Excavation - Chapter 3

The “What and Where of Excavation
“What” is Excavation

The removal of Earth material
“Where” is Excavating Done

- For Structure Foundations
  (Bridges, Retaining Walls, Etc.)

- Box Culverts

- Cofferdams & Cribs
Types of Excavation

- **Unclassified Excavation**
  - for building berms & channels
  - performed with earth moving equipment

- **Structure Excavation**
  - for structure foundations
  - box culvert bottom slabs
  - cutoff walls
  - performed w/ front-end loader, Track Excavator, backhoe, clam, etc.
Types of Excavation cont.

- **Undercut**
  - for preparing grade for box culvert or pipe
Structure Excavation

Excavator, Crane & Clam
Excavation for Bridges
How is the Quantity determined?

- **Unclassified Excavation**
  - preliminary cross sections first
  - they determine amount of excavation necessary
Excavation for Bridges

- Unclassified Excavation
  - Cross section at break points help determine if berm is correctly built
Excavation for Bridges

- **Unclassified Excavation**
  - skewed structure
  - more cross sections required

Pg 3-21, Fig 3.2
Excavation for Bridges

- Unclassified Excavation (Channel)
  - If channel work required
  - Cross sections at right angles to channel centerline

Pg 3-22
Fig 3.3
Excavation for Bridges

- **Structure Excavation**
  
  - Standard Specs state structure excavation will be paid for at plans shown quantities.
  
  - However, Engineer can request measurements of excavation be taken.
Excavation for Bridges

Structure Excavation Calculations

Pg 3-22
Fig 3.4
Excavation for Bridges

Structure Excavation Calculations

- some plans show dividing line between unclassified and structure excavation.
Excavation for Bridges

Structure
Excavation Calculations

Pg 3-23, Fig 3.5

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Excavation for Bridges

- **Structure Excavation Calculations-** using top elevation
  - fill has not begun

Pg 3-23
Fig 3.6
Excavation for Bridges

- **Structure Excavation Calculations** - using top elevation
  - fill is complete

Pg 3-24
Fig 3.7
Excavation for Bridges

- **Structure Excavation Calculations-**
  - using top elevation
  - fill is complete

![Diagram](image)

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Pg 3-24  
Fig 3.8
Excavation for Box Culverts

- Split between unclassified & structure excavation is the flowline.
- Pay based on excavation from flowline to bedding grade
Excavation for Box Culverts

- Excavation Limits for Box Culvert

Pg 3-25, Fig 3.9
Excavation for Box Culverts

- Cross Section Locations
Foundation Bearings

- Spread Footings
- Box Culvert
Foundation Bearing

- Spread Footings
  - large reinforced concrete pad that distributes load
  - size depends on bearing strength of soil under footing
  - check plans for framing method
    - Cast to neat lines in undisturbed material
    - Place concrete shortly after excavation
Foundation Bearing

- Box Culverts
  - monitor excavation near bottom of box culvert excavation for suitable bearing material
  - Substrata rock, gravel or moist sand is adequate base.
  - no simple method to determine bearing adequacy of other materials.
  - experience
Typical Undercut Limits
Foundation Bearing

- **Box Culverts-Backfilling**

  - materials conform to Section 421
  - placed in horizontal lifts not to exceed 6” each
  - compact to 95% of max. dry density
  - take periodic tests to verify compaction per the SDDOT Materials Manual
Sump Pump and Rock Substrata
Undercut Backfill failure
Foundation Bearing

- Box Culverts-Extruded Insulation Board
  - reduces effects of frost heave
  - insure equipment used to place & spread top layer of backfill is only operated on full depth of backfill
  - Pg 3-29, Fig 3.11
RCBC Insulation Board

Fig 3.11
Pg 3-30

TYPICAL SECTION
(FOR LIMITS OF UNDERCUT)
Insulation Board Installation
Cofferdam and Crib

- Cofferdam
Cofferdam and Crib

**Cofferdam**

- Bracing ring placed inside
- built by driving sheet pile around excavation area
- Interior material removed from back side
Cofferdam

Top bracing inside cofferdam

Sheet piles

Planned concrete footing

Concrete seal

Excavated area

Piles

Typical
Cofferdam and Crib

- Cofferdam
Cofferdam and Crib

- Crib
  - built complete with bracing
  - set over area to be excavated
  - sinks as area is excavated
Steel Crib
Cribs
Trench Box
Cofferdam and Crib

**Problems to watch for**

- water buildup in excavation area
- remove with pumps or well points
- insure sheet piling is deep enough to prevent “blow-in” failures
- foundation seal
- area large enough to allow work on foundation. Allow 2-3’
- Safety concerns should be coordinated with Project Engineer, Temporary Work Spec
Cofferdam Failure
Backfilling

