Experimental Study ND 98-06

Fabric Reinforced Backfill
Under Approach Slabs

Final Report

PROJECT NH-4-002(051)138

August 2004

Prepared by

NORTH DAKOTA DEPARTMENT OF TRANSPORTATION
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Ron Horner
**EXPERIMENTAL PROJECT REPORT**

### EXPERIMENTAL PROJECT

- **NO.**: CONSTRUCTION PROJ NO
- **STATE**: ND
- **YEAR**: 98
- **NUMBER**: 06
- **SURF**: NH-4-002(051)138
- **LOCATION**: Ward County

### EVALUATION FUNDING

- **NEEP NO.**: 48
- **PROPRIETARY FEATURE?**: Yes
- **1 x HP&R**: 1
- **DEMONSTRATION**: 3
- **2 x CONSTRUCTION**: 2
- **IMPLEMENTATION**: 4

### SHORT TITLE

**TITLE**: Fabric Reinforced Backfill Under Approach Slabs

### THIS FORM

**DATE**

- **MO. YR. REPORTING**: 05-02-02
- **INITIAL**: 1
- **ANNUAL**: 2
- **FINAL**: 3

### KEY WORDS

- **KEY WORD 1**: BRIDGESUBSTRUCTURES
- **KEY WORD 2**: APPROACHES
- **KEY WORD 3**: 145
- **KEY WORD 4**: 167
- **UNIQUE WORD**: 233
- **PROPRIETARY FEATURE NAME**: 255

### CHRONOLOGY

- **Date Work Plan Approved**: 02-1998
- **Date Feature Constructed**: 09-1998
- **Evaluation Scheduled Until**: 09-2008
- **Evaluation Extended Until**: 289
- **Date Evaluation Terminated**: 08-2004

### QUANTITY AND COST

- **QUANTITY OF UNITS (ROUNDED TO WHOLE NUMBERS)**
- **UNIT COST (Dollars, Cents)**
- **LIN. FT**: 1
- **SY**: 2
- **SY-IN**: 3
- **CY**: 4
- **TON**: 5
- **LBS**: 6
- **EACH**: 7
- **LUMP SUM**: 8

### AVAILABLE EVALUATION REPORTS

- **CONSTRUCTION**: 315
- **PERFORMANCE**: X
- **FINAL**: X

### CONSTRUCTION PROBLEMS

- **NONE**: 1
- **SLIGHT**: 2
- **MODERATE**: 3
- **SIGNIFICANT**: 4
- **SEVERE**: 5

### PERFORMANCE

- **EXCELLENT**: 1
- **GOOD**: 2
- **SATISFACTORY**: 3
- **MARGINAL**: 4
- **UNSATISFACTORY**: 5

### APPLICATION

- **ADOPTED AS PRIMARY STD.**: 1
- **PERMITTED ALTERNATIVE**: 2
- **ADOPTED CONDITIONALLY**: 3

### REMARKS

The R1 reinforcement fabric used to wrap the select backfill failed to meet strength specifications, but was not removed. A drop in height from the asphalt to the approach slab, causes unnecessary dynamic impacting of the approach slab and bridge. Settlement at the beginning of the approach slabs after 5 years was 3.0" for the Experimental Section and 1.6" for the Control Section. This was after maintenance patches were applied to reduce the bump. The approach slabs were mudjacked in 2003 to original elevations.
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August 2004

Written by
Mike Marquart
Disclaimer

The contents of this report reflect the views of the author or authors who are responsible for the facts and the accuracy of the data presented herein. The contents do not reflect the official views of the North Dakota Department of Transportation or the Federal Highway Administration. This report does not constitute a standard, specification, or regulation.
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EVALUATION OF FABRIC REINFORCED BACKFILL UNDER APPROACH SLABS

Background

A bump often develops at the ends of a bridge near the interface of the abutment and the embankment or if an approach slab is used, between the end of the approach slab and the embankment. Reduction in steering response, distraction to the driver, added risk and expense to maintenance operations, and reduction in a transportation agency’s public image are all undesirable effects of these uneven irregular transitions. A bump that is allowed to persist increases the chance of damage to the bridge deck from the dynamic impact of vehicles. These impact loads have been estimated to be four or five times larger than the static loads; “Hu, Y., T. Wu, C. E. Lee, and R. Machemehl, Roughness at the Pavement-Bridge Interface, Report No. 213-1F, Texas State Department of Highways and Public Transportation, Austin, Texas (August 1997) 157 PP”. Damage to the bridge deck can also be caused by snow plows in the winter. In addition, the bump can cause damage to vehicles.

