Inspection

Where the Rubber Meets the Road

Douglas J. Holdener, P.E.
Director, FCPA

Angel De Jesus, P.E.
County Materials

Sarah Matin, P.E.
Rinker Materials

1°

7°

-0.2%

2' 04"



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Douglas Holdener, P.E.



- Director
Florida Concrete Pipe Association
- 23 yrs. Civil Engineering Experience
 - Consultant (7 yrs)
 - Concrete Pipe Producer (13 yrs)
 - Concrete Pipe Association (3 yrs)
- 10 yrs. Exp. In Pipe Inspection/Assessment
- Licensed P.E. in Florida & Tennessee
- Texas A&M University (M.S. in Civ. Eng.)
- Jupiter, Florida



Angel De Jesus, P.E.



- Technical Resource Engineer
County Materials Corporation – Florida Operation
- 41 yrs. Experience
 - Pressure Pipe
 - Reinforced Concrete Pipe
 - Precast Structural Engineering
 - Pipeline Engineering
 - Manufacturing and Quality Control/Assurance
- Licensed P.E. in Florida
- University of Puerto Rico – Mayaguez Campus
 - B.S. Civil Engineering
- Orlando, Florida



Sarah Martin, P.E.



- Florida Region Engineer
Rinker Materials
- 15 yrs. Experience
 - Design Build
 - Roadway Design
 - Site Development
 - Utility Management
 - Concrete Pipe, Culvert Design and Specifications
- Licensed P.E. in Florida
- ASCE Region 5 Governor
- University of Central Florida (UCF)
 - B.S. Civil Engineering
- Orlando, Florida



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Polling Question 1



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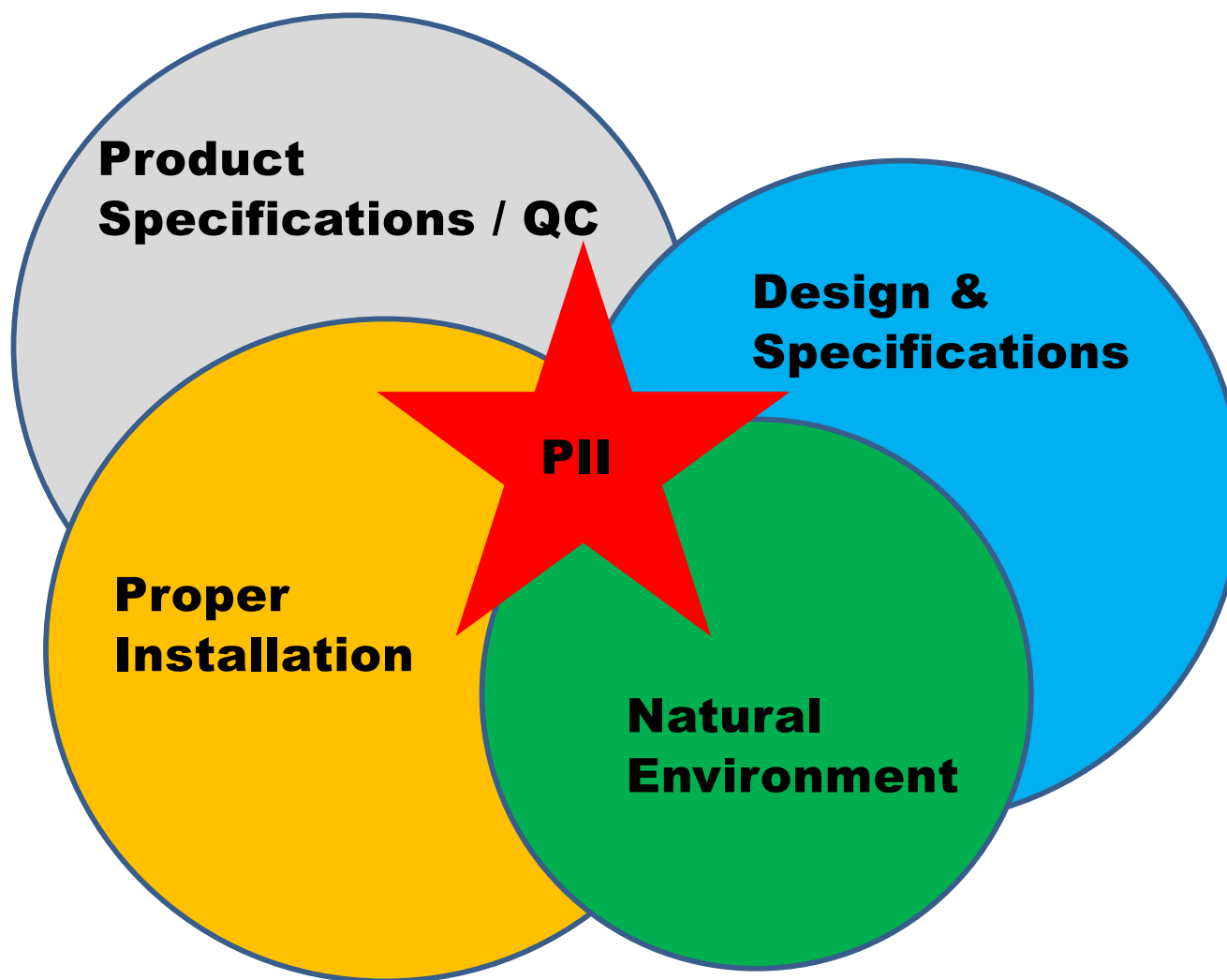
Polling Question 2



