HFL Testing Briefing

- WSDOT ABC Meeting 08.04.2010 -

University of Washington

Marc O. Eberhard, John F. Stanton, Olafur S. Haraldsson,
Todd Janes, Hung V. Tran, Michael Weinert
Overview

- Completed tests: results
- Planned tests
Specimens Tested: Overview

- Column-to-footing connection:
  - A precast column embedded in a cast-in-place foundation
Specimens Tested: Details

- Two 42 %-scale specimens constructed:
  - Specimen A: “Full Guide Spec”
  - Specimen B: Less conservative
Test Specimens

- Differences in footing details:
  - Flexural steel moved outside column.
  - Almost all shear friction steel removed.
  - Half of the footing ties removed.

Bars in slots

Specimen A

Reduced SF steel

Specimen B
Testing

1. Pure axial load
   - Factored DL + LL = 240 kips

2. Axial load plus horizontal load:
   - Constant un-factored dead load = 159 kips
   - Cyclic horiz. displacement. (Modified NEHRP).

3. Pure axial load to failure
   - Determine punching capacity
Seismic Performance

Maximum moments occur at intersections.
Seismic Performance

- Lab tests at 42% scale.
Moment vs. Drift

<table>
<thead>
<tr>
<th>South</th>
<th>Moment [kips-in]</th>
<th>Drift [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max</td>
<td>3,065</td>
<td>1.38</td>
</tr>
<tr>
<td>80% Max</td>
<td>2,452</td>
<td>8.69</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>North</th>
<th>Moment [kips-in]</th>
<th>Drift [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max</td>
<td>-3,073</td>
<td>-2.61</td>
</tr>
<tr>
<td>80% Max</td>
<td>-2,458</td>
<td>-6.85</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>North</th>
<th>Moment [kip-in]</th>
<th>Drift [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max</td>
<td>-3,114</td>
<td>-1.45</td>
</tr>
<tr>
<td>80% Max</td>
<td>-2,490</td>
<td>-6.85</td>
</tr>
</tbody>
</table>
Damage Progression

- Onset of Column Flaking
- Onset of Footing Spalling
- Onset of Column Spalling
- Onset of Bar Buckling
- First Spiral Fracture
- First Bar Fracture

Damage Level

Specimen A
Specimen B

Drift Ratio (%)
End of Cyclic Testing

Specimen A

Specimen B

No cracks in footings.
Vertical Load Test to Failure

Failure by column crushing – not punching in the footing
After all Testing

Specimen A

Specimen B

No sign of punching failure
Observed Behavior

- Both specimens behaved like c.i.p.
- Both had 80% of full strength at 7% drift.
- No shear slip between column & footing.
- No damage to the footing.
- P.C. column splice remained elastic.
Planned Tests 1: Thinner Footing

- Footing thickness may be limited by heat of hydration.
- Footing thickness $<$ column diameter.
- Investigate strength and failure mode if footing fails.
- Expected failure mode:
  - Punching shear + moment transfer
Planned Tests 1: Thinner Footing
Thin Footing Design Space

Without beam shear” rft.
Thin Footing Design Space

With “beam shear” rft.
Thin Footing: Final Design
Planned Tests 2: Drilled Shaft.

- P.C column embedded in drilled shaft.
- Investigate potential for failure in transition region.
Planned Tests 2: Drilled Shaft.

- Specimen A: per WSDOT BDM and AASHTO Seismic Guide Spec.
- Specimen B: Less conservative design of transition region.
- Need to ensure that shaft fails.
Planned Tests 2: Drilled Shaft.

- Strut-&-Tie models suggest force patterns.
- Pattern depends strongly on assumptions about shear transfer between pc column and cip shaft.
And if that does not work........