- Most structural concrete units **can not** be backfilled until the concrete reaches full design strength, Sec 460.3.Q of Standard Spec
- Backfill material usually is the same material that was originally removed.
- Place in layers - 3” to 6” in depth
- Compaction with pan type vibrating equipment to same density as surrounding material
- Backfill brought up evenly on both sides structural member
Backfilling
Box Culverts and Large Pipe

- Standard Backfill Method with like Materials.
  - Backfill brought up evenly in < 6” lifts and compacted by mechanical compactors
  - Usually same material as excavated material but may be a backfill material as specified in plans

- Imperfect Trench

- Flowable Fill

- Special Provisions may apply
Imperfect Trench

FIG. 1-E - CULVERT DETAILS
Backfilling

- Flowable Fill
  - Portland Cement
  - Fine Aggregate
  - FlyAsh
  - Water
Bridge End Backfill

- Bridge Berm Constructed per Plans and Cross Sections
- Review Special Provision, Plans and Specifications
- Construct Bridge Backfill per plans.
Bridge End Backfill

- Construct Embankment to plan configuration
  - Embankment optimum moisture: < 25%
  - Complete the necessary embankment densities (97% of maximum dry)
  - Backfill limits: 100 ft back of abutment bound by toe of bridge berm
    - 3 equally spaced densities for embankments less than 7 ft
    - 4 equally spaced densities for embankments greater than 7 ft
STATE OF SOUTH DAKOTA
DEPARTMENT OF TRANSPORTATION

SPECIAL PROVISION
FOR
BRIDGE END BACKFILL

JUNE 17, 2010

Delete Section 430 of the Standard Specifications for Roads and Bridges and replace with the following:

430.1 DESCRIPTION

This work consists of backfilling bridge abutments and sills.
Bridge End Backfill

- Select Granular Backfill - plan sheet on 3-32
  - Excavate to plans lines, scarify top 6 inches and recompact the area to 97% of max. dry density
  - Install underdrain system
  - Layout drainage fabric in which granular material is wrapped in
  - Place embankment and granular material in 8” lifts and compact each layer
  - Wrap fabric around granular material
  - Place Poly sheeting over the granular material
Bridge End Backfill Sequence of Operation

- Install Underdrain System Adjacent to Abutment Backwall
  - Place polyethylene sheeting
  - Install vertical drain
  - Place porous backfill and 4 in drainage tubing @ 1/8 inch per foot
Bridge End Backfill
Sequence of Operation

Placement of Granular Bridge End Backfill
- Material must meet plan or special provision specifications.
- Testing requirements per the MSTR of the SDDOT Materials Manual
- Two Densities at even interval throughout the height of the abutment.
Bridge End Backfill Excavation Limits

4" Dia Corrugated Polyethylene Drainage Tubing (Typ.)

Limits of Bridge End Embankment
Backfill Daylight on Shoulder

SEC. A - A
Bridge Backfill Profile

SEC. A - A
(At C2 Roadway)

*12" at C Roadway. Bottom of Trench Shall Match 1/8" per Foot Pipe Slope.
Bridge End Backfill Underdrain Detail

Granular Bridge End Backfill

Vertical Composite Drain

Abutment Backwall

Top of Berm

Type B Drainage Fabric

6 Mil Polyethylene Sheeting

Porous Backfill

4" Dia. Corrugated Polyethylene Perforated Drainage Tubing

Non-pervious Backfill Material. Backfill to be compacted to the satisfaction of the Engineer.

DETAIL "X"
(Normal to Q Abutment)
Bridge End Backfill Phased Construction

- Phase Construction shall be mechanically stabilized in accordance with the plans.
- Verify all Geotextile Fabric is taut & free of wrinkles.
- Repair all torn and punctured Geotextile Fabric per Special Provisions. Overlapped 3 ft.
- Seams shall be overlapped a minimum of 2 ft.
- Seams shall sewn using High Strength Polyester, Polypropylene or Kevlar thread.
- **Nylon thread shall not be used.**
- Geotextile Fabric shall be enclosed in a heavy duty opaque wrapping to protect from direct sunlight during storage.
Mechanically Stabilized backfill
Approach Slab Underdrain:
- Complete embankment constructed prior to excavating for approach slab underdrain
- Trench shall be 8 to 12 inches wide with vertical sides
- Trench bottom transversely graded @ 1/8th inch/ft for proper drainage
- Place 4 inch perforated drainage tubing and backfill trench with porous backfill.
- Compact porous backfill to the satisfaction of the Engineer.
Bridge End Backfill

- Tools
More Information?

- Review Plans
- Special Provisions
- Review Spec Book
- Check chapter 3 of the Structures Construction Manual
- Ask your supervisor

Questions?
- Call Office of Bridge Design 605-773-3285
Not all goes well.
10 Minute Bathroom Break