The bump at the end of the bridge is a complex problem involving a number of components, including the natural soil on which the embankment and the abutment are built, the approach fill material, the foundation type used for the bridge abutment, the abutment type, the structure type, the bridge/roadway joints, the approach slab, the roadway paving, and the construction methods. The problem affects twenty-five percent of the bridges in the United States, approximately 150,000 bridges. Each year, the amount of money spent on this problem nationwide is estimated to be at least $100 million. Survey results indicate that integral bridge abutments appear to be a special case where a bump is consistently created resulting from temperature cycles and the associated compression and decompression of the approach fill by the abutment wall.
Objective
The conventional method of constructing the embankment behind an abutment wall has not prevented the bump at the end of the bridge to any great degree. The objective of this experimental feature is to build a better foundation under the approach slab that will eliminate the bump at the interface of the approach slab and the asphalt pavement. See Figure 1

Location
This experimental feature is located on the Burlington Separation Bridge Project NH-4-002(051)138. It will be constructed on the approach end of the bridge in the eastbound lanes. The approach slab on the bridge of the westbound lanes will be used as a control. Project plan sheets and typical sections are found in Appendix A.
## Project History

### Traffic

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Table 1

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<td>1.0&quot; Milling</td>
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<td>1992</td>
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<td>1992</td>
<td>Finished Roadway Width</td>
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Table 2
**Design**

The design carries the select backfill at a 20:1 taper from the abutment all the way back until it intercepts the pavement section. The new design shows installing a void form against the abutment and building what is essentially a retaining wall against the void form. The form is later washed away to leave a 3” to 4” void that will allow the abutment to move without affecting the select backfill. Geotextile reinforcement fabric is to be used and the select backfill is to be compacted in one foot layers. The geotextile fabric is also required to be wrapped back on the sides with each foot of fill. A drainage system behind the abutment is also provided.

Design details showing the fabric reinforced backfill under the approach slab are located in Figures 2 and 3. They are also shown in Appendix B. This experimental feature was change ordered on to project NH-4-002(051)138. The change order 2p is located in Appendix B.

![Figure 2: Detail for Fabric Reinforced Backfill under the Approach Slab](image-url)
Figure 3  Detail for Fabric Reinforced Backfill under the Approach Slab
Although there is no typical drawing for the Control Section, compaction and density control for the Control Section was in accordance with Section 203.02 G of the Standard Specifications T-180. The embankment is placed in horizontal layers not exceeding 12 inches and compacted to the specified density before the next layer is placed. The soil layers are compacted to 85% of the maximum dry density as determined by AASHTO T-180. Soil moisture at the time of compaction shall be not less than the optimum moisture content and no more than 5 percentage points above the optimum moisture content.

**Construction**

Construction began on March 30, 1998 and was opened to traffic on October 27, 1998. Ron Harris Construction removed the common excavation waste material over the Structural Plate Pipe (SPP) tunnel and rough graded the 20:1 taper section at the same time. The 20:1 sections were roughly graded for the approach and end slabs. Industrial Builders then excavated for the abutments and fine graded the 20:1 sections. Abutments were poured and grading was performed for the installation of the 4" drainage system.

The drainage system was installed according to the plans. A 4" PVC perforated pipe was used and covered with size 4 drainage rock which was protected by D2 type geotextile fabric. The drainage rock that was used with the perforated PVC pipe was installed at the same time as the select backfill was installed. There was no way the drainage rock could be installed without bringing the select backfill up with it at the same time. The non-perforated PVC pipe lengths had to be adjusted to fit the existing slopes around each abutment.

The following pictures show construction of the experimental section under the approach slab of abutment 1 of the eastbound Bridge.
Photo 1 – Tacking R1 fabric before placement of the next one foot of select fill.

Photo 2 – Select fill placed over fabric wrap.
Photo 3 – Cutting void form for installation against abutment wall.

Photo 4 – Asphalt meets approach slab of the control section.
A class 5 material was tested and met the requirement for select fill. The test worksheet is located in Appendix B. The 3" void material was not available in such small quantities and an alternate 4" void form was used.

Geotextile fabrics were used to wrap the drainage system and in the select backfill. A D2 type filter fabric was used to wrap the 4" drainage system. R1 reinforcement fabric was used to wrap each 1' lift of select backfill until the required height was reached.

The approach slab was formed and poured over the experimental section at the same time as the bridge deck. The approach slab is 14" thick. Appendix B contains the concrete proportion design and compression test of a concrete cylinder for the approach slab. The roadway was paved with asphalt up to the approach slab. Photos were taken after the project was completed. Photos 4 and 5 show the approach slab of abutment 4-westbound bridge (control section). Photo 5 shows that the slab is in good condition and that the joint looks good.

Photo 5 – Approach slab meets bridge in the control section – Westbound Bridge.
Photo 6 shows a view looking west at the experimental approach slab of the eastbound bridge of the Burlington bridges. These bridges have been open to traffic for about one day. Photo 7 shows the beginning of the approach slab and surface tining. A slight dip was noticed where the asphalt meets the concrete, but appears not to affect the ride as observed from the side of the road.