RIGID RUGGED RESILIENT



PII: Where the Rubber Meets the Road





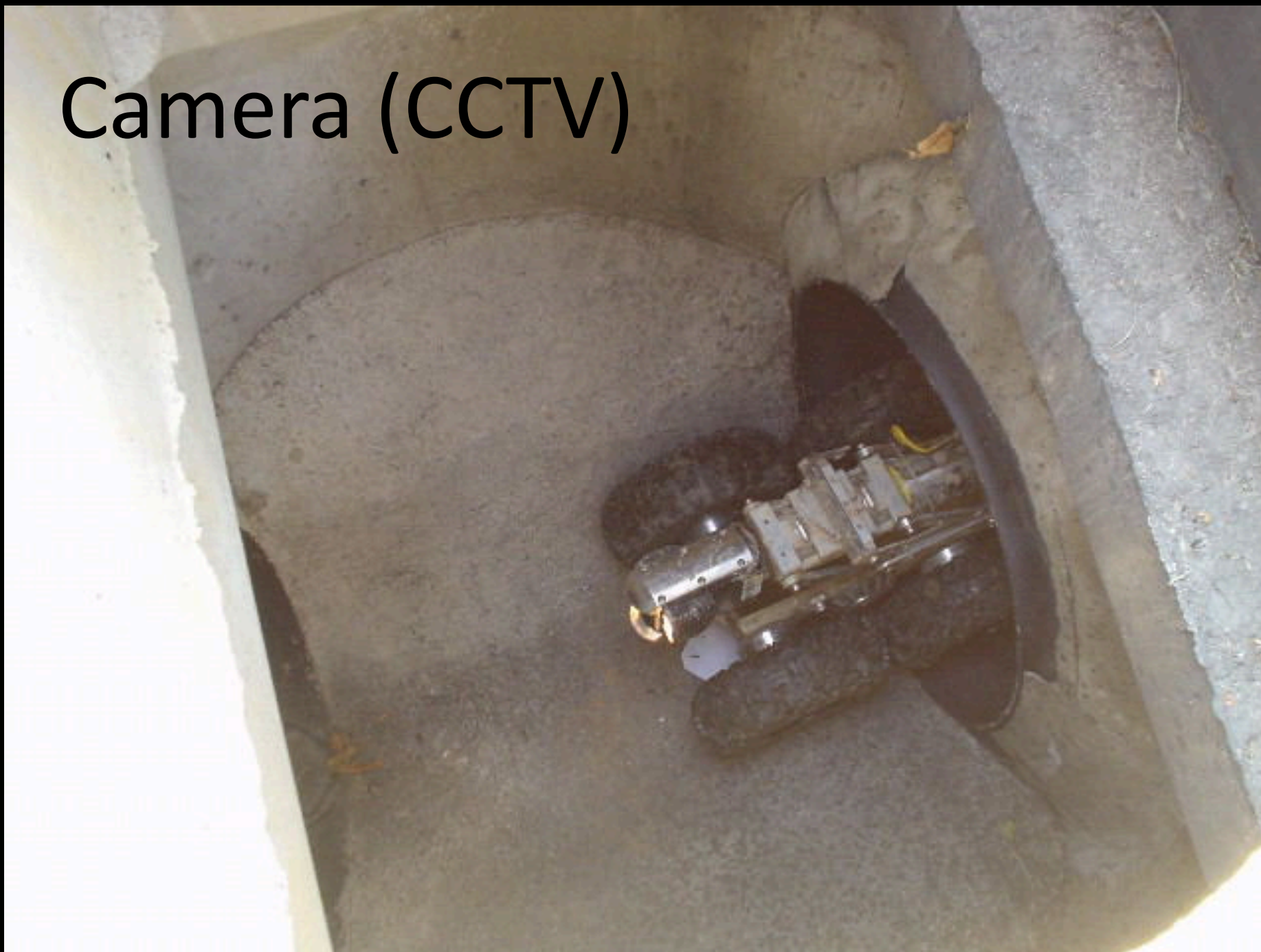
RIGID RUGGED RESILIENT



Post Installation Inspection (PII)

- What is it, Why is it done?
- Example Specifications
- Typical Inspection / Assessment Process
- Measurement Systems / “Lasers”
- Assessment Criteria / Specifications
- Benefits, Impacts, Costs

Camera (CCTV)





ROVVERX line of inspection crawlers.

Image source: Envirosight, LLC web site, <https://www.envirosight.com/rovverx.php>



Why Post Installation 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.

Source: AASHTO LRFD Bridge Construction Specifications, Section 27: Concrete Culverts, American Association of State Highway and Transportation Officials, 2019.

PII for Flexible, Plastic Pipe

All pipes shall undergo inspection during and after installation to ensure proper performance. ... Final internal inspections shall be conducted on all buried thermoplastic pipe installations to evaluate issues that may affect long-term performance.

Source: AASHTO LRFD Bridge Construction Specifications, Section 30: Thermoplastic Pipe, American Association of State Highway and Transportation Officials, 2017.

To ensure specified deflection limits are not exceeded, the engineer may require deflection testing of the pipe using specified measuring devices.

Source: ASTM D2321 – Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications, ASTM International, 2014.



Sample Specifications

701.03.08 Inspection of Pipe. The engineer will visually inspect all pipe.

The Department will require camera/video inspection on projects that have more than 250 linear feet of storm sewer and/or culvert pipe and on routes with an ADT of greater than 1,000 vehicles. Conduct camera/video inspections in accordance with KM 64-114 on 100 percent of the pipes that are located under the road and 50 percent of the pipes that are not under the road. Storm sewer runs and outfall pipes not under the roadway take precedence over rural entrance pipes. Camera/video and laser deflection inspection must be completed by a prequalified contractor that has been certified according to KM 64-114. Contractors performing this item of work must be prequalified with the Department in the work type J51 (Video Pipe Inspection and Cleaning). Testing performed by a company failing to meet these requirements will result in non-payment of the pipeline video inspection and non-certification of the pipe tested.

Deflection testing using the laser deflection method shall be limited to pipe up to 48 inches in diameter. Deflection testing using physical measurements is limited to pipes where adequate access is available and to pipes 48 inches and larger in diameter. Mandrel or physical measuring will be used for pipes larger than 48 inches in diameter. Deflection testing is not required for concrete pipe. The pipe to be tested will be selected in complete runs (junction-junction or headwall-headwall). Provide a pipe inspection summarization report in accordance with KM 64-114.

Unless the Engineer directs otherwise, schedule the inspections no sooner than 30 days after completing the installation and completion of earthwork to within 1 foot of the finished subgrade. When final surfacing conflicts with the 30-day minimum, conduct the inspections prior to placement of the final surface. The contractor must ensure that all pipes are free, clear of any debris, and as dry as possible so that a complete inspection can be performed.

Standard Specifications for Road and Bridge Construction, Section 700, Kentucky Transportation Cabinet, 2019.



