Evaluation Of Installed RCP
Why the interest in this topic???
Pipe Inspection Sweeping Across U.S.!

We are seeing a significant increase in pipe inspections of installed RCP due to two current trends - **New Install Acceptance Inspections** & **Asset Management Inspections**
Are You Seeing More Inspections of Pipe??

- Please Share Your Experience and Lessons Learned or need for information you found.
- Inspection Tools??
- Evaluation Guidelines???
Man-Way Access (Pipe 36” + up) - Tools
Remote Access - Tools
Why are Clear & Reasonable Evaluation Guidelines Important???

What Issues will you need to Evaluate in RCP????
RCP Cracks & Joints: Addressing The Challenges
What Zones would you anticipate a crack to form
Anatomy of a Crack
Role of Reinforcement

Role of Reinforcement?
Where is crack the widest?
Key Components of Crack Evaluation

Pattern/location

+ Size (width and length)

= Severity
CRACK PATTERNS,

• Longitudinal crack
  ▪ Radial Tension Sheer

• Circumferential crack

Pattern + Size = Severity
Pattern – Longitudinal Crack

Longitudinal Cracks:

- result of load on pipe
- *Acceptable Location*
  - 12 o-clock
  - 6 o-clock

NOT Structural or durability Issue if only found at invert and obvert and < 0.05”
Longitudinal Cracks
Locations…Concern

FLEXURE CRACKING DUE TO POOR SIDE SUPPORT

SHEAR CRACKING DUE TO POOR HAUNCH SUPPORT

GOOD SIDE SUPPORT

Exhibit 108. Results of poor and good side support, rigid pipe.
Pattern - Circumferential Crack

Not of Structural Concern, but may need remediation if backfill can move through crack.
Why are Circumferential/Transverse Cracks Not a Structural Issue?
AASHTO Const. Eval Guidelines

Camera Only Remote Inspection Evaluation
Criteria for Longitudinal Cracks: two longitudinal cracks the length of the pipe section is acceptable when the cracks are within 15 degrees of any quarter point of pipe, i.e. 11 O-Clock to 1 O-clock, 2 – 4 O-Clock, 5 – 7 O-clock, and 8-10 O-Clock.

Cracks at these points are signs of acceptable stress load cracks and are typically small cracks and do not allow soil infiltration and are not cause for concern unless the pipe is in an acidic condition (Ph of soil/runoff less than 5). Pipes with more than two longitudinal cracks the length of the pipe at the quarter points or pipe with cracks at 30 degrees +/- from invert i.e. 4-5 O-clock and or 7-8 O-Clock should be further evaluated by an Engineer with experience in RCP pipe design and evaluation. Any crack exhibiting significant vertical offset should be remediated
Key Components of Crack Evaluation

Pattern/location
+ Size (width and length)
= Severity
AASHTO CRACK WIDTH CRITERIA

• AASHTO section 27
  ▪ Cracks < 0.01
  ▪ Cracks > 0.01
    evaluate to determine if detrimental
  ▪ Cracks >0.10
    In non-corrosive environments (ph>5.5) cracks up to 0.10” are considered acceptable
Longitudinal cracks < 0.05" Evaluation Criteria: Pipe with cracks less than 0.05” shall be noted in the inspection report; however, no remedial action is required. Pipe with cracks greater than 0.05” and less than or equal to 0.1” and in areas where soil and or runoff Ph is 5.5 or greater shall not require remediation. Pipe with cracks greater than 0.05” and less than or equal to 0.1” and in areas where soil and or runoff Ph is less than 5.5 shall require remediation. RemEDIATE or replace pipe having longitudinal crack widths larger than 0.10”.

