IN-PLANE BAR BUCKLING IN RC COLUMNS IN EXTREME SEISMIC EVENTS

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Experimental Program

• Seven (7) full-scale RC columns were tested to better understand the effect of loading history and collapse behavior of RC columns.

• All specimens were designed according to seismic provisions in chapter 21 of ACI 318-11 code.

• The specimens were representative of the lower portion of columns in the ground floor of high-rise buildings located in high seismic regions.
Test Observation
FE Modeling

In-plane buckling direction

Outward buckling direction

CDP for cover conc.

CDP for core conc.

Embedded Bars

Compression Face

Buckling Bars

Transverse ties

25 in. (635 mm)

28 in. (672 mm)

36 in. (914 mm)

2x

fs

Poff

In-Plane Bar Buckling in RC Columns in Extreme Seismic Events
### Parametric Study

#### Important factors on in-plan bar buckling

- Concrete compressive strength
- Bar size
- Cross sectional dimension

The effect of bar spacing and tie spacing is insignificant.

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**Parametric Study Matrix**

<table>
<thead>
<tr>
<th>Model</th>
<th>Parameter</th>
<th>b·h (in²)</th>
<th>Bar Size</th>
<th>Tie Spacing (in.)</th>
<th>f’c (ksi)</th>
<th>Bar Spacing (in.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Base Model</td>
<td></td>
<td>6</td>
<td>9</td>
<td>11</td>
<td>4</td>
</tr>
<tr>
<td>2</td>
<td>Concrete Strength</td>
<td></td>
<td>36 - 28</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Bar Size</td>
<td>36 - 28</td>
<td>36 - 28</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Bar Spacing</td>
<td></td>
<td>42 x 32</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Tie Spacing</td>
<td></td>
<td>20 x 16</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Column Size</td>
<td></td>
<td>42 x 32</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td></td>
<td></td>
<td>20 x 16</td>
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</tr>
</tbody>
</table>

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**Graphs**

- Lateral Displacement vs. Top Rotation for different concrete strengths (3.5 ksi, 5 ksi, 8 ksi)
- Lateral Displacement vs. Top Rotation for different bar spacings (42x32, 36x28, 20x16)
Conclusion

• The tests at the MAST Lab revealed an in-plane bar buckling mode in reinforcing bars.
• Unlike outward buckling, transverse ties do not restrain the bars from in-plane buckling.
• MAST tests indicate that columns with larger bars and lower concrete compressive strength are more prone to in-plane bar buckling.
• In-plane bar buckling occurs in well-designed and well-built columns, otherwise the outward bar buckling controls.
• In-plane bar buckling occurs when the columns are deformed into the post-peak region.
Please See my Poster

Today, 5:15 – 7:00 pm @ Pasadena (Exhibit Hall)

Poster location: Number 063

Thank You