"Drainage Structures on County Roads"

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Drainage Structures for Roadways

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AGENDA

MODULE 1: PRECAST REINFORCED BOX CULVERT BASICS
MODULE 2: MANUFACTURING PROCESS
MODULE 3: PROPER INSTALLATION PROCEDURES
MODULE 4: BOX CULVERT APPLICATIONS/FEATURES
MODULE 5: THREE-SIDED RIGID STRUCTURES

LEARNING OUTCOMES

1. Explain the basics of precast box culverts
2. Explain the proper procedures for proper box culvert installation
3. Explain the different applications of precast box culverts
4. Explain how precast box culverts enable a pipe/bridge crew.
5. Explain the proper components for installation of a three-sided rigid frame
INSTALLATION METHODS

Trench Embankment Tunnel

Bedding - Leveling Course (6" Normal // 8" to 24" Rocky)

Foundation

Compacted Fill Material

0' Minimum Cover for Design Loading

3' Minimum Cover for Construction Loading

Trench

Embankment

Tunnel

3' Minimum Cover for Construction Loading

0' Minimum Cover for Design Loading

Bedding - Leveling Course (6" Normal // 8" to 24" Rocky)

Foundation
**Bedding - Leveling Course**

- A bedding thickness of 6 inches in non-rocky foundation.
- If foundation is rock, bedding should be a minimum of 8" (24" max).
- RCBs are designed for installed conditions not test conditions.
- Bedding should have a uniform flat surface.
- Coarse bedding materials are not beneficial due to irregular/sharp angles.
- Bedding width should equal the width of the box and the length of the box.

**Compacted Fill Material**

- This protects the box culvert during installation from impact damage.
- Should be placed in uniform layers along sides/over top of box sections.
- Should contain no debris, organic matter, frozen material or large stones.
- Placed and compacted to prevent settlement at the surface.
- Compaction and equipment loads should not exceed design strength.

**REINFORCEMENT**

- Two Layers of Steel
- Sheets of WWF
- Rebar Mats

Spacers-Ensure Space Between Wheels – Keep Steel from Wall

Spacers-Ensure Space Between Wheels – Keep Steel from Wall
MANUFACTURING

ASTM C1433
ASTM C1577

Welded wire fabric 65,000 psi
Concrete 5,000 psi
Dry Cast/Wet Cast/Steam Cured
Installation

- Scheduling/Unloading should be discussed to insure efficient delivery process.
- Prepare site, excavate trenches to the minimum required for box culvert installation.
- Divert drainage.
- Establish a good level grade using fine to medium granular material.
- Bedding – Leveling course should be a minimum of three (3) inches, except in rocky foundation it should be six (6) inches minimum.
- Make sure the first few box sections are installed correctly, this will influence line and grade to follow.
- Place joint material on the bottom half of the groove & top half of the tongue of box.
- Make certain to check that boxes are aligned correctly prior to pushing home.
- Keep the weight of the box section, being set, on the crane and use winches to pull the joint/home/dozer to home.
- Place backfill around structure to finished grade.
Construction Loads
Earth Loads
Live Loads

DIVERT DRAINAGE

Divert Drainage: Maintain dry conditions for installation
GRAVITY FLOW
Retain water upstream
Release through/around jobsite

EXCAVATION
Excavate when Necessary
Excavate for backfill/bedding
Pipe Foundation

- Explore Foundation to determine the type and condition of the foundation
- Explore to a depth in order to determine suitability
- Stable Foundation must be provided to ensure proper line and grade is maintained (select pipe bedding)

Unsuitable Material
Excavated and replaced with suitable select material
Unloading RCBs
Contact manufacturer to determine weight

Section Placement
Placement of RCBs
1st RCB sets the stage
Take your time and get it right
More time on #1 smoother it goes

Section Placement
Install first few boxes with care
Influence line and grade of rest

SKewed END/penetration
Placement of RCBs
2nd section can shift first section.
Skewed Sections/Shorter End Pieces

Placement of Gasket
Do not overlap gasket material

3/4 to 1-inch gap per
Manufacturer’s recommendation

Preformed butyl blend joint material
meeting AASHTO M-196-B
1 - square inch
Placement of Gasket
Can Arrive Already in Place

Homing of box culverts
Several techniques driven by crew capabilities, EQPT/Conditions
Continual Check Grade/Bedding

Bedding Adjustments
Keep Bedding Level
Continuously check Grade
Homing of box culverts
Ensure bedding is smooth at face of joint. Smooth out in order to improve homing of RCBs.
Placement of Membrane
All box joints
Top external joint
Extend 1' down sides
Min. width/12'-6" each side of c/l
Multi-Barrel
Create distributed load condition
Lean Grout (6" min.)
Lifts (8" max.)
1.5 Sacks p/Ton material mixture
Or
3 to 6 inches Aggregate
Size No. 78 or No. 8 (min. Grade B)

Box Culvert Bedding/Backfill
Multi-Barrel
Create distributed load condition
Lean Grout (6" min.)
Lifts (8" max.)
1.5 Sacks pc/Ton material mixture
Or
3 to 6 inches
Size No. 78 or No. 8 (min. Grade B)
Box Culvert Bedding/Backfill

Backfill material placed in lifts (6" loose/4" compacted)
Backfill free of lumps/stumps/Rocks
Bedding/Leveling Course (4"-8")

Structural Backfill
Compact 6" loose / 4" tight
Avoid Damage to Box Culvert
Compact to Receive Driving Surface
Structural Backfill
Compact 6" loose/4" tight
Avoid Damage to Box Culvert
Compact to Receive Driving Surface

