Repair of a 30’ Tall MSE Wall
(LESSONS LEARNED)

Presented by:
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History

- Wall built in the mid ’90’s
- Supports the WB main lanes of US 290
- US 290 in this location is 4 lane with an ADT of approximately 80,000
- First evidence of backfill loss was noted shortly after construction in 1995.
- Pavement distress in 2004 led to a $250k repair
- Subsequent pavement distress in 2009 led to the current repair
US 290 @ Westgate Boulevard
US 290 @ Westgate Boulevard
US 290 @ Westgate Boulevard
Drainage System
History – 2004 Repair

Distress was noted in the pavement above wall.

MSE backfill was found in storm sewer system at base of wall.

Storm sewer system was videoed and a break in the system identified, remaining system was in acceptable shape.

Plan for repair included removal and replacement of pavement, backfill of void identified, repair of storm sewer.

Repair was conducted over a weekend for an approximate cost of $250K.

2 lanes 200’ long replaced, 40 cy of flowable fill and 20 cy of concrete placed around storm sewer.
2004 Repair
2004 Repair
2004 Repair
2004 Repair
2008 Investigation (Due to pavement Distress)
2009 Repair

Depending on how much support we have lost for the retained fill, we may have sloughing of material into the void that has formed in the selected fill zone, hence the loss of support for the material under the second and third lane.

Suspected void location Actual limits unknown

Assumed breach in pipe CIV from fire pumps
2009 Repair

TYPICAL SECTION

ELEVATION

PLAN VIEW

Approximate location of borings; two were taken in the reinforced zone (select fill) and two in the retained fill.
**DRILLING LOG**

<table>
<thead>
<tr>
<th>Depth (FT)</th>
<th>Strata Description</th>
<th>Properties</th>
<th>Additional Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>702.1</td>
<td>CONCRETE, 11 inches, FLATBED FILL, brown, clayey sand</td>
<td></td>
<td></td>
</tr>
<tr>
<td>888.5</td>
<td>SAND, very loose, dry, light brown, well-graded sand (QW) with gravel</td>
<td></td>
<td></td>
</tr>
<tr>
<td>888.3</td>
<td>GRAVEL, very loose to loose, dry, light brown, well-graded gravel (SW) with sand</td>
<td></td>
<td></td>
</tr>
<tr>
<td>887.7</td>
<td>CLAY, stiff, dry, yellowish brown and gray, Fat Clay with iron stains</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Remarks:** Boring located at N 3°20'deg 13'10"E and W 97°12'48"N on 11.1 acres.

The ground water elevation was not determined during the course of this boring.

*Order: Mario Ybarra, Logger: Edward Watson, Organization: PFS*
2009 Repair

<table>
<thead>
<tr>
<th>Elevation</th>
<th>Penetration</th>
<th>Strata Description</th>
<th>Triaxial Test</th>
<th>Properties</th>
<th>Additional Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>792.1</td>
<td>CONCRETE, 1.1 inches</td>
<td>PLOWABLE PLUS, light brown, clayey sand</td>
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<td></td>
<td></td>
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<tr>
<td>803.1</td>
<td>CLAY, stiff to hard, moist, yellowish brown, fine clay with fine sand and gravel</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>815.3</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>828.3</td>
<td></td>
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<td></td>
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<td>841.3</td>
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<tr>
<td>854.3</td>
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<td>867.5</td>
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<td></td>
</tr>
<tr>
<td>880.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Remarks: Boring located at N 30 deg 13 min 55.9 sec and W 81 deg 49 min 11.8 sec. The ground water elevation was not determined during the course of this boring.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Driller: Mario Yitaka  Logger: Edward Watson  Organization: PSI
2009 Repair Details

PLAN VIEW

COMPAC'TION GROUT LOCATIONS

GENERAL NOTES:
1. Grouting work is to be installed in a primary and secondary sequence.
2. Grouting equipment and personnel shall be in place prior to commencing grouting operations. The existing grouting area shall be considered as the area between 1 and 2.
3. The composition of the grout mix shall consist of a cement, water, and water.
4. At the injection point, the mix shall be injected at a rate of 0.5 cubic feet per minute.
5. The grout mix shall achieve a minimum 20-day compressive strength of 80 psi.
6. Grout placement per injection hole shall be as follows:
   - 100 psi injection pressure
   - 5 cubic feet of grout material per cubic foot of water
   - 25 psi injection pressure

SECTION LOCATIONS:
1. Grout cylinder or grout-rectangular prism
2. Grout cylinder or grout-rectangular prism
3. Grout cylinder or grout-rectangular prism

PARTIAL ELEVATION

No soil reinforcement

*The 2.25' dimension shown in the construction drawings, C4 D20090407, shall be verified in the field. Any adjustments to grout pump settings shall be made prior to commencement of repair work.

...
2009 Repair

Approximate boring location, borings B-1 and B-2 were advanced through remaining wall retained fill. Borings B-3 and B-4 were advanced through retained fill. See boring logs for additional information.

