Design of Geosynthetic Reinforced MSEWs as Integral Bridge Abutment Walls

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EARTH IMPROVEMENT TECHNOLOGIES
Greenville Southern Connector

Private Developer in 1999

I-85 with I-385 / I-26

now

SC DOT Toll Road I-185
Greenville Southern Connector
MSEWs

• 3 Roadway Walls > 35,000 sf
• 2 Conventional Bridge Abutment Walls, each > 30 ft. tall
• 4 Integral Bridge Abutment Walls, each > 22 ft. tall
  *FIRST* in North America
Greenville Southern Connector MSEWs

- Contractor Supplied Design
- Steel or Geosynthetic MSEWs
- 1998 AASHTO (ASD) Design
- Silty Fine to Med. SAND R-Fill
- Connection FS just 1.5
- Design Seismic Load $A = 0.12g$
Integral Bridge Abutment, B19
Integral Bridge Abutment, B19
Integral Bridge Abutment, B19

1a. Bridge 19 - Bent 1

1b. Bridge 19 - Bent 3
Integral Bridge Abutment, B19

max deflection 0.25 in.

WALL HEIGHT (ft.)

0 5 10 15 20

REINFORCEMENT LOAD (lbf/ft)

0 200 400 600 800 1000 1200 1400

Bottom of Abutment Seat

PILE only

TOTAL

SURCHARGE & SOIL only
Integral Bridge Abutment, B24
Integral Bridge Abutment, B24
Integral Bridge Abutment, B24
Integral Bridge Abutment, B24

Figure 4: B 24 - Geogrid Loads
Integral Bridge Abutment, B24
Integral Bridge Abutment, B24
Greenville Southern Connector

- B19, built 1999
- B24, built 2000
- NO As-Built Survey of Face
- Can’t differentiate construction vs. post-construction movement
Greenville Southern Connector MONITORING PROGRAM

- only Total Station Survey measure
- Measure to nearest 0.01’ = 3 mm
- Repeatability / Accuracy about \( \sim 0.02' = 0.25'' = 6 \text{ mm} \)
Integral Bridge Abutment, B19
Integral Bridge Abutment, B19-b1

Fig. 6: B19 - bent 1
Integral Bridge Abutment, B19-b1

Fig. 6a: B19 - bent 1
Integral Bridge Abutment, B19-b3

Fig. 7: B19 - bent 3
Integral Bridge Abutment, B19-b3

Fig. 7a: B19 - bent 3
Integral Bridge Abutment, B19

Change in ELEVATION

Not Much in last 6.6 years

| Table 2: Number of Monitoring Points with Change in Elev. |
|---------------------------------|-------------------|-------------------|-------------------|-------------------|
| Settlement (-) or Heave (+)     | Down - 0.03'      | Down - 0.02'      | Down - 0.01'      | None 0.00'        | Up + 0.01'        | Up + 0.02'        | Up + 0.03'        | Up + 0.04'        |
| Abutment Wall                   |                   |                   |                   |                   |                   |                   |                   |                   |
| Bridge 19, b1 P-Q               |                   |                   |                   |                   | 3                 |                   |                   |                   |
| Bridge 19, b3 R-S               |                   |                   |                   |                   | 2                 |                   |                   |                   |
Integral Bridge Abutment, B24
Integral Bridge Abutment, B24-b1

Fig. 8: B24 - bent 1
Integral Bridge Abutment, B24-b1

Fig. 8a: B24 - bent 1

Stacked Batter, 3.57 degs 10.0 ins / 13.3 ft

As-Stacked Feb00
End of Const. Apr00
Sta. A enter - Oct09
Sta. B enter - Oct09
Sta. D exit - Oct09
Sta. E exit - Oct09
Sta. A enter - Jun16
Sta. B enter - Jun16
Sta. D exit - Jun16
Sta. E exit - Jun16

Sta. A & B traffic lanes entering bridge
Sta. D & E traffic lanes exiting bridge

Horizontal Setback (Inches) from Bottom of Wall

Wall Height (feet)
Integral Bridge Abutment, B24-b2

Fig. 9: B24 - bent 2
Integral Bridge Abutment, B24-b2

Stacked Batter,
3.57 degs.
8.0 ins / 10.7 ft

Fig. 9a: B24 - bent 2
Integral Bridge Abutment, B24
Change in ELEVATION

<table>
<thead>
<tr>
<th>Settlement (-) or Heave (+)</th>
<th>Abutment Wall</th>
<th>Number of Monitoring Points with Change in Elev</th>
<th>List ED</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Down - 0.03' Down - 0.02' Down - 0.01' None 0.00'</td>
<td></td>
</tr>
<tr>
<td>Bridge 19, b1</td>
<td>P-Q</td>
<td>2 10</td>
<td></td>
</tr>
<tr>
<td>Bridge 19, b3</td>
<td>R-S</td>
<td>4 8</td>
<td>2</td>
</tr>
<tr>
<td>Bridge 24, b1</td>
<td>A-E</td>
<td>1 3</td>
<td>8 10 6</td>
</tr>
<tr>
<td>B-24, b2 (see Fig.10)</td>
<td>F-K</td>
<td>3 3</td>
<td>2 1 3 8</td>
</tr>
</tbody>
</table>
Integral Bridge Abutment, B24-b2

Fig. 10 - Monitoring Point Elevation Change
Bridge 24 - Bent 2

Change in Elevation (inch.) from 2009-2016

- 15.3 ft. Height
- 13 ft. Height
- 11 ft. Height
- 9 ft. Height
- 7 ft. Height
- 5 ft. Height

Distance Along Abutment Wall (ft)

NC-DOT Geo3t2 - 2019
Greenville Southern Connector
MSEW Integral Bridge Abutments

**Summary & Conclusions**

- AASHTO 1998 ASD for MSEWs performing fine w/ Nominal FScs

- Movements small after 16 years w/i $\pm 2^\circ$ of stacked batter (NCMA)

- Aesthetics good, corner maintenance
Integral Bridge Abutment, B19
Integral Bridge Abutment, B24
Greenville Southern Connector
MSEW Integral Bridge Abutments

Summary & Conclusions

• Temperature Induced movement appears to affect both Bridges
• More Movement in 137’ span Steel vs. 87.5’ span PC concrete beams
• Future Surveys in Oct., min. Temp.
• More research on long-term performance
Questions are welcome.

Thank you for your interest.

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REFERENCES for Presentation