PERFORMANCE OF DOWEL TYPE PANEL-TO-FOUNDATION CONNECTIONS IN SLENDER PRECAST PANELS

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Low-rise Slender Panel Buildings

Not that glamorous, but a lot of them
Look simple, but in reality not that simple
Portal Frame + Panels
Dowel Type Connections

- Precast Panel
- Threaded Insert
- Floor Slab
- Starter Bar
- Foundation Cast After Panel Propping
- Foundation Cast Prior to Panel Propping
Concerns

SESOC Interim Guidance (2013)
• Vulnerability to out-of-plane loading
• Concrete in tension as part of main load path
• Possibility of breakout behind the insert
Out-of-Plane Testing
Test Setup

Section

Moment Distribution

Simplified Load Distribution
Test Setup

• Determine hierarchy of failure
• Quantify performance of existing connection details
• Investigate alternative connection details
Existing Connections

- Details determined from survey of panel buildings
- Insert connections most common
- Conventional starters (U or L) used but concerns over bending and rebending of starters for transportation

“U” Bar

“L” Bar

Shallow Inserts
Existing Connections

12 mm Inserts – Shallow Foundation
• Damage as predicted by strut and tie
• Significant strength loss following vertical cracking
• Rotation/damage concentrates in joint
Existing Connections

16 mm Inserts – Deep Foundation

- Failed to reach nominal moment strength in the joint-opening direction
- Increase in panel strength with similar joint strength
Existing Connections

“L” Bar (Standard Hooks) – Shallow Foundation

- Very little joint rotation
- Damage concentrated at termination of hooks
Existing Connections

“U” Bar ("Hairpin") – Shallow Foundation

• Very little joint rotation/damage
• Suspected that better force transfer to starter bars explains performance
Alternative Connections

• Seek to avoid damage in the joint
• Details developed with industry development
Alternative Connections

Increased Embedment

• No joint damage
• Panel reaches nominal strength
• Similar response between “bolted through”, “zero cover” and “15mm cover” iterations
**Alternative Connections**

**Strengthened Joint**
- No joint damage
- Headed stud connections failed to reach nominal moment strength
- Link bar performed well
Alternative Connections

Confined Joint

- No joint damage
- Offset reinforcement – sensitivity of singly reinforced panels

![Diagram of Inserts with Confining Steel]

2x 4-RB12TI inserts
4 x D6 stirrups

Inserts with Confining Steel

![Graph showing Moment vs Rotation]

HD12 @270 mm
In-Plane & Bi-Directional Testing
In-Plane Testing
(3 Panels: Shallow inserts, deep inserts, U-bar)
Bi-Axial Testing

Multi-Axis Substructure Testing (MAST): Swinburne University of Technology
Bi-Axial Testing
(Threaded Insert w/ Shallow Embedment – time lapse)
Assessment of Joint Strength
Panel Joint Assessment: Threaded Inserts

- Joint strength assessed based on NZS 3101 Ch 17
- Equations not suited for predicting this type of failure

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<tr>
<th>Panel Name</th>
<th>Connection Description</th>
<th>Vert Reinf</th>
<th>Mcb/Mn</th>
<th>Mcb*/Mn</th>
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Conclusions
Conclusion

• Poor performance of dowel connections with shallow embedded threaded inserts
  • brittle failure = non-compliant
Recommendation
Acknowledgements