Case Study:

I-35W River Bridge Design Build Project

Transportation Construction and Grading Innovations Technology Forum
Tuesday December 3, 2019
10:45 AM - 11:30 AM

Tom Villar, MnDOT
Brent Theroux, Barr Engineering
Ryan McShane, Ames Construction
Joe Bentler, American Engineering Testing
Project Development

- I-35W over MN River
- Original bridges built in 1956-1957.
- Replace existing bridges.
- Add roadway capacity.
- Raise roadway out of the 100yr floodplain.
  - Letting: May 9, 2018
  - Start August 2018
  - Planned Completion Fall 2021
  - Project Value $128,000,000
The Project

**Noteworthy Challenges**

- Construct the new River Crossing & Approaches off-line of the existing interstate.
- Poor subsurface conditions.
- Historic land slide during original construction of the embankment.
- Contaminated soils and groundwater South of the River
- Work within the Minnesota River Flood Plain
- Maintain six travel lanes during construction.
The Project

- 2.2 Mile Reconstruction of I-35W.
- Reconstruction of Cliff Road, Black Dog Road, 106th Street Ramps.
- Construction of two new 1,400ft Steel Girder River Bridges.
- Demolition of the Existing Steel Girder River Bridge.
- Demolition and Reconstruction of the 106th St. Interstate Bridge.
- Construction of two MSE Walls, 1,500ft in length.
- Construction of three Reinforced Soil Slopes, 3,800ft in length.
Site History – North Approach

- Original north approach embankment failed during construction in 1957
First in Area

Vertical Sand Drains Used on 700-Foot Slide

By DICK BRAUN
Soils Research Engineer

A type of highway construction new to Minnesota and its surrounding states is being used on T.H. 394, a new interstate route, south of Minneapolis. The method, called vertical sand drains, is a remedial installation to reduce pore water pressure and increase the shear strength of the foundation soil prior to placement of the fill. After consultation with the Bureau of Public Roads’ experts in Washington and the consulting firm of Howard, Needles, Tammen and Bergendoff of Kansas City, it was decided to install...
Abutment Monitoring

- GNSS receivers on both north abutments
Abutment Monitoring

- Digital and manual crack meters across gap between footings
Abutment Movement

River_Bridge_GNSS_Report: Δ Easting (mm) and Δ Height (mm)

Sensors:
- RB_East_PP (Δ Easting)
- RB_East_PP (Δ Height)
- RB_West_PP (Δ Easting)
- RB_West_PP (Δ Height)
Design - Build Pursuit

Ames Construction: Design-Build Contractor

Key Participants

• Parsons
• Alliant Engineering
• TKDA
• American Engineering Testing
Design-Build Pursuit

PROPOSED FINISHED GRADE

REVISED FINISHED GRADE

PEAT

COUNTER BALANCE EXTENSION

ORIGINAL COUNTER BALANCE

GRANULAR FILL

18" VERTICAL SAND DRAINS

SILTY CLAY LOAM WITH SAND SEAMS

CLAY

GRANULAR AQUIFER UNDER PRESSURE

LIMESTONE

300'1 200'1 100'1
Alternative Technical Concept for lateral movement

- RFP allowed 3-inches maximum of lateral movement for embankment
- With over 1 foot of vertical settlement expected, AET’s experience was at least 5 inches lateral movement should be expected
- Ames Team proposed using instrumentation to monitor both vertical settlement and lateral movement in real-time (should remain proportional)
Geotechnical Stability Analyses

*Maintain safety factor of 1.3 throughout filling*

- Needed to predict the strength gain of the clay under the embankment
Geotechnical Stability Analyses

Maintain safety factor of 1.3 throughout filling

- Approximately 10% gain in clay strength from Stage 1 to 2
Geotechnical Stability Analyses

Maintain safety factor of 1.3 throughout filling

- Approximately 10% gain in clay strength from Stage 2 to 3
Geotechnical Stability Analyses

Maintain safety factor of 1.3 throughout filling

- Approximately 5% gain in clay strength from Stage 3 to 4

To confirm assumptions about strength gain between stages, AET pushed CPT soundings through the fill and into the clay.
Construction

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\Delta V = 23 \text{ inches}
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\[
\Delta H = 7 \text{ inches}
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Surcharge left in place 5+ months
Maximum settlement = 23 inches

Maximum Lateral Movement = 6 \(\frac{1}{2}\) inches
Construction

Clearing & Site Preparation
Construction

- Temporary Earth Retention
- 60” RCP Drainage Line
- Subgrade Preparation
- Wick Drain Installation
- Settlement Period
- Embankment Construction
- Geotechnical Instrumentation
- Staged Embankment
Construction

Temporary Earth Retention

- 39,500 SF Sheet Piling
- 60 King Pile
- 35ft Depth @ 9.5 FT Spacing
Construction

60” RCP Drainage Installation

- 1,572ft 60” RCP Drainage Line
- Poor soil conditions
- Water infiltration
Construction

Subgrade Preparation

- 80,000 CY Excavation
Construction

Wick Drain Installation

- 12,500 Wick Drains, 1,129,000ft in length
- 279,000ft Predrill for Wick Drains
- 55ft – 120ft Depth
Construction

Geotechnical Instrumentation

- Vertical Shape Arrays
- Vibrating Wire Piezometers
- Earth Pressure Cells
- Horizontal Shape Arrays
- Settlement Plates
Construction

Staged Embankment

- **Stage 1:** Fill Toe Berm
- **Stage 1:** Fill 15ft
- **Stage 2:** Fill 10ft
- **Stage 3:** Fill 10ft
- **Stage 4:** Surcharge 10ft

20-Day Settlement Period per Stage
Construction

Staged Embankment

View looking Northeast to Southwest
Construction

NE Embankment Construction

- 226,000 CY of Embankment
Construction

Embankment Construction
QUESTIONS?