Photo 6 - Overview of experimental approach slab – Abutment 1 Eastbound Bridge.
Photo 7 – Asphalt meets approach slab of the experimental section.

Photo 8 shows where the approach slab on the left side of the photo meets the bridge on the right.

Photo 8 – Approach slab of the experimental section meets the bridge.
An elevation survey was conducted of the finished experimental approach slab and transition. This is to aid in the annual evaluation of the experimental project. A copy of the survey is located in Appendix C. The elevation survey did not include the control section in 1998.

**Cost**

The experimental section required 4 feet of select backfill which is about 2.5 feet less than would have been used in a standard design. The following is a break-down of the costs of the experimental section approach slab and a control or a conventionally built approach slab.

**Abutment 1 - eastbound bridge entrance approach slab (Experimental Project)**

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<td>Underdrain Pipe - PVC Non-perforated - 4in = 54 LF x $14/LF</td>
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<td>Cost of fabric, extra drainage rock and void form</td>
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<td>Cost subtracted for failing fabric</td>
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**Abutment 4 - westbound bridge entrance approach slab (Control)**

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<td>Total</td>
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Five Years and Final Evaluation

The test and control sections were visited on 11/23/99, 12/06/00, 11/15/01, 11/20/02, and 10/03/03. The asphalt roadway was chip sealed in 1999. This chip seal added a little height to the roadway and made the slight bump where the asphalt meets the approach slab more severe.

During the summer of 2000, a contract project to mill bumps at bridges included this experimental section. The milling improved the general overall ride but did not completely remove the bump. Photo 9 shows that in the cold winter months a 1 inch gap opens up between the asphalt and approach slabs. A tape measure can be inserted to a depth ranging from 6 to 12 inches.

Photo 9 – Winter 1999 gap opening of 1 inch between asphalt and approach slab in the Control Section WB.

Photo’s 10, 11, and 12 from years 1999 and 2000 show conditions that existed including bumps, gaps, and sealant failure.
Photo 10 – Experimental Section 1999 EB - asphalt to approach slab - dip.

This bump in the eastbound experimental section where the asphalt meets the approach slab has been getting worse each year. Photo’s 12 and 13 were taken in November of 2001. The approach slab receives a dynamic load each time a loaded truck hits it at highway speeds. This puts a lot of stress on the approach slab.
Photo 12 – Shows drop from asphalt to approach slab in the outside wheelpath of the experimental section of approximately \( \frac{3}{4} \) inch.

Photo 13 – Between wheel paths of driving lane – 1 \( \frac{1}{2} \)” drop from asphalt to approach slab.
The approach slabs are settling as shown in photos 14 and 15. This measurement is taken at the end of the wing wall which is 14 feet from the abutment wall or 4 feet from the beginning of the approach slab.

Photo 14 – 1 3/8” drop from wingwall to approach slab. Experimental section Rt.

Photo 15 – Experimental section Lt. Side – or Passing lane side, the guard rail bolts show stressing at the wingwall due to settling of the approach slab.
An elevation survey was conducted in 1998 on the test section (EB) beginning at the bridge and continuing 100 feet back into the asphalt pavement.

The control section (WB) was included in the elevation survey in 1999. The difference in elevation at each location was determined from 1999 to 2003 data. The elevation data is located in Appendix C. These changes in elevation are shown in the following graphs. Notice that the drop in elevation in the eastbound roadway or experimental section is slightly less than the drop in the control section. The data averaged for years 1999, 2000, and 2001 show a decrease in elevation of 2.5” for the control and 1.6” for the experimental section. The average elevation decrease figured for 2002 and 2003 was 1.6” for the control and 3” for the experimental section.

Elevations are measured at five points across the roadway, 18 feet left of centerline, 12 feet left of centerline, centerline, 12 feet right of centerline, and 22 feet right of centerline. These five points have been graphed and are shown as follows. Overall, the experimental section has not prevented the bump from occurring at the end of the approach slab. The graphs show about a 1% difference in elevation drop between the experimental section and the control section. This was the difference as of June 2003. It must be pointed out that these elevation differences between the control and experimental sections keep changing due to maintenance patching to smooth the ride.

![Graph 1](image-url)
Graph 4

Graph 5
Elevations for the control section were not collected in 1998. The graphs show that both sections, the experimental section and the control section, was consolidating up to the year 2000. The eastbound experimental section at all 5 points shows very little change in elevation from 2000 to 2001 except at the approach slab/asphalt contact. The control section is still showing consolidation at all 5 points.

In the experimental section, eastbound bridge, the asphalt is slightly higher than the concrete approach slab. This sudden change in elevation causes dynamic impacts by heavy vehicles and may be part of the reason it is still consolidating in 2001.