**U.S. Department
of Transportation**
Federal Aviation
Administration

Advisory Circular

Subject: Standard Specifications for
Construction of Airports

Date: 12/21/2018

Initiated By: AAS-100

AC No: 150/5370-10H

Change:

12/21/2018

AC 150/5370-10H

Part 11 – Drainage

Item D-701 Pipe for Storm Drains and Culverts

701-3.7 Inspection Requirements

An initial post installation inspection shall be performed by the RPR no sooner than 30 days after completion of installation and final backfill. Clean or flush all lines prior to inspection.

[Use a camera with lighting suitable to allow a clear picture of the entire periphery of the pipe interior. 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 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.]

[For pipe sizes larger than 48 inches, a walk-through visual inspection shall be performed.]

**FLORIDA
DEPARTMENT
OF
TRANSPORTATION**



**STANDARD SPECIFICATIONS
FOR
ROAD AND BRIDGE
CONSTRUCTION
JANUARY 2020**

430-4.8 Pipe Inspection: For pipes installed under the roadway, inspection is to be conducted when backfill reaches 3 feet above the pipe crown or upon completion of placement of the stabilized subgrade. For pipe installed within fills, including embankments confined by walls, inspection is to be conducted when compacted embankment reaches 3 feet above the pipe crown or the finished earthwork grade as specified in the Plans. Prior to conducting the inspection, submit to the Engineer a video recording schedule for videoing, dewater installed pipe, and remove all silt, debris and obstructions. Submit pipe videoing and reports to the Department for review prior to the continuation of paving.

For pipe 48 inches or less in diameter, submit to the Engineer a video DVD and report using low barrel distortion video equipment with laser profile technology, non-contact video micrometer and associated software. For all pipe types, provide a Pipe Observation Summary Report for each pipe run that includes:

1. Actual recorded length and width measurements of all cracks within the pipe.
2. Actual recorded separation measurement of all rigid pipe joints.

defects.

3. Detailed written observations of leaks, debris, or other damage or

includes:

For flexible pipe types, submit a Pipe Ovality Report for each pipe run that

1. Representative diameter of the pipe.
2. Pipe deformation/deflections measurements with the 5% deflection limit clearly delineated.

Laser profiling and measurement technology must be certified by the company performing the work to be in compliance with the calibration criteria posted at: <http://www.dot.state.fl.us/construction/contractorissues/laser.shtm> . Reports submitted in electronic media are preferred.



Sarah L. Martin, P.E.

Typical concrete pipe inspection, from
CCTV inspection to final report/assess.



Source: Chris Parker LinkedIn, Cues, Inc.



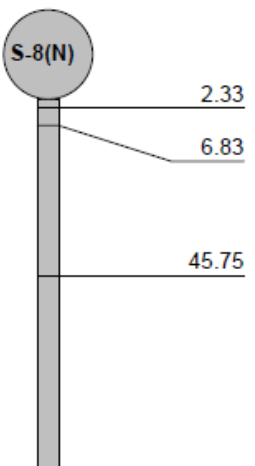
Basic Process

- Pipe installed, backfilled to subgrade
- Pipe dewatering, jetting/cleaning
- CCTV Inspection
 - Document potential concerns
 - Pan/tilt at joints
- CCTV Report
 - DVDs
 - Line Report/Observations (w/ Photos)

Inspection report

Date: 1/26/12	P.O.#: 209294-1-52-01	Weather: 1 Dry	Surveyed By: JR	section number: 21	PSR: NA
Total Pipe Length: 310	Survey Customer: ARCHER WESTERN	System Owner: FDOT	Clean Date: 1/25/12	Pre-Cleaned: H Heavy Cleaning	Map Grid #: NA

Street: SR 9B (209294-1-52-01)	Flow Control: N	Start MH: S-8(N)
City: DUVAL COUNTY	Year Renewed: NA	End MH: S-7(N)
Location Code: B Main Highway - Suburban/Rural	Tape/Media #: DVD	Total length surveyed: 310 ft
Purpose: E Pre-Acceptance	Dia/Height: O Oval 29/45	
Use: SW Stormwater	Material: RCP Reinforced Concrete Pipe	Pipe Joint length: 8
Drain. Area: NA	Lining: NA	
	Category:	
Comment: NONE		
Location details: SHEET 32		

1:700	position	observation	MPEG	photo
		S-8(N), Survey Begins	00:00:04	
		Crack Longitudinal, at 12 o'clock, appx 4.5" x < 0.01"	00:00:45	22_2a
		Crack Longitudinal, at 01 o'clock, appx 1'0" x < 0.01"	00:04:35	22_3a



Video 1: Example of Pipe Inspection Process



Basic Process (cont'd)

- Assess the Report & Video
 - Specialty Engineer
 - Accept
 - Further Evaluate
 - Repair
- Re-Inspect Any Repairs

Closing

We appreciate the opportunity to assist with this matter. If [REDACTED] or the Engineer of Record is aware of information to the contrary, or has comments or questions, then [REDACTED] would be pleased to discuss this issue further.

Sincerely,



Douglas J. Holdener, P.E.
Florida P.E. License No. 60429

Signed On: 9/17/2014

Certificate of Authorization No. [REDACTED]

Polling Question 3



2 Types / Purposes of Lasers

1. Parallel Laser Diodes (for rigid or flexible pipe)
 - For Measurement/Micrometer Calibration
 - Diodes at Fixed Distance Apart
 - Benchmarking / Scaling
 - On-screen Superimposed Micrometer
 - Measuring/Scaling Objects (cracks, joint gaps, etc.)
2. Laser Profiler (used for flexible pipe only)
 - For Measuring Pipe Shape/Deformation
 - Laser Reflects Off Inside Pipe Wall
 - Software Measures % of Diameter, Ovality
 - Laser “Ring” or 2 – 3 Laser Diodes (Triangulation)

Inspection photos

City:
DUVAL COUNTY

Street:
SR 9B (209294-1-52-01)