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CRACK PATTERNS/SIZE – Severity Summary

• Longitudinal crack
  ▪ Load Induced
  ▪ Not structural concern @ Invert & obvert
  ▪ Watch for 5 & 7 O-clock and offsets across
  ▪ Crack width less than 0.05” = Acceptable
  ▪ Seal cracks larger than 0.05” in corrosive environment

• Circumferential crack
  ▪ Not structural concern or durability concern
  ▪ Exception: width allows transport of backfill
  ▪ Exception Large cracks at joint sealing surface
Joint Evaluation
Evaluation Process for Joint

Expectation
- Required Performance
- Allowable Gap
- Evaluate Infiltration
- Evaluate Structure Offset, Cracks, Chips, spalls
Standard Practice for

Pipe Joint Selection for Highway Culvert and Storm Drains

AASHTO Designation: PP 63-09

1. SCOPE

1.1. Pipe joint design considerations are a critical component for the overall performance of culvert and storm drain installations. Experience has shown that the component responsible for many culvert and sewer performance problems and failures can be traced back to the pipe joint. The structural and hydraulic performance of the joint affects the stability of backfill and soil envelope around the pipe, the line and grade of the culvert, integrity of the overlying embankment and pavement, and compliance to storm and sanitary sewer permits. This practice is to provide clear definitions of joint performance terms, rational design methodology to determine appropriate joint performance requirements, and uniform criteria for manufacturers' joint qualification and contractors' post-installation pipe joint testing.

1.2. This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

2. REFERENCED DOCUMENTS

2.1. AASHTO Standards:
- M 36, Corrugated Steel Pipe, Metallic-Coated, for Sewers and Drains
- M 198, Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants.
Pipe Joint Performance Parameters

**Silt-tight:**
A joint that is resistant to infiltration of particles that are smaller than particles passing the No. 200 sieve. ... limit infiltration of the backfill material containing a high percentage of fines, ... utilize some type of filtering or sealing component, such as a elastomeric rubber seal or geotextile.

**Leak Resistance:**
A joint which limits water leakage at a maximum rate of 200 gallons/inch-diameter/mile/day for the pipeline system for the project specified head or pressure. Requires rubber seal
Sealing Options = Performance

Rubber O-Ring

Profile Rubber Gaskets

Tongue
Groove
Mastic
Inner
Preformed Flexible Sealant Joints


Intended to be soil and or silt tight.
Rubber Gasket Joints


1. Joint Design, Gasket
2. Hydrostatic head up to 30 feet
3. Leak Resistant
4. Laboratory tests:
   a. 10 minutes, off centered at 13 psi
   b. 10 minutes, deflected at 10 psi.

Intended provide leak resistant joint.
Manufactures Allowable Joint Gap?
Evaluation of Infiltration – Exfiltration
Chips, Spalls, Cracks at Joint

• Chips Spalls ok = No exposed Primary Steel or Exposed sealing element
• Cracks ok = Soil/silt cracks < 0.10” Leak resistant crack < 0.05”
Leak-Resistant Joint Evaluation

- Requires Rubber Gasket
- Minimal water flow through joint = OK (total leakage od any run must be less than 200”/gal
- Gap less than Manufacturer = OK
- Vertical offset less than 3/4” = OK
- No crack larger than 0.05” in joint area = OK
- No Chips or spalls that expose joint sealing material = OK
Silt-Tight Performance Evaluation

- Joint Material = Rubber Gasket or Butyl + Wrap
- Water infiltration allowed but must not transport fine material = OK
- Gap less than Manufacturer = OK
- Vertical offset less than 3/4” = OK
- No crack larger than 0.10” in joint area = OK
- No Chips or spalls that do not allow infiltration of backfill material = OK
NOTES TO INSTALLER & INSPECTOR

Minimize ALL RCP Issues:
• Handle with Reasonable Care
• Provide Solid Foundation
• Proper Bedding and Grade
• Cannot Force on Grade
• Proper Installation of Joint Materials
• Cover Before LOAD – Careful with construction Loading
Evaluation Tools are Available!
NCDOT Guidelines for Post Installation Evaluation and Repair of Newly-Installed Drainage Pipe

- Cracks/Slabbing/Spalling - RCP
- Cracks Tears - Flexible Pipe
- Deflection - Flexible Pipe
- Joint Separations - All Pipe
- Minor & Major Repairs – All Pipe
“Post Installation Evaluation and Repair Guidelines of Installed RCP”

Background on:
- RCP Loads
- Design
- Structural Confirmation
- Joint Performance

Decision Matrix
- Crack Evaluation & Repair
- Joint Evaluation & Repair
- Spalling & Slabbing Evaluation & Repair
“Crack Matrix”
Contents

• Background on RCP Loads, Design, Structural Confirmation, & Joint Performance

• Decision Matrix
  - Crack Evaluation & Repair
  - Joint Evaluation & Repair
  - Spalling and Slabbing Evaluation & Repair
C1 - Evaluate crack orientation.

