Evaluation Of Cracks In Installed RCP
Why Share this Information?

Read More About it – ACPA ePipe – PII

60% of DOT’s’s Requiring PII
Your Specs for Inspection

• Tell me about your Inspection Specs. For new projects.

• What going on in your community with respect to Asset Maint.?
Goal

Share information and tools to properly evaluate installed condition of RCP
Focus on Evaluating of Cracks

NOTE!
Insuring Correct Evaluation of RCP is Best Solution for all Stakeholders
Review = Inspection Tools and Techniques
This isn’t working at all... I should warn others not to put their cart before the horse.

Evaluation Guidelines a MUST!
BEST EVALUATION IS NOTHING TO EVALUATE!

Minimize ALMOST ALL RCP Issues:

- **START RIGHT – Stay Right!**
- **AASHTO R-073**
  - Evaluation and Acceptance of *Pre-Installed* Precast Products
- **Handle** with Reasonable Care
- **Provide** Firm Foundation
- **Provide** Soil Support that meets Design
- PREVENT SOIL MIGRATION = Good Joint Design
- **DO NOT** Force Pipe on Grade
- Proper **CAUTION** re: construction Loading
What Zones would you anticipate a crack to form
Anatomy of a Crack
Role of Reinforcement

Role of Reinforcement?
Where is crack the widest?
COME SEE......
3EB Test = Design Strength Confirmation

<table>
<thead>
<tr>
<th>ASTM C-76</th>
<th>$D_{0.01}$</th>
<th>$D_{ult}$</th>
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</thead>
<tbody>
<tr>
<td>CLASS I</td>
<td>800</td>
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</tr>
<tr>
<td>CLASS II</td>
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<tr>
<td>CLASS III</td>
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<tr>
<td>CLASS IV</td>
<td>2,000</td>
<td>3,000</td>
</tr>
<tr>
<td>CLASS V</td>
<td>3,000</td>
<td>3,750</td>
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</tbody>
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REINFORCING STEEL Working between $D_{0.01}$ to $D_{ult}$
$D_{0.01} - Design = 56,000 \text{ lbs} \newline (3.5 \times 8 \times 2000)$

$D_{ult} - Ultimate \ Load = 84,000 \text{ lbs} \newline (3.5 \times 8 \times 3000)$
Watch 3EB = Insight on Crack Behavior

• RCP Designed to accommodate small Cracks
• Small Crack will Still MEET Load
• Huge Load Capacity even after 0.01” crack
• Learn How Strong RCP is
• See the anatomy of load V crack formation

www.concrete-pipe.org
RCP Cracks – Apply Knowledge to Field Scenarios
Key Components of Crack Evaluation

Crack Pattern/location 
+ Crack Size (width and length) 
= Severity
Most Common CRACK PATTERNS,

- Longitudinal crack
- Circumferential crack
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
Longitudinal Cracks
Locations...Concern

Exhibit 108. Results of poor and good side support, rigid pipe.
Pattern - Radial Tension Sheer Cracks

- Cracks 30 deg off invert/W offset
- Slabs of concrete can become dislodged
- Slabbing is serious but can be repaired
Pattern - Circumferential Crack

Not of Structural Concern of Pipe Wall, but may need remediation if backfill can move through crack (road structure problem).
Why are Circumferential/Transverse Cracks Not a Structural Issue?
CRACK PATTERNS – Review

• Longitudinal crack
  ▪ Load Induced
  ▪ Not structural concern @ Invert & obvert
  ▪ *Watch for 5 & 7 O-clock* - Radial Tension Shear
  ▪ *Offsets across crack face* - Shear

• Circumferential crack
  ▪ Not structural concern or durability concern
  ▪ Exception: width allows transport of backfill
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

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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
AASHTO Const. W.P. & NCDOT Crack Eval. (Rigid Pipes):

- Cracks > 0.01” and < 0.05” are acceptable.
- Cracks > 0.05” but < 0.10” are acceptable unless the following additional conditions exist:
  - Minor repair is required if the pipe is located in an area of the state that exhibits corrosive soils.*
- If vertical offset across a crack is exhibited, the following guidelines shall be followed:
  - When vertical offset is less than 0.10” provide minor repair.
  - For vertical offset greater than 0.10” a determination will be made by the Department on the repair method or acceptability of the pipe.
- Cracks > 0.10” will be given consideration by the Department to replace the pipe or allow repair

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Crack Size – Summary

Concrete pipe is designed to handle controlled size cracks. PASS THE DIME TEST!!!

- Cracks ≤ 0.05” No Concern
- Cracks > 0.05 inch Consider Pattern & Ph
Summary - Key Components of Crack Evaluation

Crack Pattern/location
+ Crack Size (width and length)
= Severity

Size is Helpful – Pattern is Most Important (prefer having both but if can only have one – get pattern)
Evaluation Tools are Available!
New National Evaluation Guidelines Available….

• AASHTO Subcommittee of Construction
  ▪ Work Product - Pipe Inspection and Evaluation Guidelines
“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”
C1-Evaluate crack orientation.

C2-Is the crack longitudinal or 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.
MORE TOOLS COMING SOON!!!

ASTM xx.xx

“Inspection & Evaluation of Installed RCP”

COMING SUMMER 2017!
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 9 o-clock to 3 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)
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