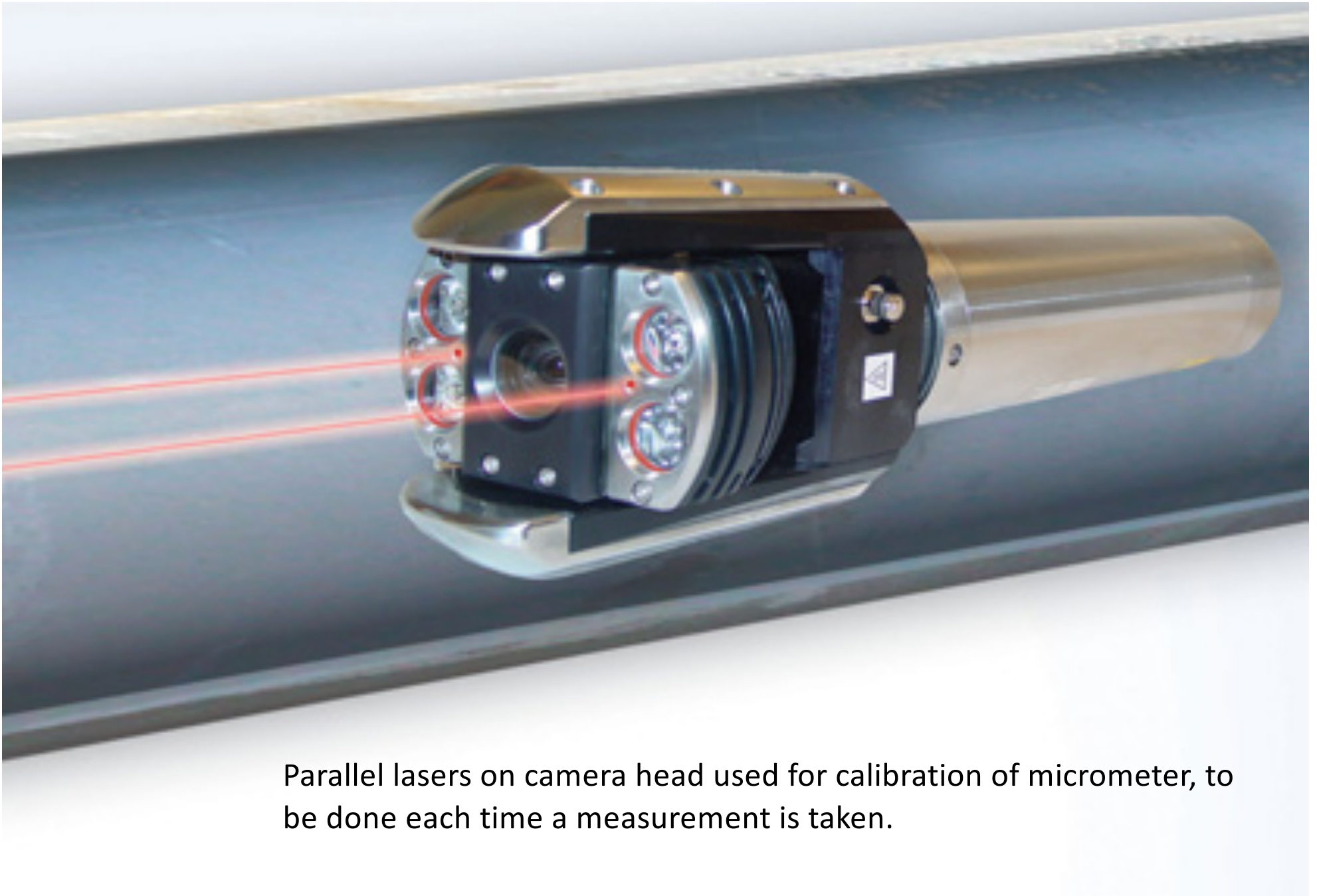
Date:
1/26/12

section number:
25

PGR:
NA

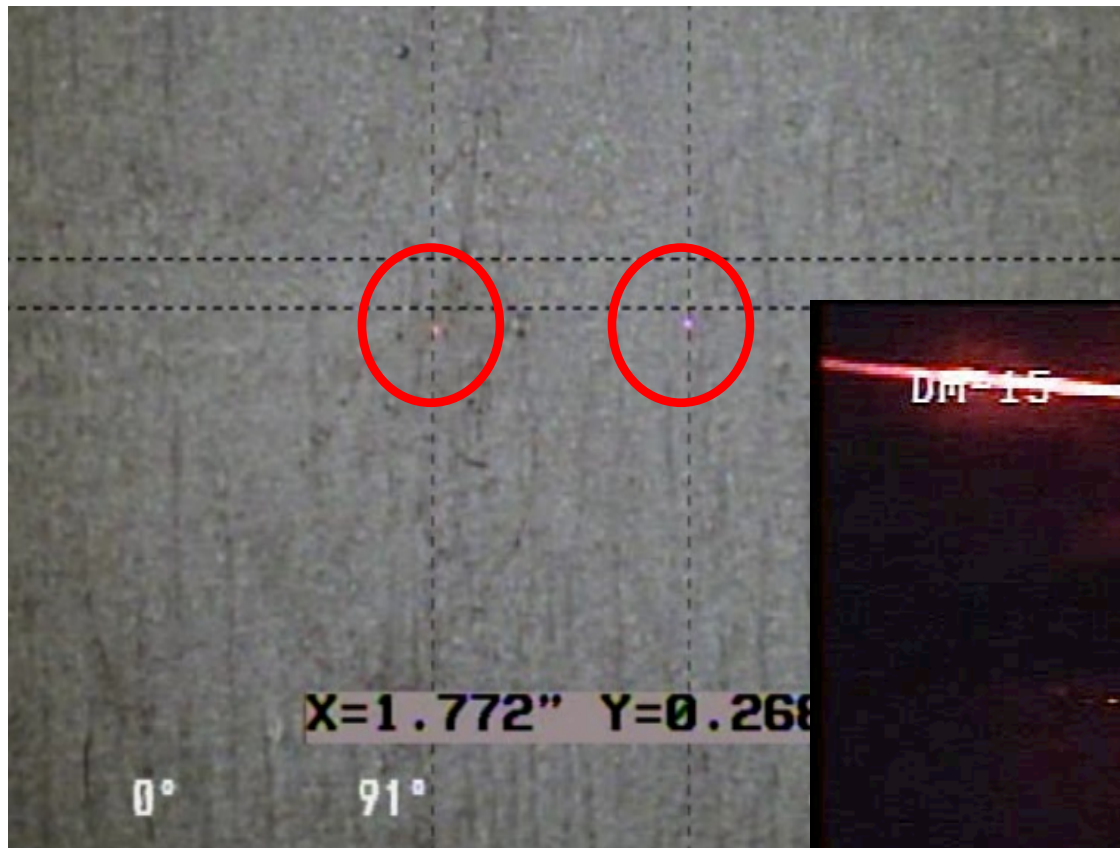


Photo: 26_2a, Tape/Media No.: DVD, 00:01:52
23.76FT, Joint ~ 0.976", > 0.875" from apex -140 deg to 145
deg (21%)



Parallel lasers on camera head used for calibration of micrometer, to be done each time a measurement is taken.