C2 - Is the crack longitudinal or transverse?

Transverse

C3 - Is there soil migration through the crack?

Yes

C22 - Seal crack with approved method.

No

C21 - Note in inspection. No repair or remediation required. Photograph for monitoring conditions subsequent inspections.

C4 - Measure crack.
Circumferential Crack with minor spalling along crack & circumferential crack with autogeneous healing.

C3 (SOIL MIGRATION W/ TRANSVERSE CRACK)

Circumferential/Transverse cracks can be evaluated similar to a joint integrity evaluation process. If the circumferential crack is not allowing transport of backfill material into the pipe, and the pipe does not have a vertical offset that could impede flow, and the pipe is in a non-corrosive environment, it should only be noted in the inspection report. Under these conditions, no remediation would be required. The severity of a circumferential crack is limited, because this type of crack will not affect the structural load capacity of the RCP pipe wall; it can be viewed similar to just another joint in the system.
Examples and Application

Stick our Head into some Pipe!

Make Application of Crack and Joint Evaluation

Discussion and Questions
• Using Crack Matrix…
  ▪ Longitudinal crack (C2)
  ▪ Crack at Invert 6 o-clock and 12 o-clock
  ▪ Crack width = 0.08” (C9)
  ▪ Soil Maps indicate Ph = 4+/- (C16)

• Any Action to be taken?
Yes - Seal Crack to protect steel and insure anticipated service life....(C17)

See Crack Repair Procedures..

- Cautions about wet v dry cracks
- ZOOM issues
- ACTUAL Accuracy
WHAT KIND OF CRACK?

WHAT IS TAKING PLACE?
• Take out Crack Matrix…
  ▪ Transverse - Circumferential crack (C2)
  ▪ Mid pipe from 3 o-clock to 9 0-clock
  ▪ Crack width = 0.06”
  ▪ No sign of soil migration (C3)
• Any Action to be taken?
• No Action Needed-
• Circumferential Crack is not structural & No soil Migration means no long term effect…(C21)
Before You Begin?

Know Performance Criteria for Installation

Have Manufacturers Allowable Gap Criteria (Soil V Silt V Leak Resistant = Diff. allowable Gap)
RCP Joint Evaluation

J1 - Inspect joint.

J2 - Is there spalling at the joint that exposes reinforcing steel?

J3 - Repair & seal joint by approved method.

J4 - Is the joint intended to be leak resistant?

J5 - Is the joint intended to be gill-tight?

J6 - Is the joint intended to be soil tight?

J7 - Is infiltration carrying soil observed?

J8 - Seal joint by approved method.

J9 - Is infiltration carrying soil observed?

J10 - Seal joint by approved method.

J11 - Is the joint gap less than manufacturer's recommendation?

J12 - Seal joint by approved method.

J13 - Is there significant penetration?

J14 - Are there cracks at the joint?
EXAMPLE

EXPOSED GASKET
Given Information:

- Joint Performance = Soil Tight
- Condition - chipped area at joint
- Joint Gap less than manuf. Allowances except for the area of chip
- Vertical Offset = no
- Primary steel Exposed – yes (J2)

Action Required?
Use Joint Eval. Matrix

Chipped Joint...
• Is there spalling (chipped area) at joint (J2) = Yes
• Is steel Exposed - yes
• Action Required?

Yes - Repair and seal joint (J3)
Example #2

MH A4-1 0035.4f MH A4
From Joint Eval. Matrix

- Is Steel Exposed (J2)? = No
- Soil Tight (J6) Application? = Yes
- Infiltration carrying soil (J7)? = No
- Is Joint Gap less than Manufacturers recommendation? Yes = (J11)
- Vertical offset (J13)? = No
- Cracks Greater than 0.10 (J15)? = No

Action Required?
GO STICK YOUR HEAD IN SOME PIPE