Calibration of Abutment Backfill Models through Physical Testing

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Outline

- Calibration issues
- Desired boundary conditions
- Available field test data
- Comparison to models
- Extension through numerical simulation
- Gaps
Calibration Issues

- Elements requiring calibration

![Graph showing load vs. deflection](image-url)
Calibration Issues

- Elements requiring calibration
  - Capacity

Capacity
- Limit equilibrium
- Methods of slices
Calibration Issues

- Elements requiring calibration
  - Capacity
  - Initial stiffness, shape
Calibration Issues

- Elements requiring calibration
  - Capacity
  - Initial stiffness, shape
  - Unload/reload

![Load vs. Deflection Graph with Cyclic Unload-Reload]
Calibration Issues

- Elements requiring calibration
- Variables
  - Wall height
Calibration Issues

- Elements requiring calibration
  - Wall height
  - Backfill soil (type, compaction)
Calibration Issues

- Elements requiring calibration
- Variables
  - Wall height
  - Backfill soil (type, compaction)
  - Wall skew
Calibration Issues

- Elements requiring calibration
- Variables
- Boundary conditions
  - Wall displacement
Calibration Issues

- Elements requiring calibration
- Variables
- Boundary conditions
  - Wall displacement
  - Wingwall configuration
Calibration Issues

- Elements requiring calibration
- Variables
- Boundary conditions
  - Wall displacement
  - Wingwall configuration
  - Backfill configuration
Desired Boundary Conditions

- Wall displacement

Why?
\[ \delta_{c-c} > \delta_{c-s} \]
Desired Boundary Conditions

- Wall displacement
- Wingwall configuration

Why?
Width >> Height
Desired Boundary Conditions

- Wall displacement
- Wingwall configuration
- Backfill configuration

Why?
## Available Field Test Data

<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td><strong>Height</strong></td>
<td>1.7 m</td>
<td>1.2 m; 1.1 m</td>
<td>1.5-2.3 m; 1.7 m</td>
<td>1.7 m</td>
</tr>
<tr>
<td><strong>Backfill soil</strong></td>
<td>Clayey silt</td>
<td>Varies</td>
<td>Clayey sand, silty sand; silty sand</td>
<td>Silty sand (SE 30)</td>
</tr>
<tr>
<td><strong>Skew</strong></td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Wall displacement</strong></td>
<td>H+θ</td>
<td>H+θ (small)</td>
<td>H, H+V; H+V</td>
<td>H</td>
</tr>
<tr>
<td><strong>Wingwall configuration</strong></td>
<td>W/H =2, integral</td>
<td>None, pile cap</td>
<td>W/H=2; 1.7. Integral, sep.</td>
<td>2D, sep.</td>
</tr>
<tr>
<td><strong>Backfill configuration</strong></td>
<td>Deep</td>
<td>Depth=H; Deep</td>
<td>Wedge</td>
<td>Deep</td>
</tr>
</tbody>
</table>
Comparison to Models

- Method of slices (LSH)
Comparison to Models

- Method of slices (LSH)

![Graph showing Comparison to Models with methods like 2D FE, 3D FE, LSH curve, and UCD test data.](https://via.placeholder.com/150?text=Graph)
Comparison to Models

- Method of slices (LSH)
- Hyperbolic fit

\[ F(y) = \frac{Cy}{1 + Dy} \]

\[ C = \left( 2K_{50} - \frac{F_{ult}}{y_{max}} \right), \quad D = 2\left( \frac{K_{50}}{F_{ult}} - \frac{1}{y_{max}} \right) \]
Comparison to Models

- Method of slices (LSH)
- Hyperbolic fit
- HFD coefficients apply for:
  - Skew = 0
  - 2D conditions
  - No uplift
  - H=1.67 m
  - As-tested backfills (deep)

\[
F(y) = \frac{C y}{1 + D y}
\]

\[
C = \left(2K_{50} - \frac{F_{ult}}{y_{max}}\right), \quad D = 2\left(\frac{K_{50}}{F_{ult}} - \frac{1}{y_{max}}\right)
\]
Extension through numerical simulation

- Variable height

\[ F(y) = \frac{a_r y}{\hat{H} + b_r y} \hat{H}^n \]

\( a_r \) & \( b_r \) derived for two tested backfills

Shamsabadi et al. (JBE, in press)
Extension through numerical simulation

- **Variable height**
- **Variable backfill strengths** (c & φ)

\[
F(y) = \frac{a_r y}{\hat{H} + b_r y} \hat{H}^n
\]

\[
\begin{align*}
a_r &= \frac{1}{\beta} (\eta - 1) \alpha \\
b_r &= \frac{1}{\beta} (\eta - 2)
\end{align*}
\]

\[
\alpha = \frac{F_u}{\hat{H}^n}, \quad \beta = \frac{Y_{uit}}{\hat{H}}, \text{ and } \eta = \frac{Y_{uit}}{Y_{50}}
\]

\[
\alpha, \ \beta, \ \eta = \text{fns} \ (c, \ \phi, \ \delta, \ \gamma)
\]

Khalili-Tehrani, 2009
Gaps

- Skew effects
- Validation data for different heights and backfills
- Gaping behavior
- Cyclic models