**Mud Jacking Approach Slabs**

The experimental feature to build a better foundation under the approach slab that would prevent the bump at the approach slab/asphalt pavement interface, has not been successful. The NDDOT thus included this experimental project in a contract to repair bridges and box culverts in 2003. The work included lifting the north and south approach slabs of the twin structures. The mud jacking was to lift the slabs to their original positions.

The 5 cross-section points of each section were plotted for comparison in graphs 6 through 19. The data representing 2003 is before mud-jacking and 2003A is after mud-jacking.
Graph 18

Graph 19
**Summary**

Spreading and compacting asphalt so it is level with the concrete approach slab is difficult. In this case, the asphalt after construction was slightly higher than the approach slab. The performance evaluation is based on the decrease in elevation over time.

The cross-section graphs show that roadway consolidation is still taking place in the control section; whereas the experimental section has stopped consolidating with exception to one location. The existing bump or dip in the experimental section at the approach slab/asphalt contact results in the application of dynamic load to the concrete approach slab by heavy vehicles. This dynamic loading may be contributing to the settlement at this interface.

The data averaged from the evaluation surveys conducted in 1999, 2000, and 2001 indicate that the average decrease in elevation was 2.5” for the control and 1.6” for the experimental section. The 2002 and 2003 evaluations show a decrease in elevation from the original to be 1.6” for the control section and 3” for the experimental section.

This experimental feature to build a better foundation under the approach slab that would prevent the bump at the interface of the approach slab and asphalt pavement, was not successful. The mud jacking of the approach slabs restored the slabs near their original elevations. Graphs 20 and 21 show the original approach slab elevations near the asphalt pavement interface for both eastbound and westbound bridges.

![Graph 20](image-url)
Recommendation

It is questionable whether the method used on this bridge project of constructing a bridge approach slab and embankment is the appropriate method to use to try and prevent the bump at the interface of the approach slab and embankment.

It is recommended that whatever method is selected for constructing the embankment behind the abutment wall, that emphasis be placed on compaction. Compaction seems to be the leading component attributing to the bump at the approach slab and roadway interface.

A better approach may be to wait a few years to construct the approach slab in order to allow time for settlement or equalization of embankment pressures.

Good planning and close attention to construction of the interface between the roadway and approach slab will better ensure a smooth transition.
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<tr>
<td>7000</td>
<td>DYNAMIC TESTING COMPONENTS</td>
<td>EA</td>
<td>8</td>
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<tr>
<td>7000</td>
<td>DYNAMIC TESTING COMPONENTS</td>
<td>MER</td>
<td>750</td>
<td>750</td>
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</tbody>
</table>

ESTIMATE NUMBER 149 RUN DATE 09/26/1997 TIME 12:47:45
100 SCOPE OF WORK  This project consists of building two new 3-span concrete girder bridges. Both bridges are 238' long with clear roadway widths of 40'.

100 GENERAL The cost of furnishing and placing preformed expansion joint filler, concrete inserts, tie wire, bar spacers, bar supports, and other miscellaneous items shall be included in the price bid for Class AAE-3 and AAE-3 concrete.

202 REMOVAL OF STRUCTURE  The existing structure is a 33'-0" x 22'-5" x 356' SPFP with timber struts in the middle 144' of the pipe. There is a concrete headwall on each end of the SPFP. There is some fill dirt placed in the bottom of the SPFP with an asphalt driving surface. The timbers shall be salvaged and remain the property of the NDDOT. The timbers shall be neatly cut at the joints, removed, and transported to the Minot District yard of the NDDOT. All other materials removed shall become the property of the contractor and shall be disposed of properly off the right-of-way.

210 EXCAVATION  Class 1 excavation, at the abutments, shall extend from the bottom of the footing to the upper limits as shown on the Detail at Abutment drawing.

210 EXCAVATION  The excavation at the abutments, as shown, and the excavation required to build the piers shall be included in the lump sum bid item, "Class 1 Excavation."

210 SELECT BACKFILL  Select backfill shall meet the requirements of Section 916.03, Class 3. The backfill shall be placed in layers of not more than 6 inches, moistened or dried as required, and thoroughly compacted with mechanical tamping equipment.

550 BRIDGE APPROACH SLABS  Mechanical finishing of the approach slabs shall be required. A mechanical or hand-held transverse metal tine finish shall be applied. Timing shall start 6" from the beginning and end of the approach slabs. A surface tolerance of 3/16" in 10 feet is also required.

602 DIAPHRAGMS  The diaphragm concrete shall be placed before the deck concrete, the concrete shall cure for at least 72 hours before deck placement.