Examples of laser calibration systems. Lasers must be at 90 degree angle to object being measured. The laser provides a fixed distance, or benchmark, for the operator to reference when scaling (i.e., comparing) an object's dimensions.

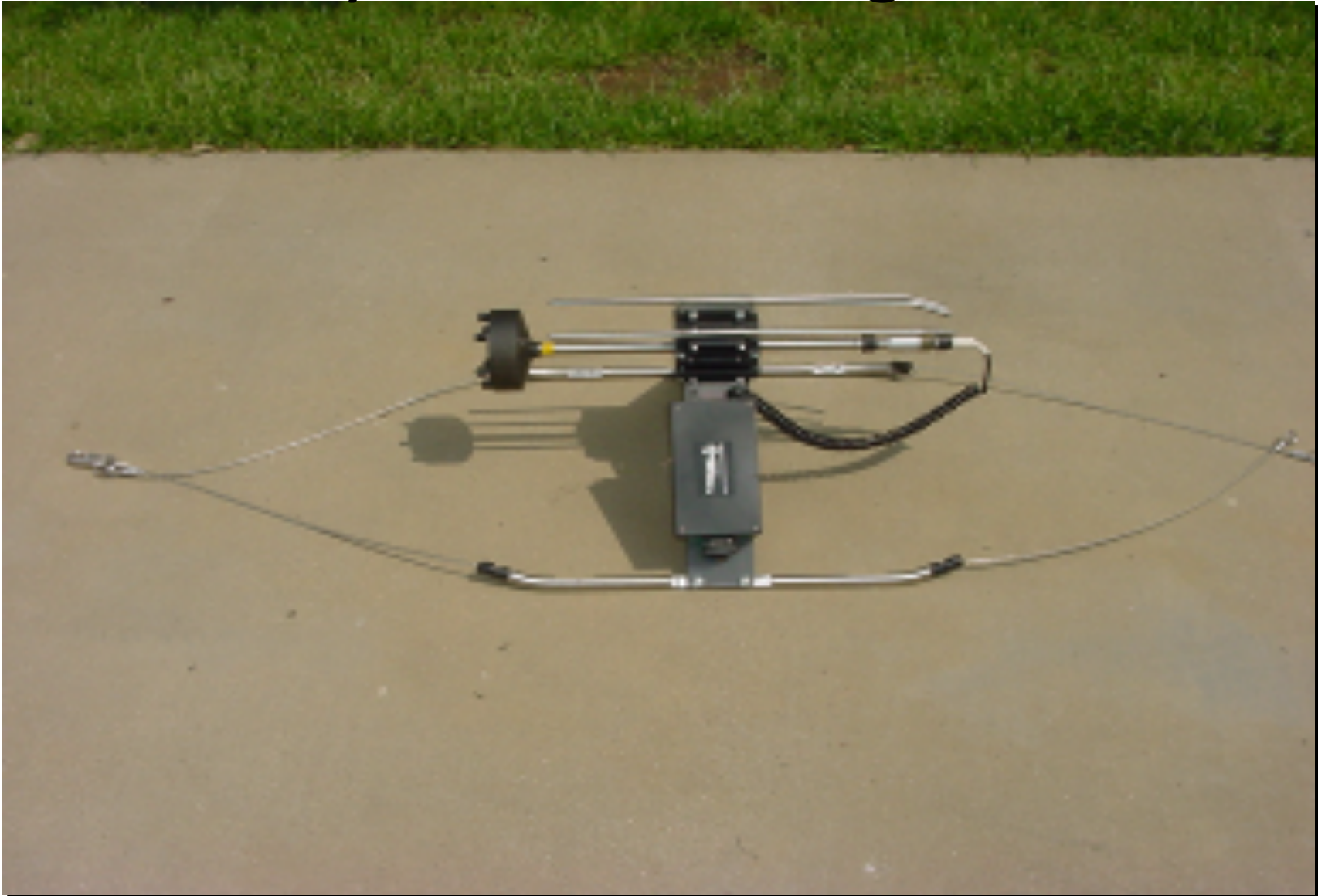




Video 2: Micrometer Calibration and Measurement

Laser Profiler

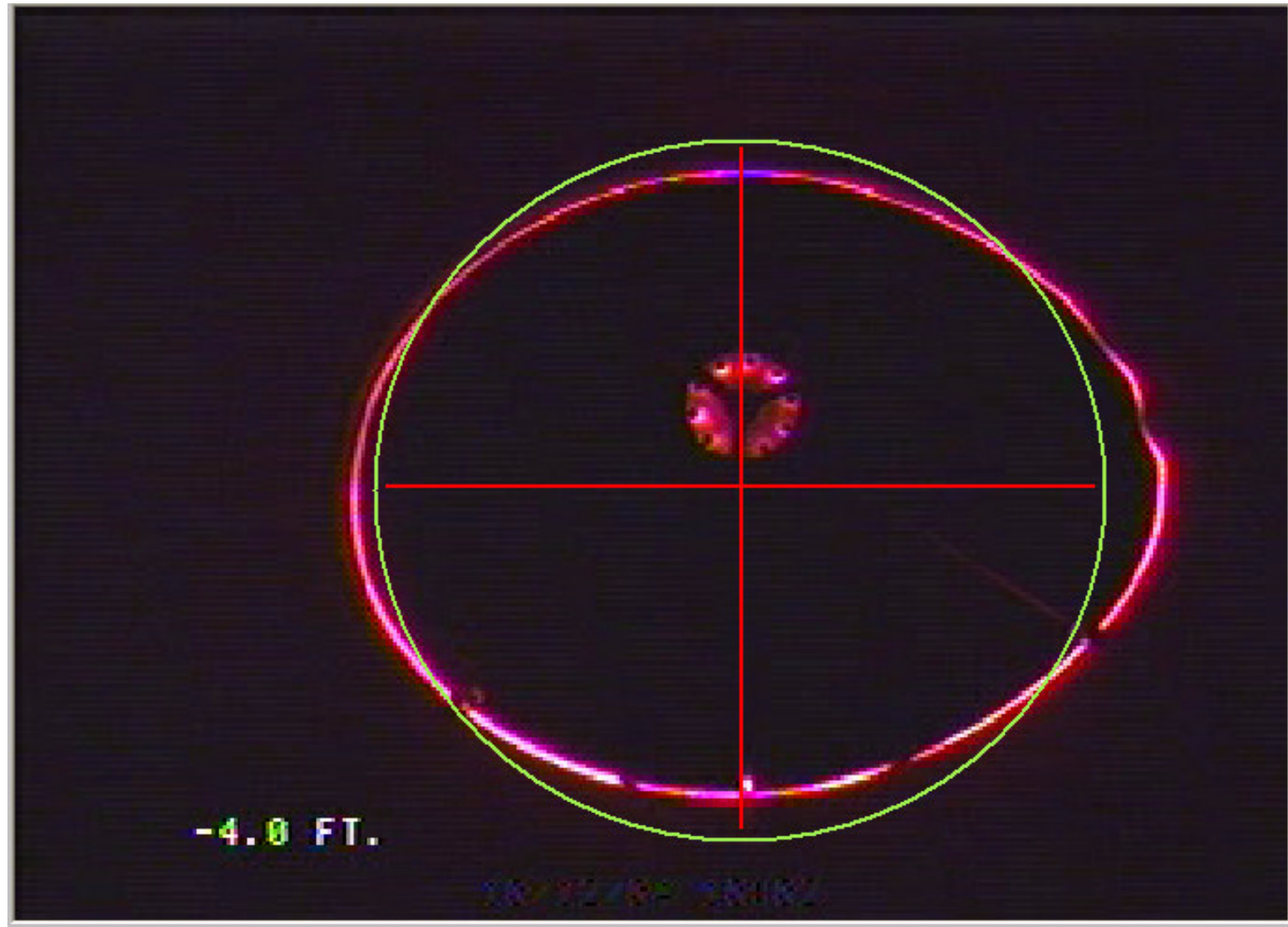
Accessory for Measuring Deformation





Video 3: Laser Profiler in Use

Laser Profiling Measures Internal Shape of Flexible Pipe



430-9.3 Installation Requirements Including Trenching, Foundation and Backfilling Operations: Check structure shape regularly during backfilling to verify acceptability of the construction method used

Replace pipe deflected 5% or more of the certified actual mean diameter of the pipe at final inspection at no cost to the Department.

Source: Standard Specifications for Road and Bridge Construction, Florida Department of Transportation, 2019.

Why limit plastic pipe deformation to $< 5\%$ of diameter ?

In order to limit the strain in the pipe wall from exceeding design limit (AASHTO) and prevent impact to long-term service life.

Installed pipe deflections that exceed five percent of the initial inside diameter may indicate that the installation was substandard. Appropriate remediation, if any, will depend upon the severity of the deflection, the condition of the pipe, and evaluation of the factor of safety using Section 12, “Buried Structures and Tunnel Liners,” of the *AASHTO LRFD Bridge Design Specifications*. Installed pipe deflections that exceed 7.5 percent of the initial inside diameter will require remediation or replacement of the pipe.

Source: [AASHTO LRFD Bridge Construction Specifications](#) American Association of State Highway and Transportation Officials, 2017.



Angel De Jesus, P.E.

Typical issues that may be
observed in PII reports.



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Typical Observations

- Freq. of observations < 2% (typ.)
- Is CCTV operated properly per specifications?
 - Speed \leq 30 ft per minute.
 - Camera pan full 360 degrees circumference of every joint.
- Cracks
 - Pattern: circumferential, longitudinal, etc.
 - Damage or structural distress
 - Width & length.
 - Evaluation criteria may range from 0.01" to 0.05" to 0.10"
 - ASTM C1840 useful in mitigating cracks.



Typical Observations

- Joint gaps
 - Some agencies have max. gap criteria.
