APPENDIX C  SUMMARY SHEETS OF POCKET CONNECTIONS
### Column to cap beam

**Type:** Pocket: Precast column bars inserted into concreted pocket in precast cap

**Title:** Connection P-1
Full Ductility Cap Pocket

**Source:** NCHRP 12-74

**TRL:** Maximum TRL: 7
TRL Gaps: 3
### BACKGROUND

**Title:** Connection P-1 (Full Ductility Cap Pocket)

**History / Description:**
- The pier cap contains a pocket, formed by a circular corrugated steel tube placed between the top and bottom bent cap reinforcing bars. To create the rest of the pocket, two short pieces of Sonotube are connected to the steel tube, one above and one below, and penetrated by the top and bottom bars. On site, the bent cap is lowered over bars projecting from columns. The pocket is filled with concrete.
- Seismic performance was tested as part of NCHRP 12-74.

**References:**
- Matsumoto (Unit 3 report - 2009) ; Restrepo et al. (2010)

**Contact Information:**
- Prof. Eric Matsumoto (Cal State Sacramento) – ematsumoto@csus.edu

### EVALUATION

**Constructability:**

*Risk Value: -1*
- Need to notch the wall of the Sonotube to place it over the top and bottom bent cap bars and then patch the notches and seal the joint before casting the cap beam.
- Precast column longitudinal bars must be located to avoid cap beam stirrups and longitudinal reinforcement that pass through cap pocket.
- There is a risk that the concrete in the pocket is not well consolidated

**Seismic Performance:**

*Value: 0*
- Plastic hinge zone in column adjacent to cap beam
- Emulative performance – similar to ductile CIP connection
- Minimal damage observed in the capacity protected joint and cap beam
- Good ductility, similar to CIP connection. Precast and CIP specimens had different rebar strain distributions and joint crack patterns. Researcher recommends more analysis and testing to fully understand connection behavior.

**Inspectability:**

*Value: 0*
- Inspectability is similar to CIP concrete.

**Durability:**

*Value: -1*
- Durability is similar to that of CIP concrete.

**Time Saving Potential:**

*Value:+1*
- Minimum formwork and no iron work is needed to finish up the connection at site

**TRL Comments:**
- No field construction experience yet.

**Additional Comments:**
- Steel congestion prevents the use of T-heads or hooks on the column bars. This may influence the distribution of stresses in the joint.
<table>
<thead>
<tr>
<th><strong>Location:</strong></th>
<th>Column to cap beam</th>
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</thead>
<tbody>
<tr>
<td><strong>Title:</strong></td>
<td>Connection P-2</td>
</tr>
<tr>
<td></td>
<td>Limited Ductility Cap Pocket</td>
</tr>
<tr>
<td><strong>Source:</strong></td>
<td>NCHRP 12-74</td>
</tr>
<tr>
<td><strong>Type:</strong></td>
<td>Pocket: Precast column bars inserted into concreted pocket in precast cap ED</td>
</tr>
<tr>
<td><strong>TRL:</strong></td>
<td>Maximum TRL: 7</td>
</tr>
<tr>
<td></td>
<td>TRL Gaps: 3</td>
</tr>
</tbody>
</table>
BACKGROUND

Title: Connection P-2 (Limited Ductility Cap Pocket)

History / Description:
- The pier cap contains a pocket, formed by a circular corrugated steel tube placed between the top and bottom bent cap reinforcing bars. To create the rest of the pocket, two short pieces of Sonotube are connected to the steel tube, one above and one below, and penetrated by the top and bottom bars. On site, the bent cap is lowered over bars projecting from columns. The pocket is filled with concrete.
- Seismic performance was tested as part of NCHRP 12-74.

References:
- Matsumoto (Unit 4 report - 2009); Restrepo et al. (2010)

Contact Information:
- Prof. Eric Matsumoto (Cal State Sacramento) – ematsumoto@csus.edu

EVALUATION

Constructability:
Risk Value: -1
- Need to notch the wall of the Sonotube to place it over the top and bottom bent cap bars and then patch the notches and seal the joint before casting the cap beam.
- Precast column longitudinal bars must be located to avoid cap beam stirrups and longitudinal reinforcement that pass through cap pocket.

Seismic Performance:
Value: 0
- Plastic hinge zone in column adjacent to cap beam
- Emulative performance – similar to ductile CIP connection
- Minimal damage observed in the capacity protected joint and cap beam
- Good ductility, similar to CIP connection. Precast and CIP specimens had different rebar strain distributions and joint crack patterns. Researcher recommends more analysis and testing to fully understand connection behavior.

Inspectability:
Value: 0
- Inspectability is similar to that of CIP concrete.

Durability:
Value: -1
- Durability is similar to that of CIP concrete, provided that the top of the pocket in the cap beam is protected by a diaphragm pour.

Time Saving Potential:
Value:+1
- Minimum formwork and no iron work are needed to finish up the connection at site.

TRL Comments:
- No field construction experience yet.