602 SURFACE FINISH "D". Surface Finish "D" shall be required for the inside and top surfaces of the barrier.

602 DECK CONCRETE  Beams and girders have slight variations in the anticipated camber. To build the deck to the designated thickness will require slight adjustments in deck elevation and/or riser dimensions. These adjustments result in minor concrete quantity discrepancies. The contractor shall consider this quantity discrepancy when he bids the unit price for Class AAE-3 Concrete. The Department will pay plan quantity of Class AAE-3 Concrete.

602 Deflection of the deck shoring shall be computed using the total dead load plus the weight of the finishing machine. The forming shall be adjusted properly to accommodate the deflection and thereby maintain the total slab thickness specified in the plans.

602 PENETRATING WATER REPELLENT TREATMENT: Penetrating water repellent shall be applied to the driving surface of the concrete deck.

602 BARRIERS: Barriers shall be constructed according to the provisions of Section 602.03 B.4 except that there shall be no expansion or deflection joints. Make 3/4" V-grooves in all faces of the barriers at each pier and at equal spaces between substructures at approximately 10-foot spacing.

602 DECK TIMING  Timing shall begin 6 inches from the beginning and the end of the deck and 6 inches from each deck joint.

612 REINFORCING STEEL  Dimensions for bent bars are given out to and to tangent intersections unless otherwise noted.

612 The bar fabricator shall add a prefix to all bar designations to differentiate between the different structures on this project.

612 All reinforcing steel shall be Grade 60.

622 PILING  Piling shall be driven with a steam, air, or diesel hammer with a rated energy and ram weight not less than 44,406 foot-pound-tons, as computed by the formula W(E-9,702)+915 E, where W is the weight of the ram in tons and E is the rated hammer energy. In no case shall the ram weight be less than 2700 pounds. The required hammer is subject to change, based on the test pile results.

622 Caution shall be used during pile driving at pier 2. There is a storm sewer and water main in the vicinity of pier 2.

2-138 3531-1
622 Toothed cast steel pile tips (ASTM A148 steel) shall be required on all pile driven.

622 The pile length shown on the plans is for bidding purposes only. The difference between the final in-place quantity and the quantity estimated by the engineer, after the test pile has been driven, will be used to determine underrun or overrun payments.

708 SLOPE PROTECTION: The concrete slope protection will be limited to the cast-in-place type shown on Standard D-708-1.

SHOP DRAWINGS: CAD-generated shop drawings may be submitted on 11-inch by 17-inch detail sheets. The contractor shall submit the following shop drawings to the Construction office for approval:

1. Prestressed I-girders

DESIGN STRENGTH:

F'c 3,000 PSI Cl. AE-3 Concrete
F'c 4,000 PSI Cl. AAE-3 Concrete
Fy 60,000 PSI GR 60 Reinforcing Steel
F'c 5,200 PSI Prestressed Girder Concrete

930 NOSING CONCRETE: The nosing concrete material shall be an elastomeric concrete or a polymeric concrete that will provide a durable edge that can withstand live-load traffic without chipping or spalling. The nosing concrete material shall be Ceva Crete 95, manufactured by E-Poxy Industries Inc., Elastomeric Concrete, as manufactured by the L S Brown Company, Silspec 900, as manufactured by Construction Materials Inc., Elastomeric Concrete as manufactured by Harris Speciality Chemicals Inc., or an approved equal. The nosing shall be mixed and installed according to the manufacturer's recommendations. The cost for the equipment, materials, and labor to install the nosing concrete on each side of the joint shall be included in the lineal foot bid item "Nosing Concrete."
SCREED ELEVATIONS

HORIZONTAL CURVE DATA
P1 STA = 463 + 86.20
T S STA = 446 + 07.51
S C STA = 448 + 57.51
A = 40° 06' 35" LT
D = 1" 35.2 - 250 SP
R = 3010.00
SE = 1° 58.45'
YC = 249.97
XC = 2.88
TS = 1778.69
L = 2854.77
SE = 0.043
C S STA = 477 + 09.28
S T STA = 479 + 59.28

DETAIL AT ABUTMENT

DETAIL "A"
**PLAN VIEW OF ABUTMENT**

- Precast Concrete Headwall
  - Incidental to underground pipe PVC nonperforated 4 inch See Details

- 2% slope

- 20-2" x 4" non-perf pipe
- 41-2 1/2" x 4" perf pipe Geotextile Separation

- Seepage trench - fill bottom
  - 2-6" with select backfill fill

- Remainder with excavated material

**BACK FACE OF ABUTMENT**

**SIDE VIEW**

**FRONT VIEW**

**RODENT SCREEN DETAILS**

**BENT BAR DETAILS**

**PLAN**

- 4" non-perf pipe

**ELEVATION**

- Prestressed Concrete Headwall Details

**NOTE**

The dimensions for the rodent screen are approximate to allow for bending and a snug fit into the slot in the headwall.

The rodent screen shall be fabricated from flattened expanded metal with screen openings of approximately 0.25 square inches. The screen shall be 16 GA metal and be hot dip galvanized after fabrication.

