2005 Tri-Service Infrastructure Systems Conference
Re-Energizing Engineering Excellence
Valley Park 100-Yr Flood Protection Project:
Use of ‘Engineered Fill’
In the Item IV-B Levee Core

by
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St. Louis District, Corps of Engineers

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St. Louis District and Location of Valley Park Project

- 10 rivers
- 5 lock & dam sites
- 5 Corps lakes
- 720 miles of levees
- 92 flood control systems
- 416 miles of navigable channel
- 70 pumping plants
- 162 recreation areas
- 1 hydropower dam
Extent of Flooding
Meramec River – 1982 Flood of Record
Meramec River – 1982 Flood of Record
Meramec River – 1982 Flood of Record
Stage Hydrograph

- Standard Project Storm
- 72 hr Total: 9.88 Inches
- Runoff from 80 PMP storm
  - Peak flow: 284,000 cfs
- .38 PMP Ratio
  - Peak flow: 158,000 cfs
  - Peak stage: 43.9 feet
- .25 PMP Ratio
  - Peak flow: 86,000 cfs

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Alignment of 100-Yr Flood Protection Project.
Details of the Valley Park Levee.
Design and Construction Challenges

- Relocation of many aerial and buried utilities.
- Closure structures across arterial roads.
- Closure structure across active main line railroad.
- Crossing sewage treatment plant surge lagoon.
- Confusing real estate.
- Dealing with buried hazardous and special wastes.
- TCE contamination in the groundwater.
- Two existing creek relocations/realignments.
- Stream bank, hardwood and wetland mitigation.
- Induced flooding in FEMA floodway.
- Glass Plant foundation ruins.
St. Louis Plate Glass Company
Artists Rendering – Circa 1909
St. Louis Plate Glass Company
Location With Respect to Levee Alignment
St. Louis Plate Glass Company
Extent of Ruins
Glass Plant Conditions after 85 Years
Glass Plant Conditions after 85 Years
Glass Plant Conditions after 85 Years

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Absorbent Cotton Material
How to Deal With Waste Products?
Haul Off-Site?

- Haul Off-Site
  - Original Plan per 1993 Feature Design Memorandum
  - Hauling and disposal costs have skyrocketed since 1983.
  - MO Department of Natural Resources not satisfied with possible use of storage volume in local landfill.
  - Have to replace volume with suitable off-site borrow.
  - The St. Louis District estimated a total volume of 185,000 cu-yds of material.
How to Deal With Ruins?
Leave In-Place and Realign Levee?

- **Two Significant Restraints**
  - Levee alignment can’t move riverside because FEMA floodway is near the existing riverside levee toe. Calculated levels of induced flooding upstream are unacceptable.
  - Levee alignment can’t move landside because existing development is in the way. Real estate costs to purchase industrial property makes this infeasible.
How to Deal With Ruins?
Recycle and Reuse?

- St. Louis District investigated crushing the concrete and blending it with two other waste products that were on-site.

- These waste products included:
  - Cinders and slag
  - Absorbant Cotton material.

- The District decided to explore crushing the concrete and blending it with the other two waste products.

- We called it ‘Engineered Fill’.
Slope Stability Analyses of Engineered Fill Section.

Factor of safety: 1.367
Side force inclination: -18.4 degrees
Specifications for Engineered Fill

- Concrete crushed to 4”(-) size.
- Initial Blending Ratios:
  - 20% Crushed Concrete
  - 65% Cinders/slag
  - 15% Absorbent Cotton Materials.
- Test Fill Required Before Advancing to Production.
Concrete Ruins – Initial Excavation
Concrete Ruins – Initial Excavation

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Concrete Ruins – Initial Excavation
Concrete Ruins – Rock Hammer Reduction
Concrete Ruins – Rock Hammer Reduction
Concrete Ruins - Crushing
Concrete Ruins - Crushing
Concrete Ruins – Crushing Movie
Concrete Ruins - Crushing
Cinder Excavation
Cinder Excavation
Blending Operations
Portable Package
Blending Operations
Three Individual Hoppers
Blending Operations – Conveyor Belt
Blending Operations
Crushed Concrete Load
Blending Operations – Cinder Load
Blending Operations
Top Load Into Trucks
Inspection Trench Completed
Engineered Fill - Test Fill
Absorbent Cotton Material
Absorbent Cotton Material
Absorbent Cotton - Spreading
Engineered Fill – Disking Test Fill
Engineered Fill – Compacting Test Fill
Engineered Fill Test Fill - 5th Lift
Elevations vs Number of Passes

Elevation (ft) vs Number of Passes
Engineered Fill Test Fill - 5th Lift
Dry Density vs Number of Passes
Test Fill Inspection Trench
Test Fill Inspection Trench
Results of Sieve Analyses
Engineered Fill Material
Results of Sieve Analyses