 - Consider allowable extensibility of the supplier's joint design.
- Joint observations
 - Allowance varies by local codes.
 - Silt tight, Soil tight, Leak resistant, Water tight.
- Pipe wall condition
 - E.g., moisture permeating



Video 4: RCP Inspection of Longitudinal Crack



Video 5: Inspection of Pipe with Wall Staining

Polling Question 4





Sarah L. Matin, P.E.

Acceptance criteria, ASTM C1840 and its importance in contract documents.



Designation: C1840 – 17

Standard Practice for Inspection and Acceptance of Installed Reinforced Concrete Culvert, Storm Drain, and Storm Sewer Pipe¹

This standard is issued under the fixed designation C1840; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This practice covers the requirements for inspection and acceptance of installed reinforced concrete pipe by either person-entry, or remote inspection as shown in Figs. 1 and 2, respectively.

1.2 The scope of this specification is intended for installa-

1.8 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*



ASTM C1840

Installation Inspection Acceptance

- Peer-Reviewed Standard
- In Use Nationally
- Only for Concrete Pipe
- Defines Criteria for Acceptance
 - Crack Patterns and Dimensions
 - Wall Condition / Infiltration through Pipe Wall
 - Joint Infiltration and Separation
- Environmental/Durability Criteria



and a third dimension between the air and the air [0.3 mm to 0.3 mm] with an allowable tolerance of ± 0.01 in. [0.3 mm], verified by a minimum of five readings for each of the three test points.

6.2.1.3 Verification testing must be successfully completed within one year prior to time of the inspection being performed.

6.2.1.4 Verification shall be administered by an independent third-party lab. The independent lab shall be ISO/IE 17025 accredited.

6.2.1.5 More than one operator may be certified on a specific piece of equipment. Every operator certified for a particular piece of equipment must be tested individually and prove proficiency in setup, usage and be able to make accurate and repeatable measurements as required above. The test data for any or all certified operators for a piece of equipment shall be included in the proof of certification.

7. Inspection Report Requirements

7.1 Person-entry and Remote Inspection Report Requirements:

7.1.1 A report shall be provided to the owner or engineer along with all recorded video/still digital images, in electronic media on a digital media storage device.