**BURLINGTON SEPARATION**

**ABUTMENT UNDERDRAIN DETAILS**

- 2-138 353l-7
NOTE

THE ABOVE ESTIMATED MATERIAL QUANTITIES ARE FOR INFORMATIONAL PURPOSES ONLY. ALL MATERIALS INCLUDING CONCRETE REINFORCING BARS BACKER ROD POLYETHYLENE MEMBRANE SAW CUTTING SILICON SEALANT PREFORMED JOINT FILLER AND LABOR REQUIRED TO BUILD THE APPROACH SLABS AND APPROACH SLAB BARRIERS SHALL BE INCIDENTAL TO THE PAY ITEM "CONCRETE BRIDGE APPROACH SLAB". NOSING CONCRETE SHALL BE PAID FOR AS A SEPARATE PAY ITEM.

THE CONCRETE SHALL BE CLASS AE-3 AND THE REINFORCING STEEL SHALL BE GRADE 60. THE POLYETHYLENE MEMBRANE SHALL MEET THE REQUIREMENTS OF ASTMD 1667.

THE BAR MARKS BEGINNING WITH AN "x" INDICATE AN EPOXY COATED BAR.

SURFACE FINISH D SHALL BE REQUIRED FOR ALL SURFACES OF THE CURE IN-PLANTS.
NOTE

THE ABOVE ESTIMATED MATERIAL QUANTITIES ARE FOR INFORMATIONAL PURPOSES ONLY. ALL MATERIALS INCLUDING CONCRETE REINFORCING BARS BACKER ROD POLYETHYLENE MEMBRANE SAW CUTTING SILICON SEALANT PREFORMED JOINT FILLER AND LABOR REQUIRED TO BUILD THE APPROACH SLABS AND APPROACH SLAB BARRIERS SHALL BE INCIDENTAL TO THE PAY ITEM "CONCRETE BIDGE APPROACH SLAB" MOSAIC CONCRETE SHALL BE PAID FOR AS A SEPARATE PAY ITEM.


SURFACE FINISH "D" SHALL BE REQUIRED FOR ALL SURFACES OF THE CURB TRANSITIONS.

CONTROL SECTION

2-138 353L-26
NOTES

STAGE 1
1. Place the 1' thick preformed expansion joint filler the 1/2" x 4' preformed expansion joint filler and the polyethylene membrane.

STAGE 2
2. Place the new approach slab concrete. 2" x 3 1/2" blockout shall be formed between the curbs in the approach slab as shown.

STAGE 3
3. Nosing concrete shall be placed in the blockout areas both in the abutment and in the approach slab according to the manufacturer's recommendations and installation procedures.

4. After the nosing concrete has cured clean the joint and install the backer rod and the silicone sealant according to section 550.04 M 3 of the standard specs.
Appendix B
Detail for Fabric Reinforced Backfill under the Approach Slab

Figure 3
NORTH DAKOTA DEPARTMENT OF TRANSPORTATION

CHANGE ORDER

SFN 11570

CHANGE ORDER 2C

PROJECT No. (0021051)138

CONTRACTOR: INDUSTRIAL BUILDERS, INC.
PO BOX 406
FARGO, ND 58108

ORIGINAL CONTRACT AMOUNT
$ 1,545,260.02

DATE 07/08/1998

SPECS CODE NO. NO. ITEM OF WORK

UNIT PRICE QUANTITY QUANTITY UNIT PRICE AMOUNT AMOUNT

DECREASE TO BID ITEM

PARTICIPATING (EX FEDERAL FUNDS)

210 198 SELECT BACKFILL TCN 366.000 -366.000 3.000 -7,728.00

ADDED CONTRACT ITEM

210 197 SELECT BACKFILL EXPERIMENTAL L SUM 0.000 1.000 5.227 140 5,227 14

210 200 SELECT BACKFILL C. Y. 0.000 1,706.000 12.000 20,472.00

NET INCREASE OR DECREASE TO DATE 19,522.14 PART 0.00 NON-PART TOTALS 25,799.14 -7,728.00

DUE TO THIS CHANGE, THE CONTRACT TIME
MAY BE REVISED IF THE WORK AFFECTS/AFFECTED THE CONTROLLING OPERATION.

EXPLANATION OF CHANGE IN PLAN RECOMMENDED

If the Federal Funds authorized in the cost participation agreement with the local agency is exceeded and Federal Funds are not available for this change, the local agency will assume the total cost of this change order.

SEE ATTACHED SHEET

CONTRACTOR

DATE

PROJECT ENGINEER

DATE

DISTRICT ENGINEER

DATE

REGION ENGINEER

DATE

B-3
CHANGE ORDER 2P. 2C

Spec.  Code
210  0197  Select Backfill - Experimental

Materials and Research requested an experimental project be installed on the approach slab by Abut #1 - Right Bridge. The experimental project requires an increase in Size 4 Aggregate and Type D2 Filter Fabric quantities. It also adds Void Form and Type R1 Geotextile Fabric. The following shows the allowable cost of labor, material and equipment, which compare favorably to average annual bid prices.