End Treatments
Footings
Toewalls/Wingwalls
Aprons
Headwalls/Apron/Wingwalls
WWF exposed along top/walls/bottom

#4 Rebar @ 10" o.c. top of headwall
#4 J Bar (2 per box) for headwall
Headwalls/Apron/Wingwalls Match Embankment Slope

Headwalls/Apron/Wingwalls Flared to Maximize Flow Reduce Maintenance
ACCELERATED PRECAST CONSTRUCTION CHARACTERISTICS

MULTI-BARREL**SKEWS**PENETRATIONS**LOW WATER CROSSING **ELBOWS**MINIMAL COVER**OPEN CHANNEL**BOTTOMLESS BOX LARGE BOX CULVERTS**MULTICELL**JACKING BOX CULVERTS

O'Brien County, Iowa
Hancock Concrete Products

Single 12' x 10'
Curved Alignment
End Section 2:1or3:1 Slope
0-15-30-45 degree skews

1' U-Tie 1' above Centerline
Multi-Cell
Reduces Installation Time
Requires Greater Lift Capability
Precast Headwall Attached

Innovative
Low Flow Culvert
Corbels for Approach Slabs
Large Box Culverts
Allowed per Special Design
Up to 24’ Span (Wet Cast)
Requires Greater Lift Capability

23 x 8 Reducer

Determine the weight of 8’x8’ RCB:
- Cast in place (9.5”x8”x9.5”) = 0.992 CY/FT = 2.01 tons/ft
- Precast
  - (8”x8”x8”) = 1.8 tons/ft
  - (8”x7”x7”) = 1.63 tons/ft
- Concrete = 150#/CF or 4050#/CY

Which does a contractor prefer:
- 5’x2’ Cast In Place
- 5’x2’ Precast

Low Water Crossing
Triple Barrel CMP
Vertical Curve with Highpoint
Roadway Washes Away Each Event
Features
Multi-Cell Precast Box Culvert
Level Grade to Minimize Velocity
Toe-Walls & Apron Tied into Boxes

Peak Flow
SKEWED END

RCBs are skewed
Left Forward Skew
Right Forward Skew
Limited: size/degree of skew

Features
Penetration Addressed in Plant
Top and Bottom Penetrations

Features
Penetration Addressed in Field
Contract Manufacturer
Features
Manufacture Any Bend Angle
Bends on Multi-Barrels
Saves Money/Eliminates Junction Box

Innovations
Precast Fitting Saves Money + Time
Versus Cast in Place
Factors
1. Nature of soil, water table & effects of dewatering
2. Jacking/Receiving Pit
3. Length, alignment and outside dimension of pipeline
4. Jacking Forces
5. Pipe Joints
6. Loads on shield and pipe
7. Size of invert cone
8. Lubrication
9. Grouting
10. Spoils Removal
THREE-SIDED RIGID FRAME

Terminology

- Final Backfill
- 0’ Minimum Cover for Design Loading
- 3’ Minimum Cover for Construction Loading
- Compacted Fill Material
- Foundation
- Piles (if required)
- Shim(s)
- Footer/Keyway (Per Manufacturer’s Design)
Installation

- Planning/Scheduling insures efficient process.
- Lift plan/handling discussion addresses adequate lift capacity and procedures.
- Prepare site, including any diversion of drainage.
- Construct footing per design/Inspect for compliance.
- Place sections, shim for support.
- Keep the weight of the section, being set, on the crane and pull section home to final position.
- Grout keyway in rigid frame, grout at footing.
- Place external joint wrap material across the top and one foot down the wall of the 3 sided rigid frame.
- Place backfill in specified lifts (alternating sides) on each side of structure to finished grade.

Prepare Site – Key Steps

- Divert Drainage
- Reroute Utilities
- Excavation/Demolition/Removal

Footing

- Inspected before delivery of sections
- Cast-in-place footing
- Keyway sized per leg dimension
- Soil bearing capacity data provided by engineer/owner
Styles
- Spread Footing
- Stem wall
- Pile Supported

Precast Footing
- Precast Rigid Frame
- Precast Wingwalls
- Precast Footers

Planning/Scheduling
- Completed Before Delivery
- Lift plan determined
- Ensures efficiency
- Critical Path Created
- Route – Traffic Considerations

40'x12'x8'
(12' legs/18'' slab = 105,600#)
- **Installation**
  - Lift Plan/Handling
  - **Plan = Success**
    - Identifying Proper Crane
      - i. Reach
      - ii. Lift capacity
    - Rigging
  - **Warren County**
    - Shipping Restrictions
    - Double Drum Crane

- **Shims**
  - Addresses irregularities
  - Creates uniform bearing
  - Shims may vary in thickness
Installation
Placement

Proper Equipment is Critical
Take your time and get it right
Ensure sections sealed properly

Placing additional sections

Placing 1st Section

Installation
Placement

All Sections placed

Almost Completed

Completed
Bridge Replaced

Multi-cell options
Guard rail capable

External sealing band
- Across top & T-dowel wall
- Prevent migration of soils
End Treatments
- Headwall/parapet
- Wingwalls
- Torewalls
- Apron
- Gabions/Rip rap

Embeds
- Rails
- Wing walls
- Head walls
- Parapets
- Curbs

Minimum Cover
- Designed for 0' cover (minimum)
- Wearing surface required
Installation

Skew

Plan View

Skews
- Standard Skews
- Special Skews
- Multi-cell Skew
Why Consider Accelerated Precast Construction?

The traveling public deserves it.
FHWA is promoting it.
ACPA wants to team with FHWA.
Our Industry Provides it.
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