7.1.1.1 The report shall include the location, length, and width measurements of all cracks. Cracks shall be recorded to the nearest 0.5 in. [15 mm] for length and 0.01 in. [0.3 mm] for width. Cracks smaller than 0.05 in. [1.5 mm] shall be noted as less than 0.05 in. [1.5 mm] in width when remote inspection procedure is utilized

to the structure).

8. Installed Pipeline Evaluation and Acceptance Criteria

8.1 Inspection of newly installed reinforced concrete pipe shall occur after final fills are placed over the pipe, but before pavements or other structures are installed.

NOTE 2—For deep fills, the soil should be allowed time to settle prior to inspection, AASHTO Section 27 states that post installation inspections should not be completed until 30 days after all backfill has been placed.

8.2 *Crack Evaluation*—Cracks shall be evaluated based upon crack pattern (location and orientation in the wall), length, crack width, and environmental conditions.

8.2.1 *Longitudinal Crack Observations Not Requiring Remediation:*

8.2.1.1 Longitudinal cracks less than or equal to 0.01 in. [0.3 mm] in width and length up to the entire pipe segment require no further investigation.

8.2.1.2 Longitudinal cracks having a width less than or equal to 0.05 in. [1.5 mm] and length up to the entire pipe segment and in a non-corrosive environment are considered minor and are not a cause for further investigation unless the observed crack pattern meets or exceeds conditions listed in 8.2.2.

8.2.2 *Longitudinal Crack Observations Requiring Further Engineer Evaluation:*

8.2.2.1 Longitudinal cracks having a width greater than 0.01 in. [0.3 mm] and less than 0.05 in. [1.5 mm] and length up to the entire pipe wall that exhibit the following patterns or conditions require further evaluation by an engineer

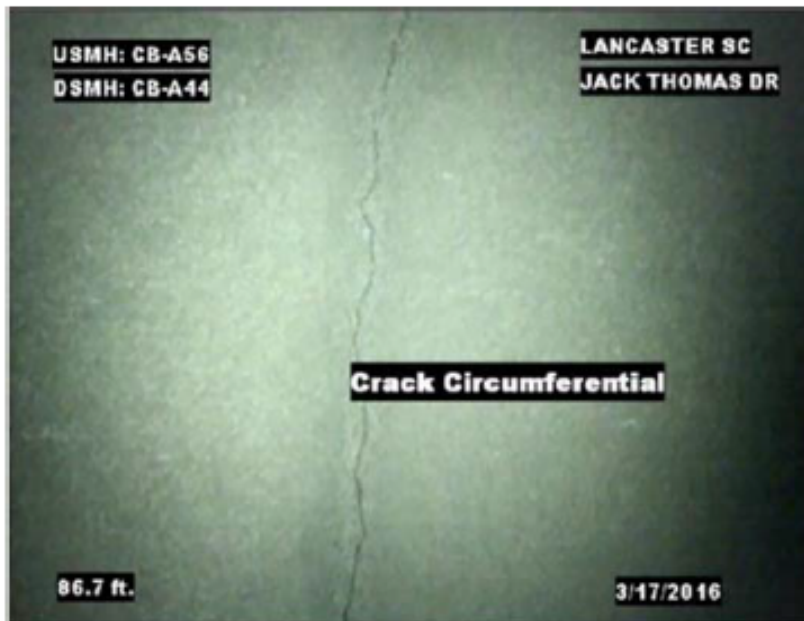


FIG. 6 Circumferential Crack

Defines criteria for acceptance:

- Not Requiring Remediation
- Requiring Further Engineer Evaluation
- Requiring Remediation



C1840/C1840M – 17

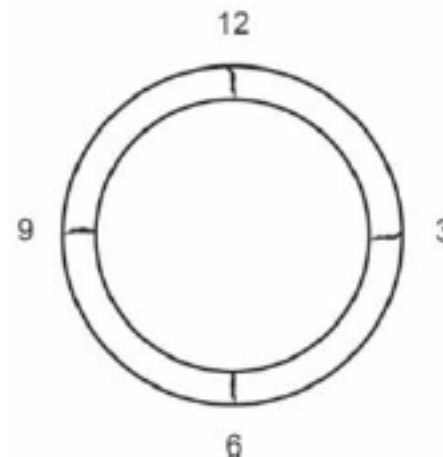


FIG. 7 Hinged Cracks (Multiple Longitudinal Cracks)



FIG. 10 Level 1 Infiltration

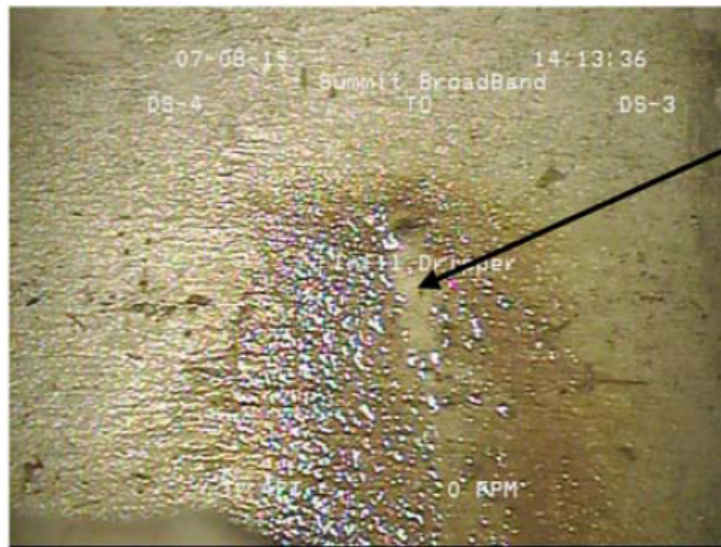


FIG. 11 Level 2 Infiltration

Video clearly indicated water flowing along surface of the pipe wall

Common terminology vs jargon
Defines significance levels
Illustrations

Incorporate specific inspection requirements for the various types of pipes beneath the general inspection requirements.

[Reinforced concrete pipe shall be inspected, evaluated, and reported on in accordance with ASTM C1840, "Standard Practice for Inspection and Acceptance of Installed Reinforced Concrete Culvert, Storm Drain, and Storm Sewer Pipe." Any issues reported shall include still photo and video documentation. The zoom ratio shall be provided for all still or video images that document any issues of concern by the inspection firm.]

