ABC Steel Bridge System and Use of UHPC for Seismic Applications

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AASHTO Technical Committee for Seismic Design

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Brief Introduction to Simple for Dead Load and Continuous for Live Load (SDCL) Steel Bridge System
Moment Diagram

Dead Loads

Live Loads

Conventional System

SDCL System
Construction Sequence
Conventional construction

Place steel girders over support
Connect the steel beams over the pier by filling $\frac{1}{2}$ to $\frac{2}{3}$ of the concrete diaphragm.
Construction Sequence
Conventional construction

Final step- Place the deck
Tensile forces are resisted by steel reinforcement

Need for mechanism that could resist the compression
SPECIMEN No.1

Direct Transfer of Compression Force
SPECIMEN No.2

No End Detail
SPECIMEN No.3
End Plate Only
Drift = \( \frac{D}{L} \) (in/in)

Moment = \( M \) (kips-ft)

Test 1

Test 2

Test 3

Moment vs. Drift graph showing data for Test 1, Test 2, and Test 3.
WEB – BOTTOM FLANGE
Advantages of SDCL

1- No bolted splices
2- Constant cross section
3- No end steel diaphragm
4- End of girders are protected by concrete
SDCL
ABC Application- Non-Seismic Box Girder
Detail over the pier – Non Seismic

- Cope Top Flange
- Longitudinal Reinforcement
- Deck
- Girder
- Bearing Blocks
Temporary Bracings were not used
Pick up device
2014- 2nd and 3rd quarter Issue of AISC Engineering Journal


Seismic Application of SDCL in Seismic areas
And using abc
**Time History Analysis**

- *Eight earthquake records were selected, scaled to AASHTO’s response spectrum and applied in the model*

<table>
<thead>
<tr>
<th>Earthquake Name</th>
<th>Scale Factor</th>
<th>Year</th>
<th>Station Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>San Fernando</td>
<td>3.3358</td>
<td>1971</td>
<td>&quot;Palmdale Fire Station&quot;</td>
</tr>
<tr>
<td>Imperial Valley-06</td>
<td>1.9876</td>
<td>1979</td>
<td>&quot;Cerro Prieto&quot;</td>
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<tr>
<td>Irpinia</td>
<td>2.1188</td>
<td>1980</td>
<td>Italy</td>
</tr>
<tr>
<td>Loma Prieta</td>
<td>3.6419</td>
<td>1989</td>
<td>Anderson Dam (L Abut)</td>
</tr>
<tr>
<td>Northridge-01</td>
<td>2.4706</td>
<td>1994</td>
<td>Sunland - Mt Gleason Ave</td>
</tr>
<tr>
<td>Duzce</td>
<td>3.407</td>
<td>1999</td>
<td>Turkey</td>
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<td>Manjil</td>
<td>0.7572</td>
<td>1990</td>
<td>Iran</td>
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<tr>
<td>Darfield</td>
<td>1.2595</td>
<td>2010</td>
<td>New Zealand</td>
</tr>
</tbody>
</table>
Moment demand along the girders
Non-integral

Strength I = 1.25DC + 1.5DW + 1.75LL

Extreme Event I = 1.25DC + 1.5DW + 0.5LL + (mean)EQ
Integral Connection- Bottom flange not connected
Moment - Drift

Experimental Results (Test 3)

Experimental Results (Test 1)
Connection under investigation

For sake of clarity the concrete diaphragm is not shown
For ABC or Conventional Construction

For sake of clarity the concrete diaphragm is not shown
Cap Beam to Column Connection
Detail
Using UHPC for Seismic Application
Currently most column to cap beam connection details require disturbing The reinforcement in the cap beam.
New Connection Concept

Cap Beam

Column
Major Component

1- Use UHPC to develop bars over short length

2- By discontinuing some of the bars, determine the location of plastic hinge

3- Large tolerances
Test Setup Details

- Support:
  - 8' to 6'
  - 6' to 12'

- Load:
  - 11'6.0" to 8'
  - 4'8.0" to 1'8.0"

- Plastic Hinge:
  - Between 4'8.0" and 1'8.0"
Thank You

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