**Labor**

<table>
<thead>
<tr>
<th>Labor Hours</th>
<th>Rate</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1 operator, 1 carpenter, foreman, 2 laborers)</td>
<td>$56.65 per hour x 20 hrs</td>
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<tr>
<td>H/W Benefits</td>
<td>$6.60 per hour x 20 hrs</td>
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<tr>
<td>75% Payroll Additive</td>
<td>$7.40 per hour x 20 hrs</td>
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<tr>
<td>Subsistence</td>
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**Material**

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<tbody>
<tr>
<td>Geotextile Fabric - Type R1</td>
<td>693 sy x $0.88 per sy</td>
<td>$609.84</td>
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<tr>
<td>Void Form and Freight</td>
<td>1 Lump Sum</td>
<td>$835.92</td>
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<tr>
<td>Additional Size 4 Aggr</td>
<td>20 cy x $18.00 per cy</td>
<td>$360.00</td>
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<tr>
<td>Additional Type D2 Filter Fabric</td>
<td>67 sy x $0.99 per sy</td>
<td>$66.33</td>
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<td>5% Sales Tax</td>
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<tr>
<td>Walk Behind Packer</td>
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<td>Wacker Packer</td>
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<td>Total Equipment</td>
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<td>$704.84</td>
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Grand Total = $5,327.14

Spec.  Code
210  0198  Select Backfill - Ton
210  0200  Select Backfill - CY

The Select Backfill Quantity in the plans was computed wrong. The original plan quantity was computed for the Select Backfill being installed just below the approach slabs, which have 20' lengths. The new plan quantity is computed with longer lengths, which are 122', 80' and two at 78'. This changes the quantity from 966 tons to 2559 tons.
Original Plan Quantity  
966 ton x $8.00 per ton  
= $7,728.00

New Plan Quantity  
2559 ton x $8.00 per ton  
= $20,472.00

The contractor removed Class 5 from under the SPP Tunnel. He proposed to use this material for the Select Backfill. The material was tested and passed for Select Backfill.

The pay quantity for Select Backfill was originally to be paid for by the Ton. Now it will be measured and paid for by the CY, in accordance with 210.04 C 2 of the Standard Specifications:

\[
\begin{align*}
2560 \text{ ton} / 1.875 \text{ ton per cy} &= 1365 \text{ cy} \\
1365 \text{ cy} \times 1.25 \text{ for shrinkage} &= 1706 \text{ cy} \\
2559 \text{ ton} \times $8.00 \text{ per ton (bid price)} &= $20,472 \\
$20,472 / 1706 \text{ cy} &= $12.00 \text{ per cy}
\end{align*}
\]

**Total Cost of the Select Backfill**

\[12.00 \text{ per cy} \times 1706 \text{ cy} = $20,472.00\]

This price includes all labor, equipment and material necessary to complete the work.
### GRAVEL

**Project:** NH-4-00Z (051) 138  
**County:** WARD  
**Submitted By:** WAYDE SWENSON  
**Date Received:** 5/27/98

<table>
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<tr>
<th>(mm)</th>
<th>Ret</th>
<th>Wt. Ret.</th>
<th>% Ret.</th>
<th>% Pass</th>
<th>ND Spec.</th>
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<td>Non-Cum</td>
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<td>4&quot;</td>
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<td>90</td>
<td>3 1/2&quot;</td>
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<td>75</td>
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<td>63</td>
<td>2 1/2&quot;</td>
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- **Soundness % Loss:** AASHTO T-104 Tested By
- **Specific Gravity:** AASHTO T-25 Tested By
- **% Absorption:** AASHTO T-25 Tested By
- **L.A. Abrasion (Grad.):** AASHTO T-96 Tested By
- **Wt. Rodded Lb/cu ft (Kg/m³):** AASHTO T-19 Tested By

### SAND

**Pit Location:**  
**Owner:**  
**Submitted By:**  
**Date Received:** 5/27/98

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<td>Non-Cum</td>
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<td>9.5</td>
<td>3/4&quot;</td>
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- **Soundness % Loss:** AASHTO T-104 Tested By
- **Specific Gravity:** AASHTO T-34 Tested By
- **% Absorption:** AASHTO T-34 Tested By
- **Color:** AASHTO T-21 Tested By
- **Wt. Loose Lb/cu ft (Kg/m³):** AASHTO T-19 Tested By
- **% Moisture:** AASHTO T-255 Tested By