[Flexible pipes shall be inspected for rips, tears, joint separations, soil migration, cracks, localized buckling, settlement, alignment, and deflection.][Determine whether the allowable deflection has been exceeded by use of a laser profiler for internal pipe diameters of 48 inches or less, or direct measurement for internal pipe diameters greater than 48 inches. Laser profile equipment shall utilize low barrel distortion video equipment. Deflection of installed pipe shall not exceed the limits provided in the table below, as a percentage of the average inside diameter of the pipe.



Advisory Circular

Subject: Standard Specifications for Construction of Airports

Date: 12/21/2018

AC No: 150/5370-10H

Initiated By: AAS-100

Change:



Angel De Jesus, P.E.

Impacts and benefits of final inspection to
the industry and end user.

The Good Old Days?





Final Inspection Benefits

- Consistent, competitive approach to final product inspection and acceptance
- Preserves quality standards expected by the owner
 - (e.g., DOT, HOA, local gov't)



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Polling Question 5

SR 9B (209294-1-52-01)

5-7-7 <- 5-7-8

Final Thoughts

1°

7°

-0.2%

2'04"



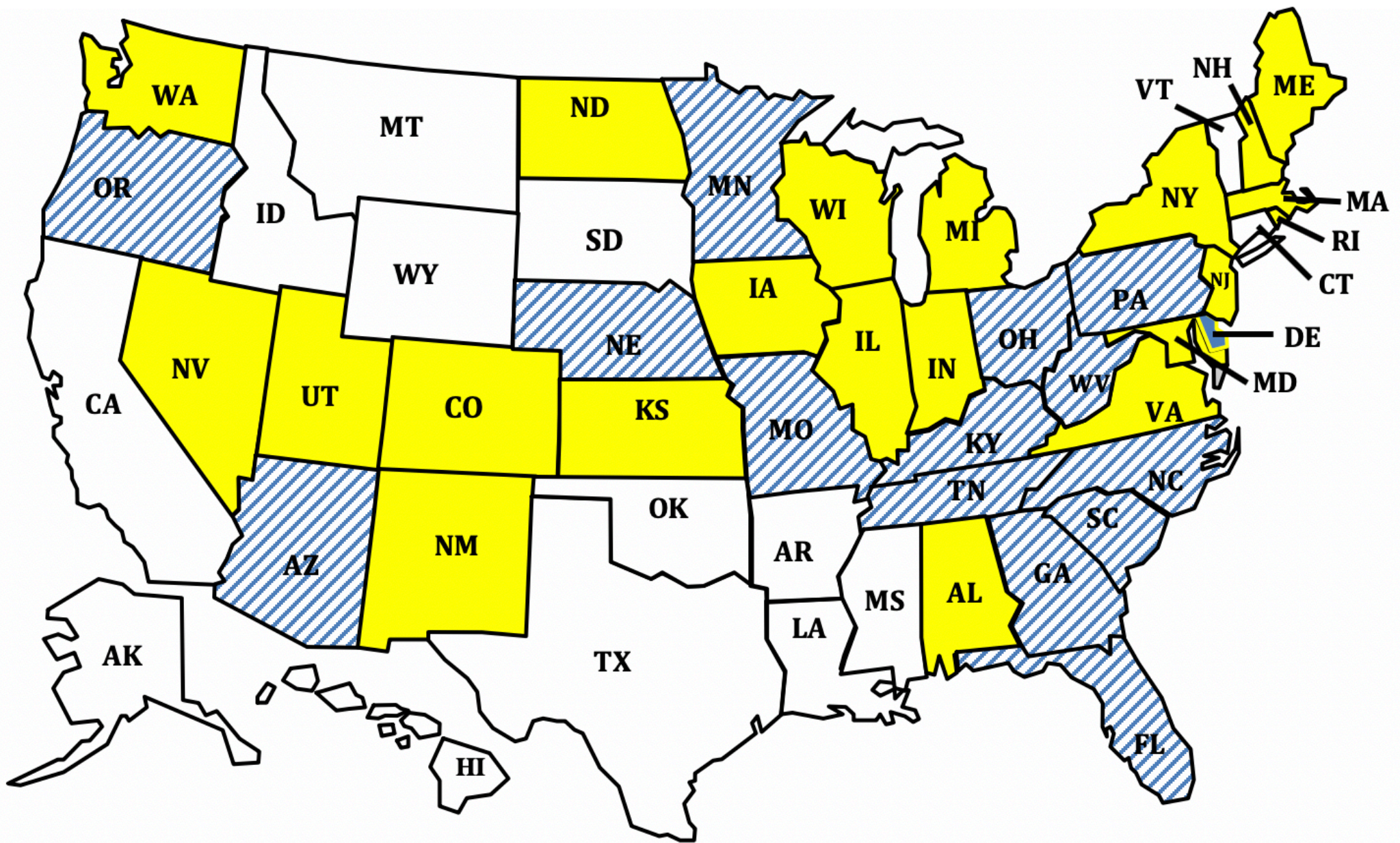
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Pricing

- CCTV \$1.25 - \$1.50 LF
- Laser Profiling \$1.25 - \$1.50 LF
- CCTV Report & DVD \$100 Each
- Profiler Report & DVD \$100 Each
- Desilting/Jetting \$200 Hour
- Dewatering \$200 Hour

Note: Typical, Florida Market Pricing, Fall 2019.



- ☐ No info or no PII
- ☒ PII for Acceptance of Installed Pipe (mandrel, Visual inspection, or CCTV only)
- ☒ Advanced PII techniques (CCTV + Profiler, or Laser Micrometer)



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Resources

- Example Agency Specifications
 - FDOT Standard Specifications for Road and Bridge Construction (SSRBC), Section 430-4.8
 - KTC Standard Specifications for Road and Bridge Construction, Section 700
 - FAA AC 150
- Acceptance Criteria
 - ASTM C1840
 - AASHTO LRFD Bridge Const. Specifications, Section 27
 - ACPA PII Resources
- Camera Suppliers / Inspection Contractors



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Questions & Answers



ACPA's Next Webinar...

Pipe Flotation Design

**Jennifer Schaff (County Materials)
& Josh Beakley (ACPA)**

April 23, 2020 at 1PM (EST)

Thank You