Absorbent Cotton Material
Results of Sieve Analyses

Crushed Concrete
Results of Sieve Analyses

Cinders and Slag
Results of Sieve Analyses
Measured Engineered Fill and Theoretical Computations

<table>
<thead>
<tr>
<th>LOCATION</th>
<th>SOURCE</th>
<th>SAMPLE #</th>
<th>DEPTH/ELEV.</th>
<th>MATERIAL DESCRIPTION</th>
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<tbody>
<tr>
<td>ENG. TEST FILL</td>
<td>5-08</td>
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<td></td>
<td></td>
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<tr>
<td>ENG. TEST FILL</td>
<td>5-2B</td>
<td></td>
<td></td>
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<tr>
<td>ENG. TEST FILL</td>
<td>5-4B</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ENG. TEST FILL</td>
<td>5-6B</td>
<td></td>
<td></td>
<td>Silty gravel with sand</td>
</tr>
<tr>
<td>ENG. TEST FILL</td>
<td>4-1B</td>
<td></td>
<td></td>
<td></td>
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</table>

Base on Grad. obtained from 4-9-06 Tnl. part of final Blended eng. fill.
Drilling Hole for Pressuremeter
Drilling Hole for Pressuremeter
Menard Style Pressuremeter
Pressuremeter Control Panel
Some Pressuremeter Damage
**Typical Menard Pressuremeter Results**

**PRESSUREMETER TEST RESULTS**

- **Project Description:** Valley Park Floodwall
- **Boring No.:** PMT-2
- **Depth:** 4 ft
- **Sample Description:** Engineered Fill; Crushed Concrete and Bricks, Slag, Cinders and Fibrous Cotton Residue
- **Project Stationing:** Station 46+62
- **Date:** 6/15/2004
- **Page:** 1 of 1
- **Approved By:** JS

### Pressure Increment vs. 60 Sec. Reading

| Pressure Increment (bars) | 0   | 0.25 | 0.5  | 0.75 | 1    | 1.25 | 1.5  | 1.75 | 2    | 2.25 | 2.5  | 2.75 | 3    | 3.25 | 3.5  | 4    | 4.5  | 5    | 5.5  | 6    | 6.5  |
|--------------------------|-----|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| 60 Sec. Reading (cc)     | 8   | 84   | 182  | 244  | 263  | 277  | 286  | 297  | 307  | 315  | 324  | 334  | 346  | 355  | 366  | 388  | 416  | 450  | 493  | 542  | 633  |

#### Pressure-Volume Relationship

- **Modulus, \( E_m \):** 65 bars, Limit Pressure, \( p_l \): 4.8 bars
- **Pressure Increment for \( E_m \), (bars):** 1, 2 \( P_900 \), 7 bars
- **Volume Increment for \( E_m \), (cc):** 263, 307 \( P_{1, #2-Probe #4} \), 2.3 bars
- **Undrained Shear Strength, \( S_u \):** 0.7 bars, 1.4 ksf

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### PRESSUREMETER TEST RESULTS

**Project Description:** Valley Park Floodwall  
**Project Number:**  
**Client:** Broteke Well & Pump  
**Date:** 6/15/2004  
**Page:** 1 of 1  
**Approved By:** JS

**Boring No:** PMT-2  
**Depth:** 6 ft  
**Surface Elevation:** 426.9 ft  
**Test Elevation:** 420.9 ft  
**Sample Description:** Engineered Fill; Crushed Concrete and Bricks, Slag, Cinders and Fibrous Cotton Residue  
**Project Stationing:** Station 46+62

<table>
<thead>
<tr>
<th>Pressure Increment (bars)</th>
<th>60 Sec. Reading (cc)</th>
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<tbody>
<tr>
<td>0</td>
<td>5</td>
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<tr>
<td>0.25</td>
<td>80</td>
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<tr>
<td>0.5</td>
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<tr>
<td>0.75</td>
<td>163</td>
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<tr>
<td>1</td>
<td>202</td>
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<tr>
<td>1.25</td>
<td>265</td>
</tr>
<tr>
<td>1.5</td>
<td>338</td>
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<tr>
<td>1.75</td>
<td>423</td>
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<tr>
<td>2</td>
<td>538</td>
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<tr>
<td>2.25</td>
<td>665</td>
</tr>
</tbody>
</table>

**Pressure-Volume Relationship**

- **Modulus, E:**  
  - 20 bars: 42 ksf  
  - Limit Pressure, $p_l$: 0.4 bars  
  - 0.8 ksf

- **Pressure Increment for E:**  
  - 0.5 bars

- **Volume Increment for E:**  
  - 138 cc: 202

- **Undrained Shear Strength, $S_u$: 0.1 bars  
  - 0.2 ksf
Stability Analyses Using Pressuremeter Results.

Factor of safety: 1.469
Side force inclination: 14.63 degrees
Completed Section of Engineered Fill
Completed Levee Section
Flood Control Project Dedication
For More Information, Contact:

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CEMVS-ED-GF

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