PCMAC Workshop
Sacramento, California
November, 2010

Caltrans’ Next Generation Bridge

Disclaimer: The opinions presented here are those of the presenter and do not necessarily reflect Caltrans’ official policy.
Caltrans NGB Effort

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NGB Systems

- Consider all bridge types
- Consider speed of construction
- Consider variety of materials
- Test to validate ideas; service/seismic
- Develop codes/specs
- Consider maintenance
Caltrans NGB Effort

Next Generation Bridge
Caltrans Division of Engineering Services

NGB

- Research Network
- Codes and Specifications
- Design Innovation
- Long Term Bridge Performance
- Materials Science
  - HSC, FRP, SMA, SCC, HPS
- Accelerated Bridge Construction

11/16/2010
Component Level Example

- **Abutment Shear Keys**

First tested 2002

Category ‘A’ Decision Document 2008
Sacrificial Shear Key Design
Construction of New Keys
Completed Seismic Shear Keys
Isolated Key for 68.6m (226 ft) span
Next Generation Bridges

Initial Focus:
Next Generation Bridges

Initial Focus: Precast elements
Next Generation Bridges

Initial Focus: Precast elements - *columns*
Next Generation Bridges

Initial Focus: Precast elements - *columns*

Plastic Hinge Zone
8. SEISMIC DETAILING

8.1 Splices in Reinforcing Steel

8.1.1 No Splice Regions in Ductile Components

Splicing of flexural reinforcement is not permitted in critical locations of ductile elements. The “no splice” region shall be the greater of: The length of the plastic hinge region as defined in Section 7.6.3 or the portion of the column where the moment demand exceeds $M_p$. A “no splice” region shall be clearly identified on the plans for both hinge locations of fixed-fixed columns.

8.1.2 Reinforcement Spliced in Ductile Components & Components Expected to Accept Damage

Reinforcing steel splices in ductile components outside of the “no splice” region shall meet the “ultimate splice” performance requirements identified in Memo to Designers 20-9.
Next Generation Bridges

We can see by comparing CA to Japan, that varying seismic hazard maps and detailing practices exists between countries.
Comparisons – Japan / Caltrans
Comparisons – Japan / Caltrans

- 131 feet
- 39.4 feet
Comparisons – Japan / Caltrans

37.5 feet

144 to 170 ft spans
Comparisons – Japan / Caltrans
Comparisons – Japan / Caltrans

16.4 feet
Comparisons – Japan / Caltrans

7 feet

16.4 feet

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Comparisons – Japan / Caltrans
Next Generation Bridges

We can see by comparing CA to Japan, that varying seismic hazard maps and detailing practices exists between countries.

Furthermore, given the same 1000 year event uniform hazard map used within the US, various DOT’s are addressing seismic capacity in detailing differently.
Precast elements are to emulate Cast-in-Place performance.

Precast element tests are required to validate expected performance.
Next Generation Bridges
Proposed Construction Concepts
Next Generation Bridges
Proposed Construction Concepts

1. Wrap each main PC Column flange and
main column reinforcement in footing.
2. Tolerances required for placement of
main column reinforcement in footing,
3. Field fabricate column main links as required.

<table>
<thead>
<tr>
<th>Section</th>
<th>Note</th>
<th>Description</th>
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<tbody>
<tr>
<td>Section A-A</td>
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</table>

STAGE 1
ELEVATION - PRECAST COLUMN PLACEMENT

STAGE 2
ELEVATION - COLUMN BASE CONNECTION

STAGE 3
ELEVATION - COLUMN BASE POUR

11/16/2010
Next Generation Bridges
Proposed Construction Concepts

1. Match mark with PC Column Paint and
2. Mark Rogers Location in Footing.
3. Field Fabricon Column Main Line as Required.
4. Roughen surface with 1/4" amplitude during casting.
5. All holes are "drilled" [sic] not bored connections.
6. Finish and smooth PC Column and provide good welds.

STAGE 1
ELEVATION - PRECAST COLUMN PLACEMENT

STAGE 2
ELEVATION - COLUMN BASE CONNECTION

STAGE 3
ELEVATION - COLUMN BASE POUR

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Next Generation Bridges
Proposed Construction Concepts

1. Watch mark main PC Column Paint and
   splice main reinforcement to footing.
2. Tolerances required for placement of
   main column reinforcement in footing.
3. Cast ribbons column main lines as required.

Guidelines

- Denotes infill with SCC in column void.
- Denotes grouted injection.

Notes:

1. Roughen surface 3/4" amplitude during casting.
2. All heads are "trimmed" after splice connection.
3. Paint main and secondary PC column and primary grout voids.

Stage 1
Elevation - Precast Column Placement

Stage 2
Elevation - Column Base Connection

Stage 3
Elevation - Column Base Pour

11/16/2010
Next Generation Bridges
Proposed Construction Concepts

<table>
<thead>
<tr>
<th>Stage</th>
<th>Description</th>
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<tbody>
<tr>
<td>1</td>
<td>Elevation - Precast Column Placement</td>
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<tr>
<td>2</td>
<td>Elevation - Column Base Connection</td>
</tr>
<tr>
<td>3</td>
<td>Elevation - Column Base Pour</td>
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</tbody>
</table>

### Notes:
1. Watch north side column bolts and north-south reinforcement in footing.
2. Ensure complete closure of column reinforcement in footing.
3. Field fabricate column links as required.
4. Roughen surface to 3/4" amplitude during casting.
5. All heads are "deformed" non-square connectors.
6. Place and embed 1 PC column and pour lower grade tariffs.

