Seismic Behaviour of low-rise Precast Concrete Wall to foundation Connection

Vinu Sivakumar  
Supervisor: Dr. Lucas Hogan  
Co-Supervisor: Dr. Rick Henry
Why Precast Concrete Panels?

* Precasting in New Zealand started in 1950’s and its usage has steadily increased since 1960’s (Park, 2002).
* Speed up construction
* Reduce the amount of site work
* Commonly used in low-rise building such as office, school, car park.

Source: Concrete structures NZ ltd

Source: Quake Centre UC

Source: Wilco Precast
DOWEL CONNECTIONS
Precast wall to foundation connection

Dowel type of connection detail

Threaded Insert

Starter bars

Source: Beattie, 2007

Source: Pouya Seifi et al., 2016
Panel to foundation connection

Source: Hogan et al., 2017
Hogan et al., 2017 studied that when the panel was loaded with a joint-opening moment, the concrete behind the insert head has to resist the load in tension to complete the load path as shown below.

Concrete Cone break out – critical failure mode

Source: Hogan et al., 2017
Summary of the Research work

Challenges with Seismic Performance of low-rise buildings with precast panels

➢ There are lot of these buildings
➢ The foundation connection doesn’t work in the out-of-plane direction
   a) This direction the panels are used for cladding
   b) Panels provide lateral resistance for the building in their in-plane direction

Research Needs:

➢ Develop a robust foundation connection
   a) Understand the performance in both out-of-plane and in-plane
➢ Understand the ability for the panels to withstand in-plane demands if damaged in the out-of-plane direction (bi-axial loading)
➢ Develop numerical models to understand the demand on buildings with the existing details and if a retrofit program is urgent.
However, this detail does not satisfy the industry favour of placing the outside face of wall panels right on the legal boundary line. Therefore, builders prefer cranked bar detailing.
Robust Connection

Cranked bar detail

➢ Incorporated RB16 couplers for
➢ Easier transport
➢ Avoiding re-bending of bars.

RB16 COUPLERS
Out-of-plane behaviour of the connection

<table>
<thead>
<tr>
<th>Drossbach</th>
<th>Cranked bar</th>
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<tbody>
<tr>
<td>• Flexural dominated response</td>
<td></td>
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<tr>
<td>• Failure above the foundation</td>
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<tr>
<td>• Recommended to Industry as alternative details</td>
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In-Plane testing

Precast walls to be tested in the STL lab
Bi-directional behaviour

Dowel Panel-0 mm

Dowel Panel-50 mm cover

Source: Hogan et.al, 2017
Bi-directional behaviour

Dowel Panel-0 mm

In-plane loading

Bi-axial loading

Dowel Panel-50 mm cover

In-plane loading

Bi-axial loading

Source: Hogan et.al, 2017
Numerical Modelling

- Existing panel connection
- Robust panel connection

Source: Openseespydoc.readthedocs/RC wall
System level Modelling

Prototype – 1 (Moderate amount of Side Openings)  Prototype-2 (High amount of end Openings)
Thank you for your patience.