Methods at Iowa DOT—Flooded Backfill and Plastic Pipe

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ABSTRACT

This presentation discusses methods used at the Iowa Department of Transportation (Iowa DOT) to address the problem of flooded backfill and plastic pipe.

Key words: flooded backfill—Iowa DOT—plastic pipe
Agenda

• Field problem to address
• Flooded Backfill
  – Research and abutment backfill application
  – Expansion to other applications
  – Current details
• Plastic Pipe
  – Specification
  – Pilot projects
• Questions?
Field Problem to Address

• Dips at bridges abutments
Flooded Backfill - Research

  - Conducted by Iowa State University in cooperation with CTRE, IHRB, and Iowa DOT.
  - Final Report issued in January 2005
  - Issued recommendations for pilot field trials
TR-481 Recommendations

• Use porous backfill behind abutments
• Use geo-composite drainage systems to improve drainage capacity and reduce erosion around the abutment.
• Connect the approach slab to the abutment
• Change expansion joint at the bridge to a construction joint of 2 inches.
TR-481 Recommendations continued…

• Use a more effective joint sealing system at the “CF” joint.
• Change the abutment wall rebar from #5 to #7 for non-integral abutments.
• For bridges with soft foundations or embankment soils, implement practices of better compaction, preloading, ground improvement, or soil reinforcement that reduces time-dependent post construction settlements.
Lab Evaluation of Granular Backfill

- Granular Backfill, Gradation #32, did not drain
  - Gradation #32 allows up to 10% passing the #200 sieve
- Granular Backfill is drainable when 4% or less pass the #200 sieve (Floodable Backfill)
Lab Evaluation of Abutment Backfill

- Equipment and Materials
  - 6.5’ long clear plastic tube
  - 2.25” inside diameter
  - Floodable Backfill
  - Porous Backfill
- Four trials performed
Lab Evaluation of Abutment Backfill Results

- After saturation – flow rate essentially the same for all trials
- Minimal migration of floodable backfill into porous
- Concern with floodable backfill bridging or bulking during flooding
Abutment Backfill Process

- Shape base of excavation
  - Slope 2% away from abutment footing
  - Slope 4% in direction of subdrain outlet
  - Compact excavation base
Abutment Backfill Process continued…

- Install geotextile fabric
  - In base of excavation and 3’ vertically
  - Anchored to footing and pinned in soil
Abutment Backfill Process continued…

• Install subdrain at toe of excavation
  – Extend subdrain through fabric at outlet
• Place 2’ of porous backfill uncompacted
• Place 2’ of floodable backfill uncompacted
  – Less than 4% passing #200 material
Abutment Backfill Process continued…

- Surface flood each 2’ lift of floodable backfill with water
  - Start at high point and work toward outlet
  - Surface flood for approx. 5 minutes, with a minimum 2 inch diameter hose, at each location
  - Location intervals approx. every 6’
Abutment Backfill Process continued…

- Proof test with vibratory compactor
Abutment Backfill Process continued…

• Proceed with next lift of floodable backfill, flood, and proof compact
• Repeat until backfill is to grade
Roadway Pipe Application

• Field Issue – Settlement at new roadway pipe installations

• Evaluated flooded backfill during 2005 Construction Season
Roadway Pipe Recommendations

• Use same material, lift thickness, and flooding technique as done with abutment backfill
• Place soil plugs at the ends of the pipe to contain floodable
• Use porous or floodable material for bedding – dependent on type of pipe
• Cap with flowable mortar in shallow installations
Roadway Pipe Bedding and Drainage

• For Concrete Pipe
  – Water escapes through pipe joints and subdrain
Use of Flowable Mortar Cap

- Fill \( \leq 4' \) over the pipe
  - Use 12” flowable mortar cap

- Fill \( > 4' \) over the pipe
  - a flowable mortar cap is not required
Flowable Mortar Test
Plastic Pipe

• 1974 FHWA requires concrete pipe on “high facilities”

• December 2006, FHWA changed the regulation.

• States are responsible for implementing
Test Projects

- Iowa DOT selected 6 test projects
- All of the significant grading projects over several years
Problems Flooding Plastic
Design Changes to Address Drainage

• Drainage
  – No pipe joints
Design Changes to Address Drainage

- For CMP or Plastic Pipe
  - Place 4” porous backfill below pipe and extend porous through the soil plugs
Keeping the Products Equal

• For Concrete Pipe
  – 2” of floodable backfill may replace the 4” of porous backfill
Design Changes to Address Floating

- With the porous backfill, any other method of securing the pipe was left to the contractor’s discretion.
Fair Bidding Between Products

Where a regrouted metal pipe envelope technique is to be employed, each envelope shall be manufactured by means approved by the Engineer. Envelopes may be developed either as a part of a shop fabrication or field installation.

The methods shown in the illustrations above are not the only methods which may be used to determine the appropriate Envelope Method for particular route of conduits, as follows:

(a) Trench and Envelope Construction
(b) Pour and Envelope Construction

Minimum and maximum allowable areas for envelope-protected pipe envelope shall be 2 feet and 4 feet, respectively.

1. The trench of the pipe and the pipe shall be excavated in accordance with the contractor's trench specification. The pipe is to be installed in the trench with the specified spoils placed on the sides of the trench.
2. The pipe shall be constructed with a concrete bed for a minimum of 12 inches in diameter and shall have a minimum of 3 inches of concrete placed on each side of the pipe to prevent movement of the pipe.
3. The pipe is to be covered with a concrete bed for a minimum of 12 inches in diameter and shall have a minimum of 3 inches of concrete placed on each side of the pipe to prevent movement of the pipe.
4. The concrete bed is to be placed in the trench with a minimum of 3 inches of concrete placed on each side of the pipe to prevent movement of the pipe.
5. The pipe is to be covered with a concrete bed for a minimum of 12 inches in diameter and shall have a minimum of 3 inches of concrete placed on each side of the pipe to prevent movement of the pipe.
Fair Bidding Between Products

Construct embankment to this line before placing culvert.

**FILL INSTALLATION**
(for rigid pipes only)

**CLASS ‘B’ BEDDING & BACKFILL**

Iowa Department of Transportation
Roadway Pipe Backfill Detail

When a single-steel pipe is placed using gravity flow, each steel pipe shall be separated by minimum embedment depths of 10 feet (3.0 meters) in length. Longitudinal spacing may be increased as required to reduce frictional forces. Minimum embedment depths per (2) class shall be shown on the approved roadway cross-section. All embedment depths shall be at least 10 feet (3.0 meters) in length.

- Trench installation:
  - Backfill shall extend to the side of the trench.
  - Trench shall be backfilled with a minimum of 10 feet (3.0 meters) in length.

- Elongated pipe:
  - Pipe shall extend to the side of the trench.
  - Trench shall be backfilled with a minimum of 10 feet (3.0 meters) in length.

- Typical section - soil plug:
  - Soil plug shall extend to the side of the trench.
  - Trench shall be backfilled with a minimum of 10 feet (3.0 meters) in length.

- Overall bedding and backfill:
  - Bedding shall extend to the side of the trench.
  - Trench shall be backfilled with a minimum of 10 feet (3.0 meters) in length.
Results?

- No plastic pipe were used on the 6 test projects
- CMP pipe were used. Floating was not a problem.
Questions?

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