### Notes
- **Attention Advised**
- **W.C. = 0.11%**
North Dakota State Highway Department
CONCRETE PROPORTION DESIGN

PROJECT: NH-4-002(051)138
TYPE OF WORK: STRUCTURE

DESIGN NO.: 4 DATE: 05/07/98 CLASS OF CONCRETE: AAE-3

TYPE & BRAND OF CEMENT:
SOURCES: Cement LAFARGE ; Sand GRAYE PRODUCTS ; Rock GRAYE PRODUCTS

SPECIFIC GRAVITIES:
Gc= 3.14 (Cement); Gfa= 2.57 (Flyash); Gs= 2.66 (Sand); Gr= 2.69 (Rock)*
*(Combine if two rock sizes)

PERCENT OF TOTAL AGGREGATE (by weight):
S= 38% Sand, Ra= 62 % Size 3 Rock; Rb= 0 % Size 5 Rock

CALCULATIONS: (for 27 C.F. Batch Size)

<table>
<thead>
<tr>
<th>PROPORTIONS</th>
<th>LBS/BATCH</th>
<th>C.F.</th>
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</thead>
<tbody>
<tr>
<td>CEMENT:</td>
<td></td>
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</tr>
<tr>
<td>(54lbs/Sack) x (6.5 Sacks/C Y ) x (27 /27) Adjusted to 5.5 Sacks/C Y for Flyash</td>
<td>519.35</td>
<td>2.65</td>
</tr>
<tr>
<td>LYASH:</td>
<td>122.20</td>
<td>0.76</td>
</tr>
<tr>
<td>WATER:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(4.5 Gal/Sack) x (8:13) x 6.5 Sacks Cement/C Y. (includes free moisture in aggregates)</td>
<td>232.82</td>
<td>3.73</td>
</tr>
<tr>
<td>AIR:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.50 % (assumed entrained air in mix)</td>
<td>XXXXXX</td>
<td>1.76</td>
</tr>
</tbody>
</table>

Dry Wt., T= 3025.53

Absolute Volume, V, of Total Aggregate

Combined Density of Total Aggregate

SAND, Dry Wt. = 1149.70
ROCK, Size 3, Dry Wt. = 1875.83
ROCK, Size , Dry Wt. = 0.00

TOTAL WEIGHT PER BATCH = 3899.90 BATCH SIZE = 27.00

CALCULATED UNIT WEIGHT = 144.44 lbs/C.F.

B-7
# MATERIAL TESTING SERVICES, INC.

## COMPRESSION TESTS OF CONCRETE CYLINDERS

**OBJECT** NH-4-002(051)133  
**DATE** October 12, 1998

**REPORTED TO** North Dakota Department of Transportation  
**PO Box 1396**  
Minot, North Dakota 58702

**Laboratory Number** 98-094

### FIELD DATA

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<tr>
<th>Field Name</th>
<th>Value</th>
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<td>Job Identification</td>
<td>68</td>
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<tr>
<td>Date Cast</td>
<td>9/14/98</td>
</tr>
<tr>
<td>Age To Be Tested (days)</td>
<td>23</td>
</tr>
<tr>
<td>Slump (if given)</td>
<td>2-3/4&quot;</td>
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<tr>
<td>Air Content (if given)</td>
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<tr>
<td>Unit Weight (if given)</td>
<td>145.8 lbs</td>
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<tr>
<td>Location of Pour</td>
<td>Right bridge, deck and approach slab</td>
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**Cylinders Submitted By** North Dakota Department of Transportation

### CONCRETE MIX

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<thead>
<tr>
<th>Mix Proportions</th>
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<tbody>
<tr>
<td>Cement</td>
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<tr>
<td>Fine Aggregate</td>
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<tr>
<td>Coarse Aggregate</td>
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<td>Admixture</td>
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Specified Strength at 28 days: AAE-3

### COMpressive StRENGTH

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<th>Test Method - ASTM C 39, 6&quot; x 12&quot; Cylinder</th>
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<td>Compressive Strength (psi)</td>
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<td>Compressive Strength (MPa)</td>
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### REMARKS

B-8

Material Testing Services, Inc  
by [Signature]
Appendix C
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<th>Appr South</th>
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<th>Pinterest</th>
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Bm #6A 8.69 1690.13 281-44
3/31/04
Sunny, high 40's, wind 20-25 mph.

1 86.09
2 85.72
3 85.11
4 84.60
5 84.07
6 86.08
7 85.79
8 85.20
9 84.64
10 84.18
11 86.18
12 85.89
13 85.34
14 84.69
15 84.34
16 86.22
17 85.93
18 85.42
19 84.75
20 84.48
21 86.21
22 85.98
23 85.46
24 84.75
25 84.51
26 86.05
27 85.83
28 85.32
29 84.72
30 84.47

EAST BOUND BRIDGE

Approach slab
Approach slab + Bridge joint

C-10