Project: PRECAST BRIDGE COLUMNS WITH ENERGY DISSIPATING JOINTS

Test Model: SC-2 (1/3-Scale Precast Segmental Concrete Column)

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Abstract:

Conventional bridge construction involves a time consuming process associated with traffic delays and risk to public safety. In contrast, prefabricated bridge systems can expedite construction, thus minimizing traffic delays and construction site safety risk. Under moderate and strong earthquakes, it is essential for bridge columns to dissipate energy through nonlinear deformations in plastic hinges. Existing details for precast segmental columns offer minimal energy dissipation as a result of the discontinuity of longitudinal reinforcement; therefore, precast members are not used in high seismic zones.

A series of innovative precast concrete segmental columns are being developed and studied at the University of Nevada, Reno through a research project funded by the California Department of Transportation. The purpose of the study is to develop precast columns that are able to dissipate energy under cyclic loading. The first phase of this project involved analytical and experimental study of a segmental concrete column incorporating an elastomeric bearing pad in the plastic hinge. The second phase of the project includes designing and testing three different segmental concrete columns with different low-damage plastic hinges. In one column a conventional reinforced concrete detail is used and it is called SC-2 (Segmental with Concrete). The other two columns incorporate ECC (Engineered Cementitious Composite) referred to as SE-2 (Segmental with ECC) and FRP wrap referred to as SF-2 (Segmental with FRP) at the lower two segments, respectively.

SC-2 is a one-third scale precast concrete segmental column with longitudinal steel dowels connecting the base segment to the footing. Unbonded post tensioning is used to connect the segments and to minimize the residual displacements. Energy dissipation will take place mostly through the yielding of the longitudinal bars at base segment. The column will be subjected to the Sylmar earthquake (Northridge 1994) record with increasing amplitudes until failure. SC-2 column will be a benchmark based on which the advantages of other specimens consisting of innovative materials at plastic hinges will be evaluated and quantified.
## Model Details Summary

<table>
<thead>
<tr>
<th>Column Height [inch]</th>
<th>Column Diameter [inch]</th>
<th>Longitudinal Steel ratio in first segment [%]</th>
<th>Transverse Steel ratio in all segment [%]</th>
<th>Aspect Ratio [%]</th>
<th>Axial Load [kips]</th>
<th>Axial Load Index</th>
<th>Scale</th>
<th>Subjected ground Motion</th>
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</thead>
<tbody>
<tr>
<td>72</td>
<td>16</td>
<td>1.00</td>
<td>1.41</td>
<td>4.5</td>
<td>80</td>
<td>103</td>
<td>21</td>
<td>17.33</td>
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## Rebar Properties

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<th>Reinforcement</th>
<th>f_y [ksi]</th>
<th>f_u [ksi]</th>
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<tbody>
<tr>
<td>Longitudinal bars</td>
<td>64</td>
<td>94</td>
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## Concrete Properties

<table>
<thead>
<tr>
<th></th>
<th>7 Day Strength [ksi]</th>
<th>28 Day Strength [ksi]</th>
<th>Test Day</th>
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</thead>
<tbody>
<tr>
<td>Footing and Third Segment</td>
<td>5.22</td>
<td>7.31</td>
<td>Pending</td>
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<tr>
<td>Base Segment</td>
<td>3.13</td>
<td>5.45</td>
<td>Pending</td>
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<tr>
<td>Second, Forth Segments</td>
<td>3.81</td>
<td>5.21</td>
<td>Pending</td>
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Note: For testing, a time compression factor of 0.577 is used.

Sylmar EQ Time Histories
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</tbody>
</table>
Force-Displacement Under Sylmar Groundmotion
X0.1, 0.25, 0.5, 0.75, 1, 1.25, 1.5
Thread bar 1 5/8" diameter
Prestressing Unbonded Tendon Force=103 kips

Lift Bars
2 # 5
Opening 11" x 11"
Height 7"

PVC Pipe dia. 2.5 inch
thickness 0.25 inch

#3 @ 2.0 in
Spiral

2 1/2 in

8 # 4
Longitudinal Bars

#3 @ 2.0 in
Spiral

Typical Segment

1/2 inch Cover Thickness

116 in

14 in

20 in

116 in

26 in

10 # 4
Longitudinal Bars

25 in

36 in

36 in

111 in

PVC Pipe dia. 2.5 inch
thickness 0.25 inch

#3 @ 2.0 in
Spiral

Base Segment

16 in

3/4 inch Cover Thickness

Column View
sg38  ⌀ 50” Height
sg37  ⌀ 50” Height
sg36  ⌀ 50” Height
sg35  ⌀ 50” Height
sg34  ⌀ 50” Height
sg33  ⌀ 50” Height
sg32  ⌀ 50” Height
sg31  ⌀ 50” Height
sg30  ⌀ 50” Height
sg29  ⌀ 50” Height
sg28  ⌀ 50” Height
sg27  ⌀ 50” Height
sg26  ⌀ 50” Height
sg25  ⌀ 50” Height
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sg23  ⌀ 50” Height
sg22  ⌀ 50” Height
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sg19  ⌀ 50” Height
sg18  ⌀ 50” Height
sg17  ⌀ 50” Height
sg16  ⌀ 50” Height
sg15  ⌀ 50” Height
sg14  ⌀ 50” Height
sg13  ⌀ 50” Height
sg12  ⌀ 50” Height
sg11  ⌀ 50” Height
sg10  ⌀ 50” Height
sg9   ⌀ 50” Height
sg8   ⌀ 50” Height
sg7   ⌀ 50” Height
sg6   ⌀ 50” Height
sg5   ⌀ 50” Height
sg4   ⌀ 50” Height
sg3   ⌀ 50” Height
sg2   ⌀ 50” Height
sg1   ⌀ 50” Height

sg59  ⌀ 50” Height
sg60  ⌀ 50” Height
sg61  ⌀ 100” Height
sg62  ⌀ 100” Height

Strain gauges on Post-tensioning Rod