REPAIR INLET AND GRATE PAD AS ADJUST INLET

ADJUST RCP AND INLET TO MAINTAIN DRAINAGE. BACKFILL WITH FILLABLE FILL

SELECT FILL

REINFORCED CONCRETE PAVEMENT REPAIR

NOTE:
1) RCP and inlet pads shall be backfilled with fillable fill.
2) Actual limits of reinforced concrete repair to be determined in the field by the engineer after grouting operations are completed.
3) Concrete shall meet a compression strength of 3000 psi within 24 hours. A minimum ultimate strength of 3000 psi is required. The contractor shall provide a mix design to be reviewed and approved by the engineer.
4) Sawcut longitudinal joints to match existing joints within 6 hours of placement without damaging the concrete.
5) Joints shall extend a minimum of 1/8" into existing concrete pavement.
6) Seal joints with Class S or U sealant.
7) Use train to level up to re-establish original cross slope across repair prior to placing concrete.
8) Full depth repair shall be completed between 8:00 on Tuesday and 6:00 on Thursday. Work will not be allowed during special events such as home football games, music festivals, etc., as determined by the engineer.

REINFORCED CONCRETE PAVEMENT REPAIR DETAIL

TEXAS DEPARTMENT OF TRANSPORTATION

9/10/09
2009 Repair

Work Sequence

• Contract was to be completed in 30 calendar days

• Work began in Sept. 2009 and was to be completed using day and night shifts.

• Compaction and slurry grouting was to be accomplished in 3 weeks with repair of storm sewer system and replacement of pavement in the remaining week.
2009 Repair
2009 Repair Day 3
2009 Repair
Day 4
2009 Repair
Soldier Pile Installation
2009 Repair
Soldier Pile Installation
2009 Repair
Prestressed Ground Anchor
2009 Repair

NOTES:

TIERSACKS
1. TIERSACKS AND HARDWARE SHALL BE MANUFACTURED BY TYRIKOS CORPORATION.
2. ANCHOR PLATES SHALL BE 50 KG STEEL.
3. TIERSACK GROUTION SHALL BE NEXT CEMENT AND SHALL ACHIEVE A MINIMUM 28-DAY COMPRRESSIVE STRENGTH OF 4000 PSI.
4. TIERSACK UNBONDED LENGTHS SHALL HAVE CORROSION-RESISTANT STEEL SHAPING FILLED WITH A PTA-APPROVED CORROSION INHIBITOR.
5. TIERSACKS MAY BE POE-MOUNTED AT THE OPTION OF THE CONTRACTOR TO REDUCE TIERSACK STRESSES. UNBONDED LENGTHS MAY BE REDUCED TO A MINIMUM OF 30 FT SUBJECT TO SATISFYING TESTING REQUIREMENTS FOR THE DESIGN LOADS SPECIFIED.
6. TIERSACKS SHALL BE PLACED IN THE DESIGN LOADS UNLESS THE DESIGN LOADS SPECIFIED ON COMPLETION OF THE TIERSACK FACING. TIERSACKS SHALL BE PLACED IN THE DESIGN LOADS SPECIFIED ON COMPLETION OF THE PANEL.

MATERIALS
1. SOLDIER PILE STEEL SHALL BE ASTM A 893, GRADE 50.
2. SHOTCRETE USED FOR CONCRETE BEARING ELEMENTS AND PLASTERS SHALL ACHIEVE A MINIMUM 28-DAY COMPRRESSIVE STRENGTH OF 3000 PSI.
3. CONCRETE USED FOR SOLDIER PILE INFL. SHOULDER IS 8500 PSI.
4. STEEL REINFORCEMENT SHALL CONFORM TO ASTM A 615, GRADE 60.
5. WELDED WIRE FABRIC REINFORCEMENT SHALL CONFORM TO ASTM A 185 (F = 24,000 PSI).

TYPICAL SECTION
SCALE: 1/60
ANCHORED SOLDIER PILE WALL STABILIZATION
2009 Repair
Ground Anchor
Installation
2009 Repair
Ground Anchor
Installation
2009 Repair Ground Anchor Installation
2009 Repair Ground Anchor Installation
2009 Repair Ground Anchor Installation
2009 Repair Fascia Installation
2009 Repair
2009 Grout Takes
Total = 250 cy
2009 Inclinometer Installation

Inclinometer location, approximately 10’ on either side of the existing inlet at the base of the wall.

Inclinometer to be advanced through the 5’ sidewalk.
2009 Repair

- Installed inclinometers
- Drilled 15 borings in grouted areas
- Commenced slurry grouting operations, pumped a total of 60 cy of slurry grout.
Inclinometer #1

Depth, ft.

Movement, in.

Inclinometer #2

Inclinometer 2

Movement, in.

Depth, ft.

Inclinometer #3

Inclinometer 3

Movement, in.

Depth, ft.

Drainage Retrofit
Permanent Facing
Final Storm
Sewer Survey
Lessons Learned

Don’t believe everything you hear:
– Original Void Est. = 60 to 70 CY
– Actual Volume of Void exceeded 250 CY

Grout Formulation, Instrumentation Plan and Grout sequence need to be thoroughly understood prior to construction.

Additional instrumentation, i.e. inclinometers should be considered due to potential destabilization during construction.

Consider temporary shoring support measure to “contain/retain” the wall during work.
The Saga Continues?