### Diagrams:
- **SECTION A-A**
  - Diagram showing column placement and connection details.

### Figures:
- **STAGE 1**
  - Elevation view with precast column placement.
- **STAGE 2**
  - Elevation view with column base connection.
- **STAGE 3**
  - Elevation view with column base pour.

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Next Generation Bridges
Proposed Construction Concepts

STAGE 1
ELEVATION - PRECAST COLUMN PLACEMENT

STAGE 2
ELEVATION - COLUMN BASE CONNECTION

STAGE 3
ELEVATION - COLUMN BASE POUR
Next Generation Bridges
Proposed Construction Concepts

1. Match work Main PC Column Reinf and Shift Vertical Reinf.
2. Templates required for placement of Shift Vertical Reinforcement.
3. Field reinforce column main lines as required.
4. Leg bending to as required.
5. All holes are "Ultimate" bolt spuit continuous.
6. Flange and support PC Column and provide pour seal.
Next Generation Bridges
Proposed Construction Concepts

1. Match work for PC Column Reinforcement and Shift Vertical Alignment.
2.脱帽 are required for placement of shift vertical alignment.
3. Hold 3/8" steel column wall lines as required.
4. Reinforcement to be extended.
5. All areas are "Ultimate" butt spliced connections.
6. Place and support PC Column and provide grout seal.

**SECTION A-A**

**STAGE 1**
ELEVATION - PRECAST COLUMN PLACEMENT
17" x 17 1/2"

**STAGE 2**
ELEVATION - COLUMN BASE CONNECTION
17" x 17 1/2"

**STAGE 3**
ELEVATION - COLUMN BASE POUR
17" x 17 1/2"

LEGEND:
- Denotes grout injection.
- Denotes shift vertical reinforcement.
- Denotes grout injection.

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Next Generation Bridges
Proposed Construction Concepts

1. Watch work with PC Column Rebar and shift vertical restraint.
2. Tension required for placement of shift vertical restraint.
3. Hold temporary column wall lines as required.
4. Reduce strain to 1/2 in. rebar.
5. All terms are "Ultimate" until further notice.
6. Flange and support PC column and provide grout seal.

LEGEND

- Denotes staging wil1 with SCC in column void
- Denotes grout injection.

SECTION A-A

STAGE 1
ELEVATION - PRECAST COLUMN PLACEMENT

STAGE 2
ELEVATION - COLUMN BASE CONNECTION

STAGE 3
ELEVATION - COLUMN BASE POUR

NOTE:
- Contractor shall verify all controlling fixed dimensions
- Before execution of fabricating and material
Next Generation Bridges
Proposed Construction Concepts

LEGEND:
- Denotes stages intil with SCC in column void
- Denotes grout injection.

SECTION A-A
1' = 1'-0".

STAGE 1
ELEVATION - PRECAST COLUMN PLACEMENT
1' = 1'-0"

STAGE 2
ELEVATION - COLUMN BASE CONNECTION
1' = 1'-0"

STAGE 3
ELEVATION - COLUMN BASE POUR
1' = 1'-0"

NOTE:
- Contractor shall verify all controlling fixed dimensions before erection of foundations
- Any material...
Next Generation Bridges
Proposed Construction Concepts

1. Match work Wales in Column Beams and Shift Vertical Sections.
2. Tempers required for placement of Shift Vertical reinforcement.
3. Hold rebar column main lines as required.
4. Rebar/anchor as per requirements.
5. All inner are "Ultimate" wall spuit continues.
6. Place and support PC Column and provide grout seal.

SECTION A-A
1' = 1'-0"

STAGE 1
ELEVATION - PRECAST COLUMN PLACEMENT
1' = 1'-0"

STAGE 2
ELEVATION - COLUMN BASE CONNECTION
1' = 1'-0"

STAGE 3
ELEVATION - COLUMN BASE POUR
1' = 1'-0"

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SECTION A-A

NOTES:
1. Use PLT reinforcement in lap zone. Temporary bracing may be required.
2. All Anchor bars "cutoff" will apply to all lengths.
3. Only staggered "Mistakes" will apply to all lengths.
4. Roughen Lap zone surfaces in 1/4" emulsion during casting.
5. Lap Zone for Pour #1 shall be mortared in a threaded surface.

LEGEND:
- SEE INSET (Pour #1)
- Pile Pour #2
- Pile Pour #3

ELEVATION—PO COLUMN at TYPE II PILE

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Next Generation Bridges
Proposed Construction Concepts

NOTE:
1. Use "installed" guy wires shown in main
PC Column Point
2. All hps are "Ultimate" bolt splice continuous.
3. Column plr reinforcement to be hot dip galvanized.
4. PL and support PC Column to maintain 3/4"
minimum joint filler material thickness.

STAGE 1
ELEVATION - PRECAST COLUMN PLACEMENT

STAGE 2
ELEVATION - COLUMN BASE POUR

SECTION A-A

KEY DETAIL

NOTE:
The Contractor shall verify all
column locations time critical.
Surveying of installating
detailed work.
UNR Research Contract, July 2010
Principal Investigator: Dr. Saiid Saiidi
Professor of Civil & Environmental Engineering
Connection Detail #1:
Connection Detail #1:          Proposed Test Protocol

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Next Generation Bridges
Alternative Configurations
Concurrent Research
Concurrent Research

University of Washington

CFT connection tests
Concurrent Research

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CFT connection tests
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CFT connection tests

High-strength fiber-reinforced grout fills void to achieve composite action
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Research Notes

The Earthquake Engineering Group

September 2006
GRG Vol.4, No.4