Additional Comments:
- Steel congestion prevents the use of T-heads or hooks on the column bars. This may influence the distribution of stresses in the joint.
Location: Column to cap beam

Title: Connection P-3
Abu Dhabi Column Pocket

Source: Civil Engineering Magazine

Type: Pocket: Reinforcing cage precast in cap beam is cast into pocket in top of column ED

TRL: Maximum TRL: 3
TRL Gaps: None
**BACKGROUND**

**Title:** Connection P-3 (Abu Dhabi Column Pocket)

**History / Description:**
- A rebar cage protruding from the bottom of each end of the precast cap beam is embedded in a void at the top of hollow precast piers. The connection is completed by pumping self-consolidating concrete through a tube from the top of the cap beam down into the pocket. A sacrificial slab in the column limits the pour depth.
- In 2009, completed three bridge structures of over 1 km length in Abu Dhabi (LRFD seismic zone 2).

**References:**
- Karapiperis et al. (2010)

**Contact Information:**
- www.archirodon.net

**EVALUATION**

**Constructability:**

*Risk Value: -1*
- Longitudinal cap beam reinforcement has to be outside of pocket, which might cause congestion or a wider beam
- There is a risk that the concrete in the pocket is not well consolidated

**Seismic Performance:**

*Value: -2*
- Plastic hinge zone in column below to cap beam
- Connection reinforcement is spliced in cap beam and column, hence in the potential plastic hinge zone
- The connection reinforcement is inside the column reinforcement; hence to develop the full column moment capacity will be uneconomical.

**Inspectability:**

*Value: 0*
- Inspectability is similar to CIP concrete

**Durability:**

*Value: 0*
- Durability is similar to that of CIP concrete

**Time Saving Potential:**

*Value: +1*
- Minimum formwork and minimum iron work is needed to finish up the connection at site

**TRL Comments::**
- Only low-seismic deployment and no known cyclic load testing

**Additional Comments:**
-
**Location:** Superstructure to substructure  
**Type:** Pocket: Precast pile with infill RC concrete plug that extends into cap.  
**Title:** Connection P-4  
**Source:** Florida DOT  
**TRL:** Maximum TRL: 3  
TRL Gaps: none
**BACKGROUND**

**Title:** Connection P-4 (Precast cap beam and hollow precast pile with infill concrete plug)

**History / Description:**
- A rebar cage protruding from the bottom of each end of the precast cap beam is embedded in a void at the top of hollow precast piers. The connection is completed by pumping self-consolidating concrete through a tube from the top of the cap beam down into the pocket.

**References:**
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**Contact Information:**
- Florida DOT

**EVALUATION**

**Constructability:**
- **Risk Value: -1**
  - Longitudinal cap beam reinforcement has to be outside of pocket, which might cause congestion or a wider beam
  - There is a risk that the concrete in the pocket is not well consolidated

**Seismic Performance:**
- **Value: -2**
  - Plastic hinge zone in column below to cap beam
  - Connection reinforcement is spliced in cap beam and column, hence in the potential plastic hinge zone
  - The connection reinforcement is inside the column reinforcement, hence to develop the full column moment capacity will be uneconomical

**Inspectability:**
- **Value: 0**
  - Inspectability is similar to CIP concrete

**Durability:**
- **Value: -1**
  - Durability is similar to that of CIP concrete, provided that the pocket in the top of the cap beam is protected by a diaphragm pour.

**Time Saving Potential:**
- **Value: +1**
  - Minimum formwork and minimum iron work is needed to finish up the connection at site

**TRL Comments:**
- Only deployment in no seismic region

**Additional Comments:**
-
Location: Superstructure to substructure

Title: Connection P-S

Source: Iowa DOT

Type: Pocket: Steel pile with infill RC concrete plug that extends into cap.

TRL: Maximum TRL: 3
TRL Gaps: none

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**SECTION THROUGH CORRUGATED METAL PIPE (CMP)**

**PRECAST CONCRETE PIER CAP SECTION**
BACKGROUND

Title: Connection P-5 (Pipe pile to precast cap connection)

History / Description:
- The pile cap contains a pocket formed by a circular corrugated steel tube. No cap beam reinforcement penetrates the pocket. The pile made of a concrete filled steel pipe is connected by casting the from the pile projecting connection reinforcement steel into the cap beam pocket.

References:
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Contact Information:
- Iowa DOT

EVALUATION

Constructability:
Risk Value: -1
- Longitudinal cap beam reinforcement has to be outside of pocket, which might cause congestion or a wider beam
- There is a risk that the concrete in the pocket is not well consolidated

Seismic Performance:
Value: 0
- Concentrated plastic hinge zone between steel pipe and cap beam through strain penetration
- The connection reinforcement is inside the steel pipe; hence to develop the full column moment capacity will be uneconomical.

Inspectability:
Value: 0
- Inspectability is similar to CIP concrete

Durability:
Value: -1
- Durability is similar to CIP connected steel piles, provided that the pocket in the top of the cap beam is protected by a diaphragm pour.

Time Saving Potential:
Value: +1
- Minimum formwork and minimum iron work is needed to finish up the connection at site

TRL Comments:
- Only non-seismic deployment

Additional Comments: