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

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- Co-Supervisor: Dr. Rick Henry

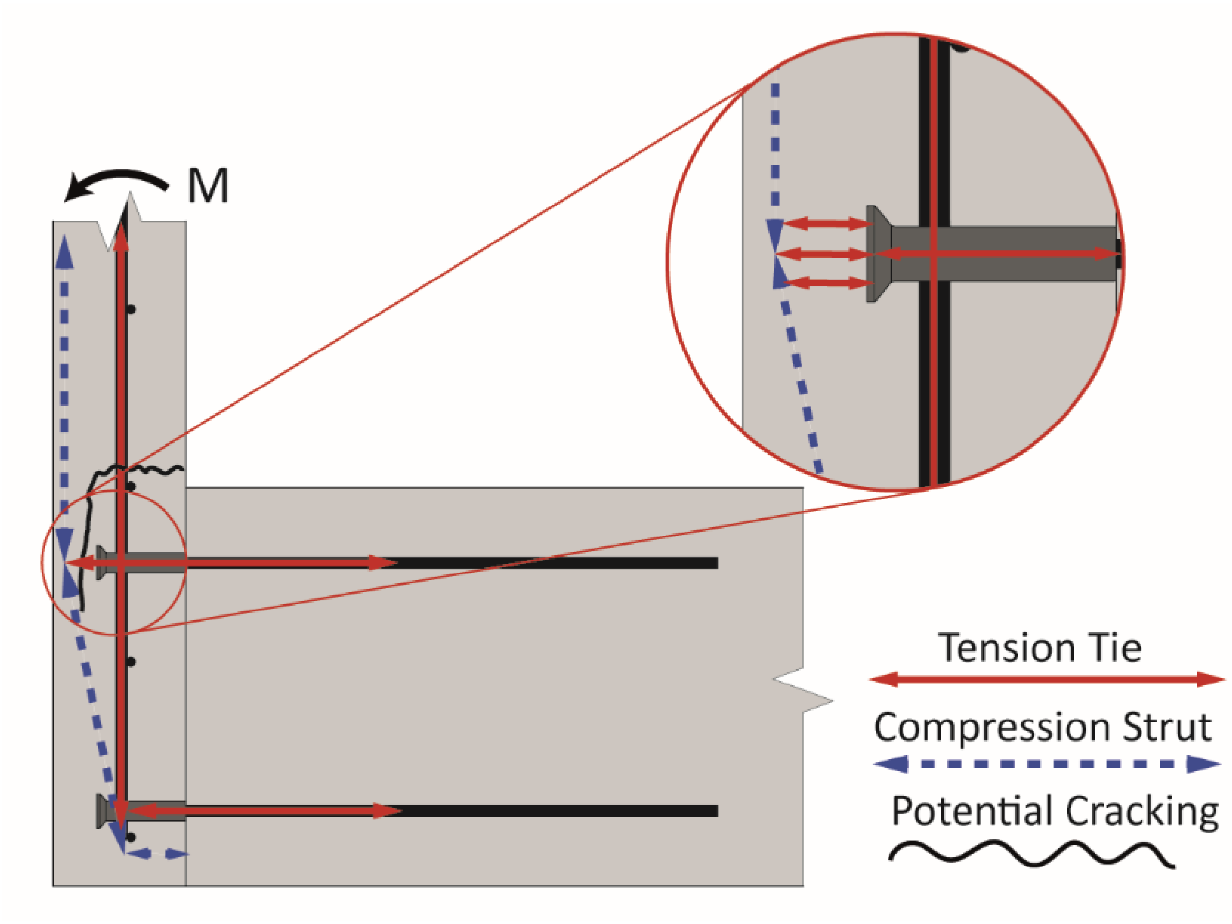
1. Slender Precast walls

- Extensively used in NZ.
- Commonly used in the low rise structure.
- Essentially act as cladding bracing the building.
- These panels are connected to the foundation by dowel type starter bar-threaded insert connections.

2. SESOC Interim Guidance (2013)

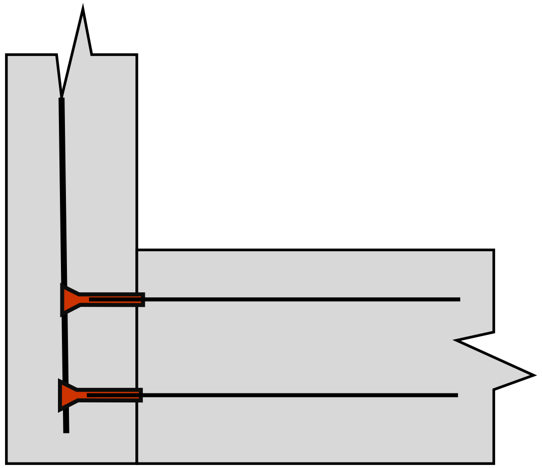
Concrete in tension as part of main load path

Flexural crack behind the insert and vulnerable under out-of-plane loading

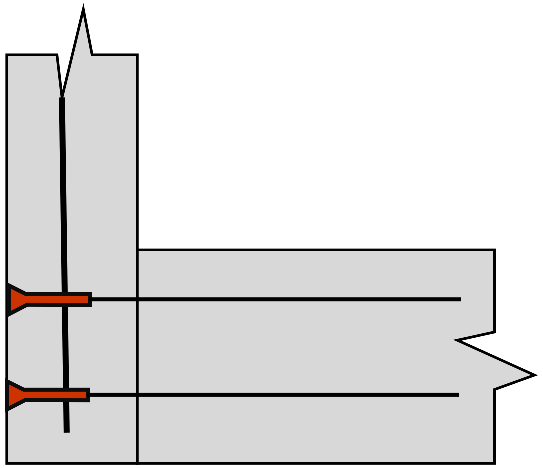


OOP failure

3. Capacity of the connections are they okay?



SHALLOW INSERT – C50



DEEP INSERT – C0

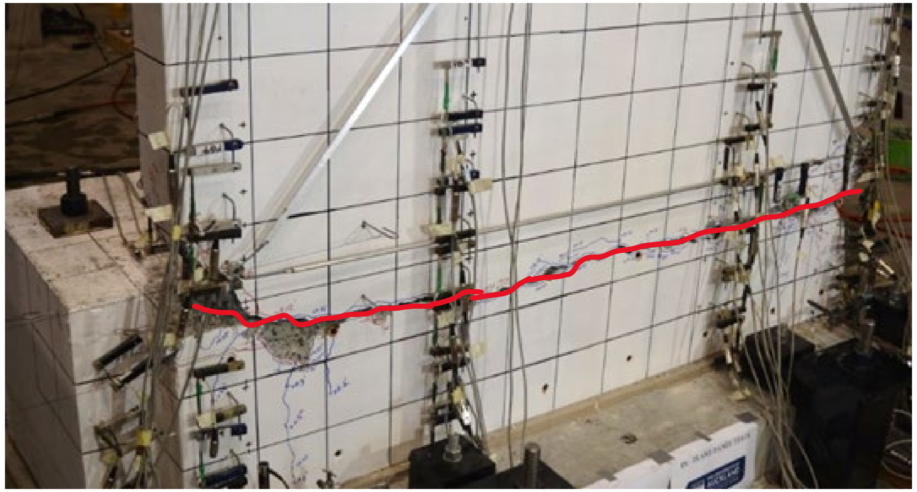
Performance of the connection

In-plane

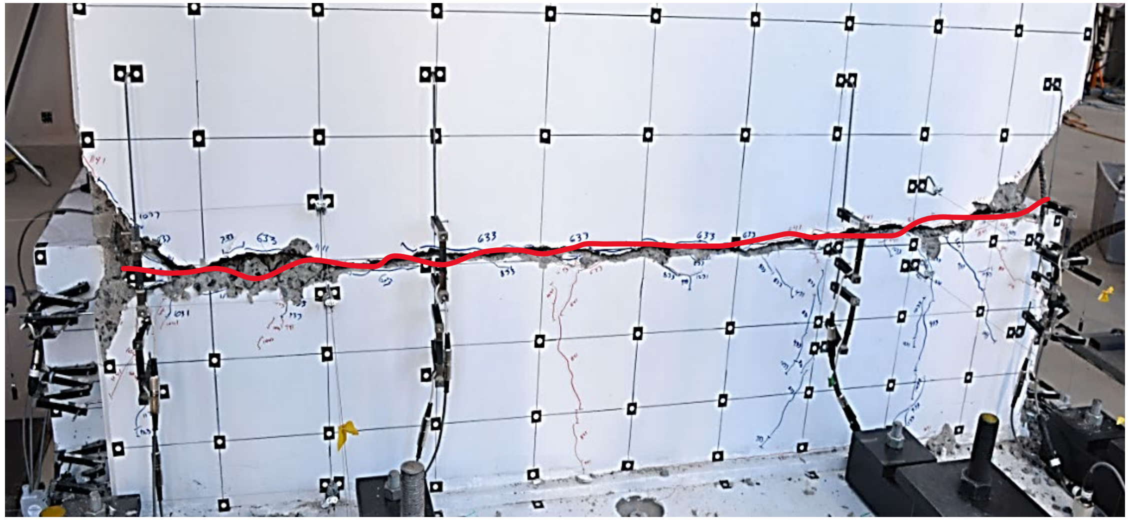
Out-of-plane

Bi-axial

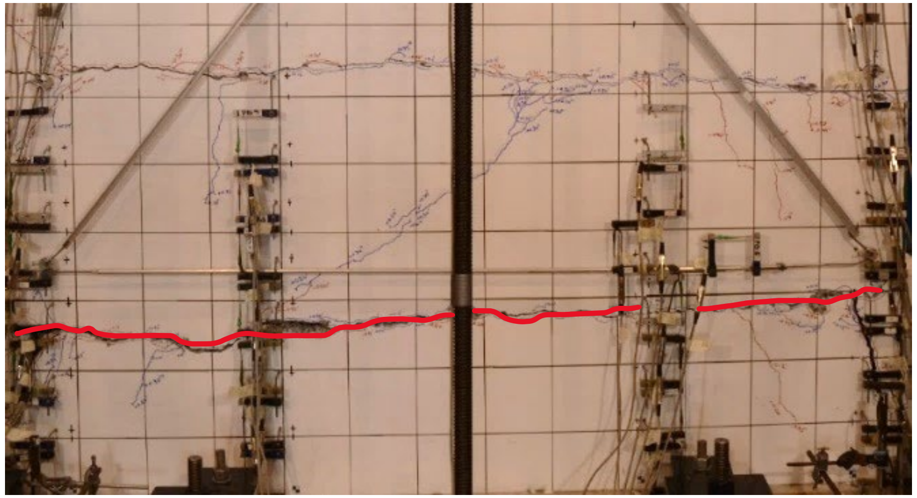
Damage Progression



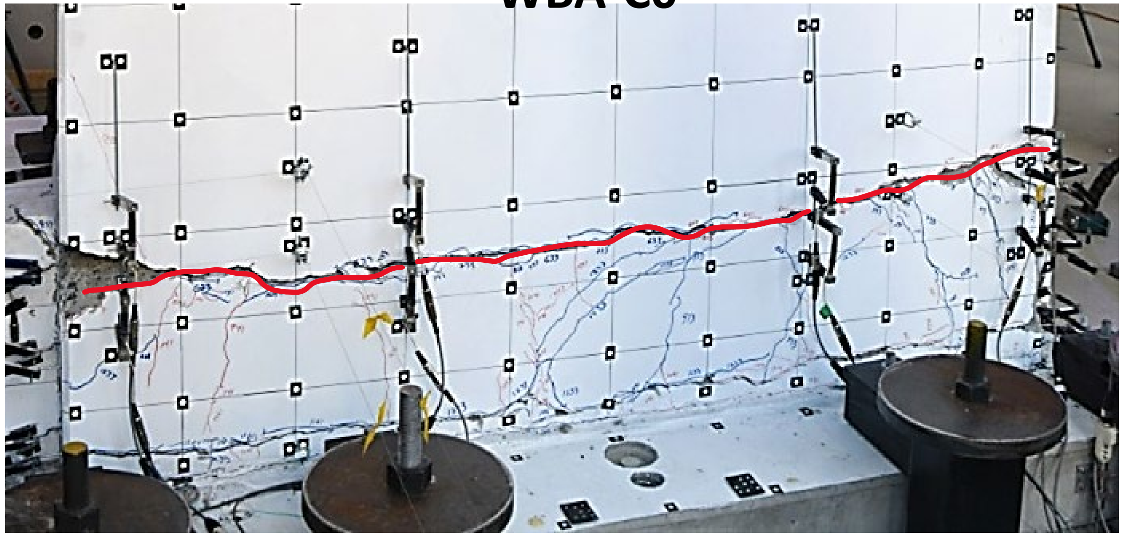
WIN-C0



WBA-C0

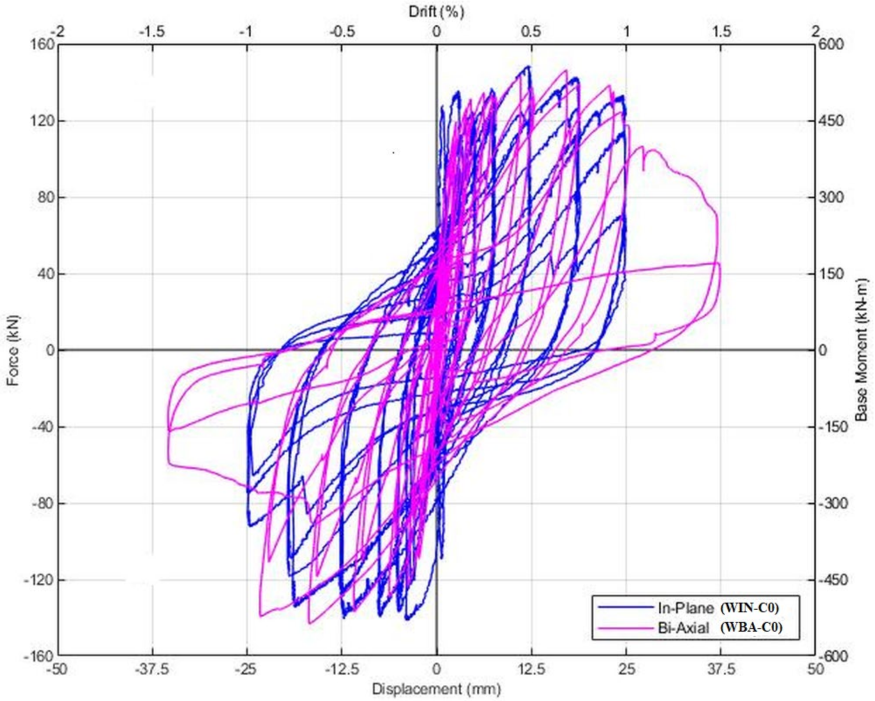


WIN-C50

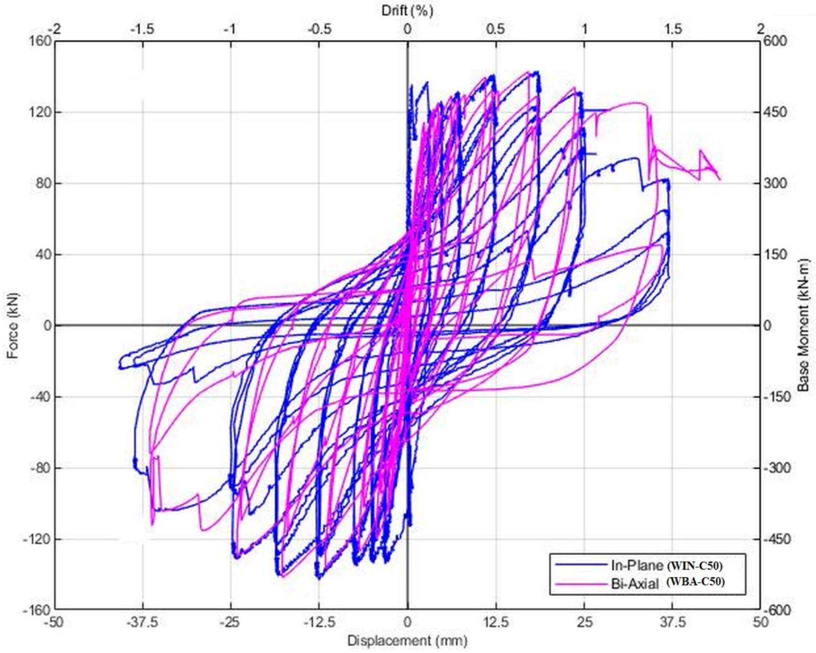


WBA-C50

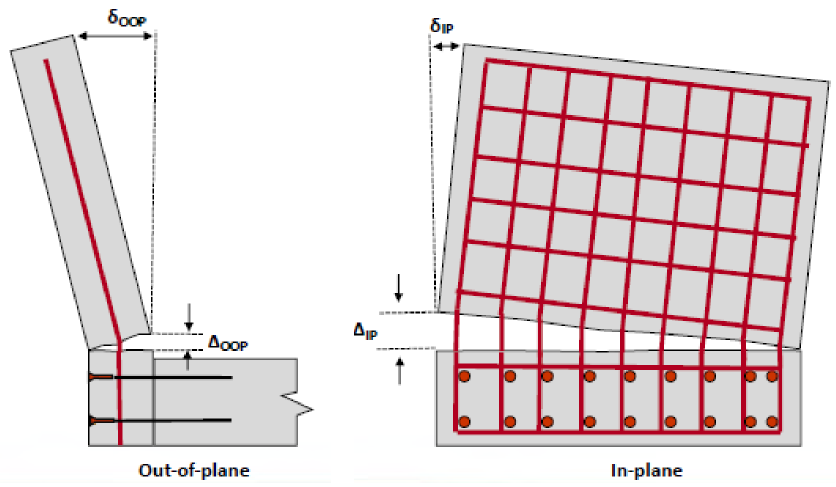
Hysteresis of the panels



Deep inserts



Shallow inserts

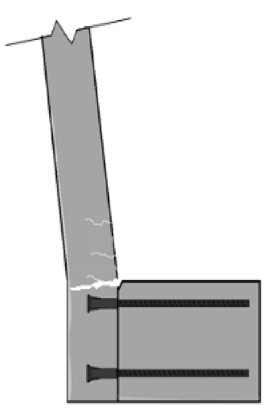


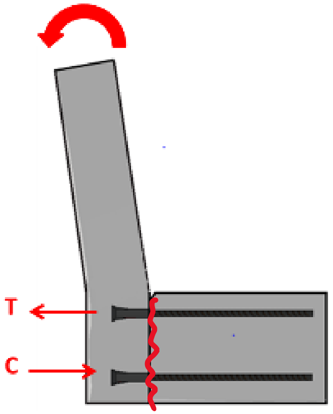
$\delta_{OOP} > \delta_{IP}$

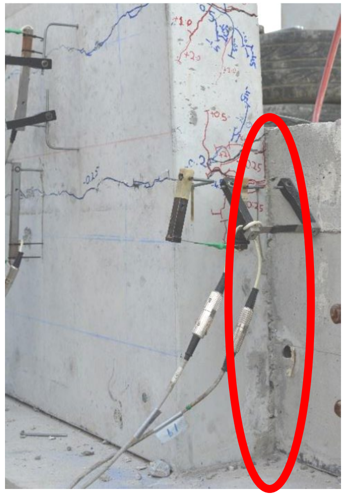
$\Delta_{IP} > \Delta_{OOP}$

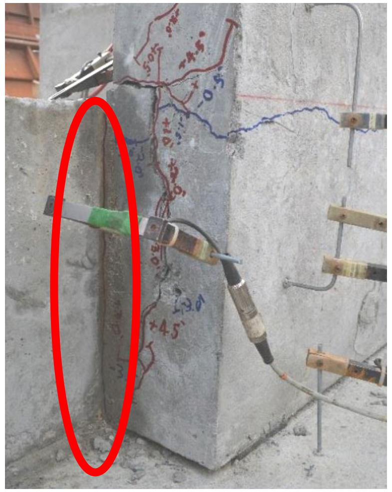
Panel can't close the in-plane crack when loaded in the out-of-plane

4. Interface crack



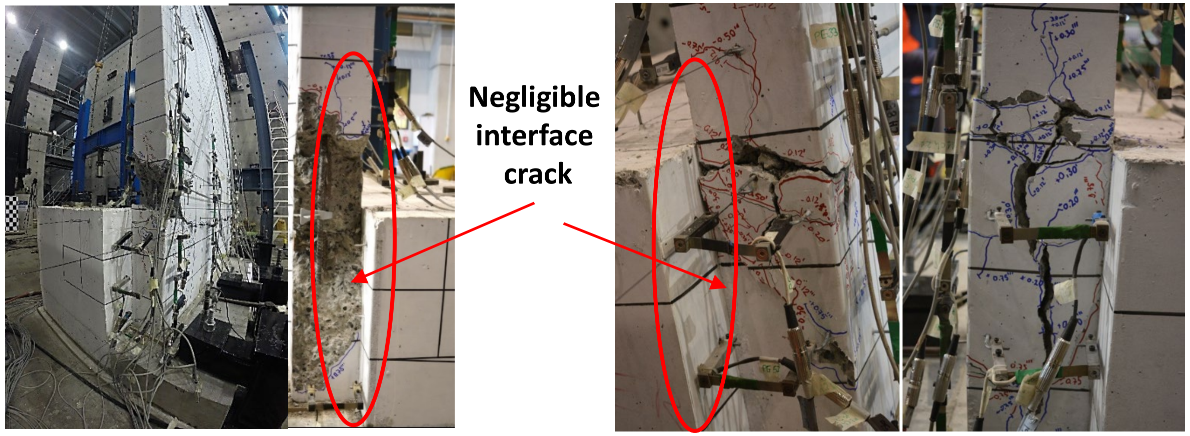






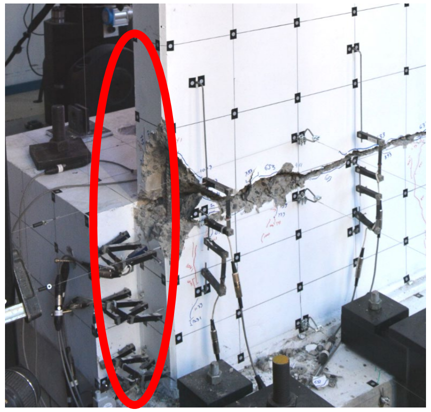
Panel-TI12-C0 Panel-TI12-C50

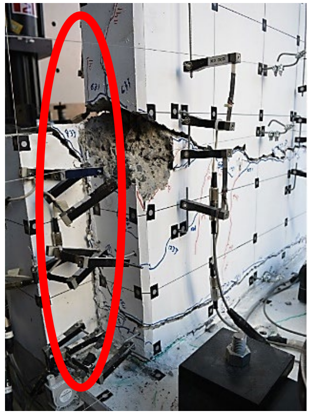
Observed damage by (Hogan et al,2018) (OOP)



WIN-C0 WIN-C50

Observed damage by (Gjata et al,2019) – (IN-PLANE)

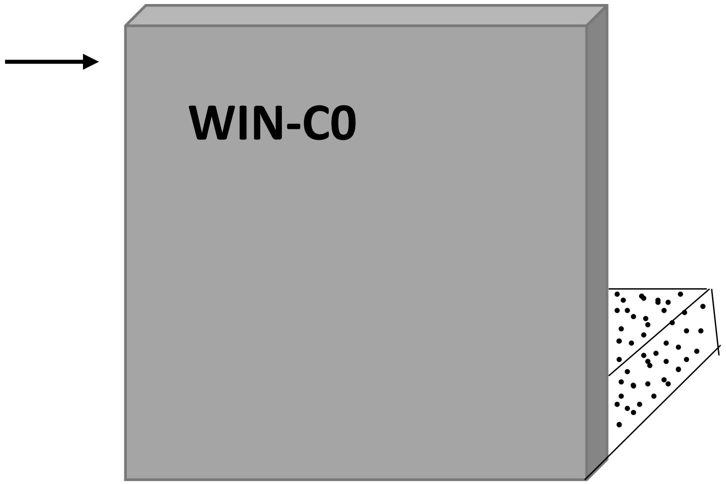


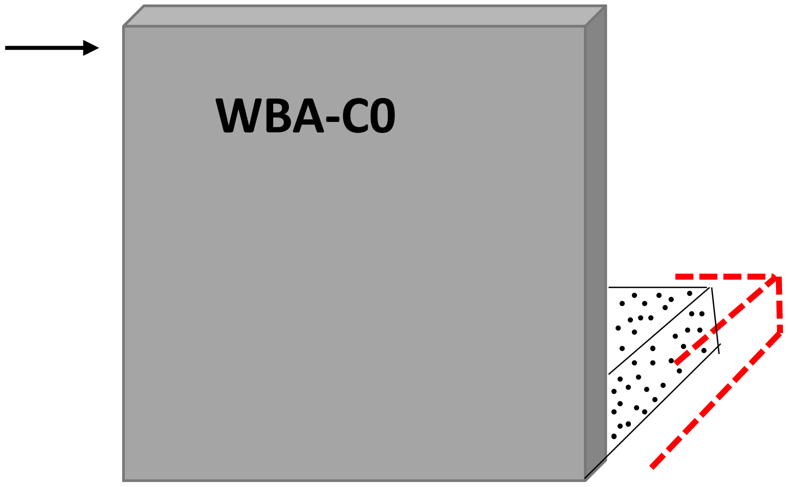


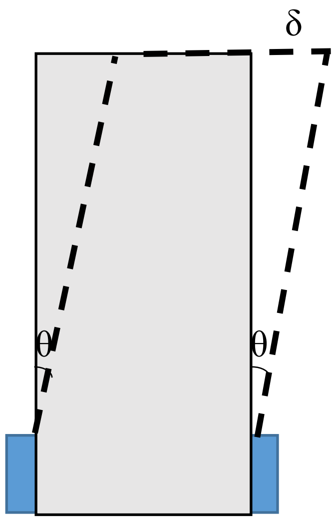
WBA-C0 WBA-C50

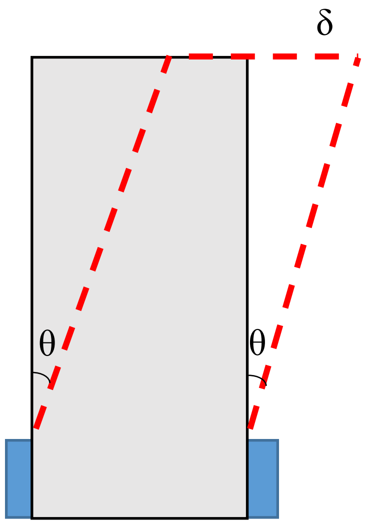
Tested by (Hogan et al,2018) – (BI-AXIAL)

Foundation movement







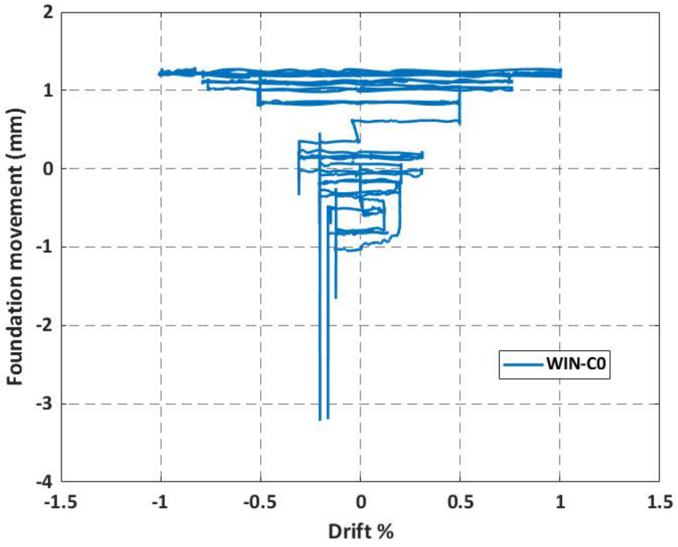


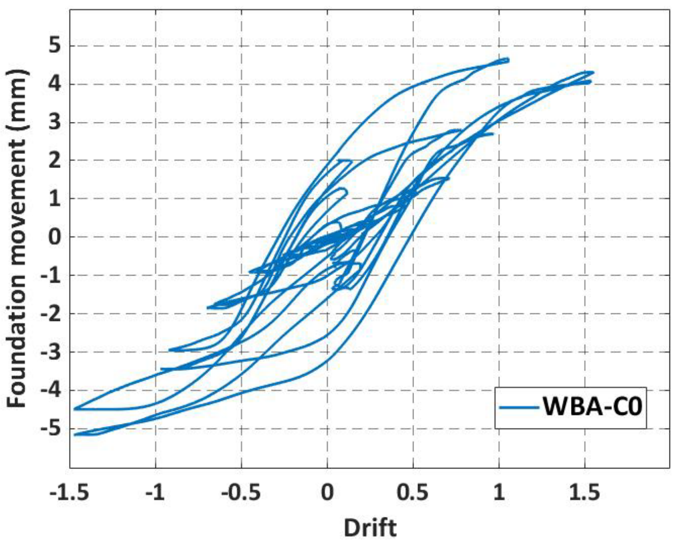
WIN-C0

10 mrad
at 1%

WBA-C0

15 mrad
at 1.5%



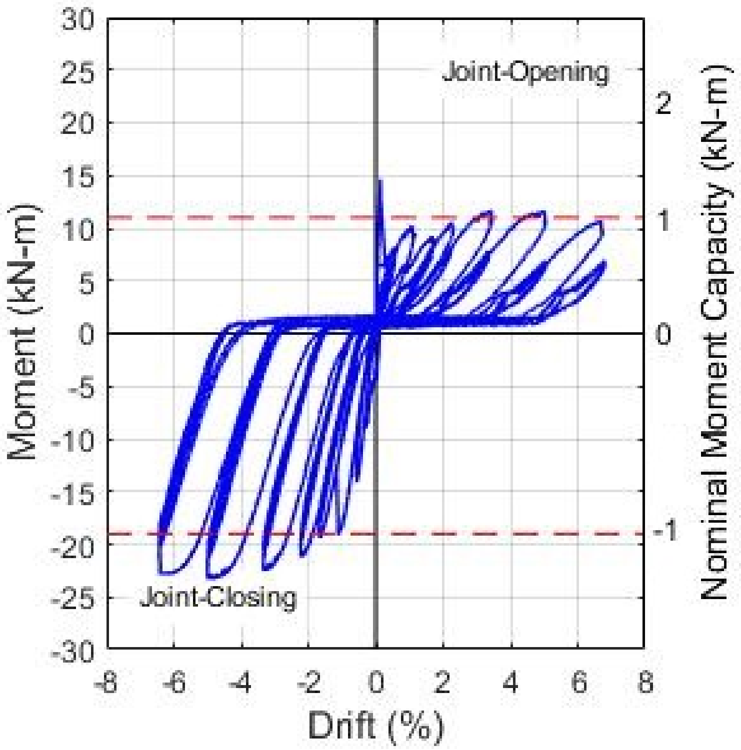


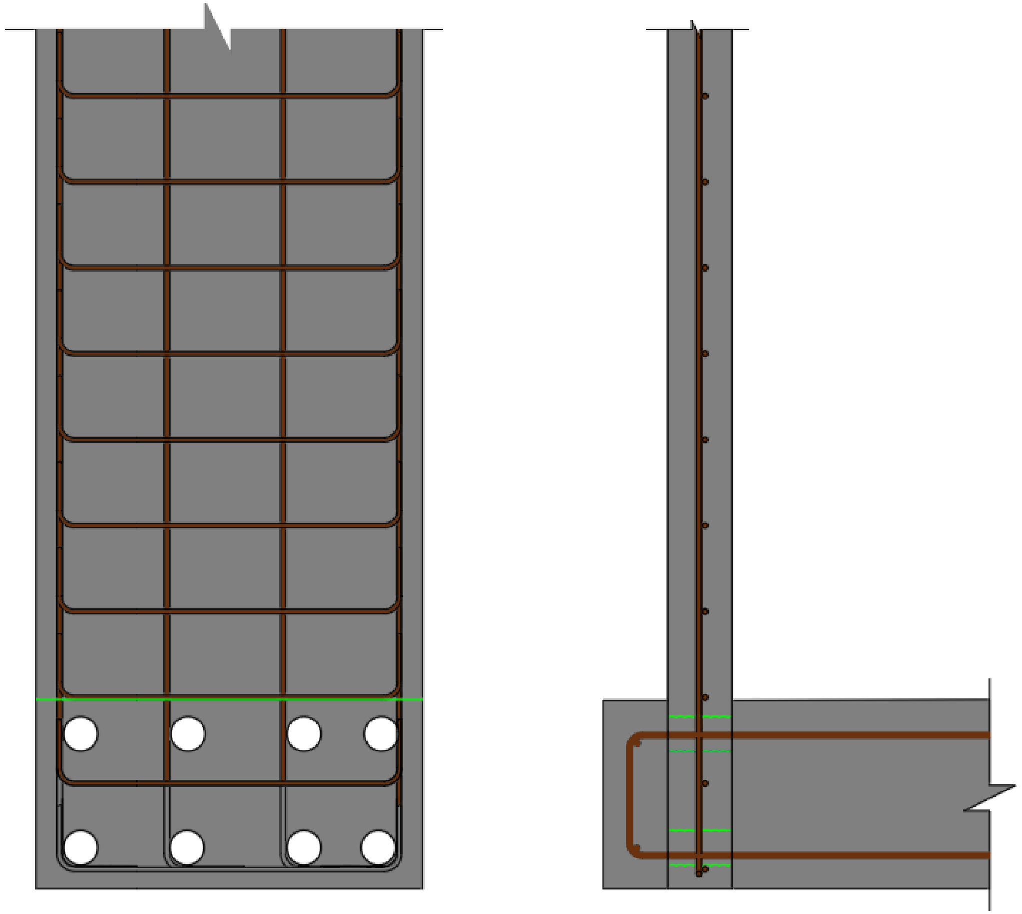
Is there any alternative connection details?

Proposed Alternative Details

Horizontal Drossbach Detail

It cannot be built if erected on the boundary.

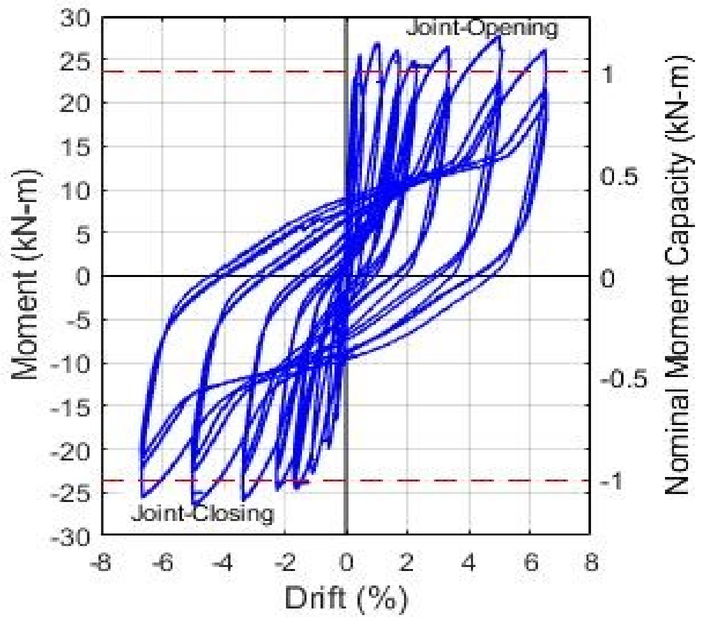


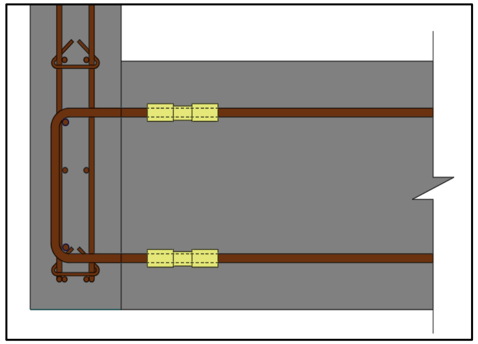


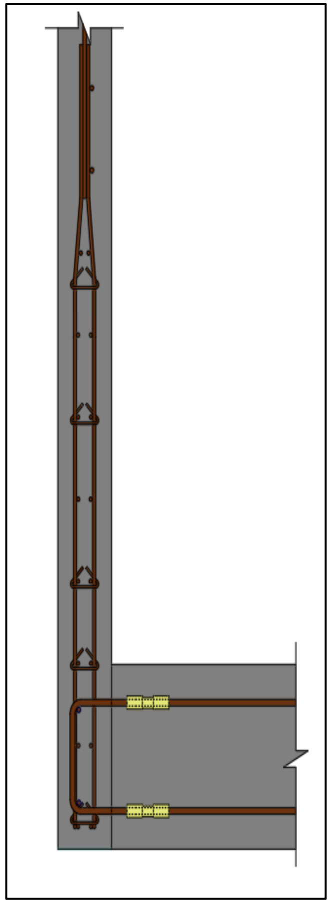
(Han et al., 2020)

Proposed Alternative Details

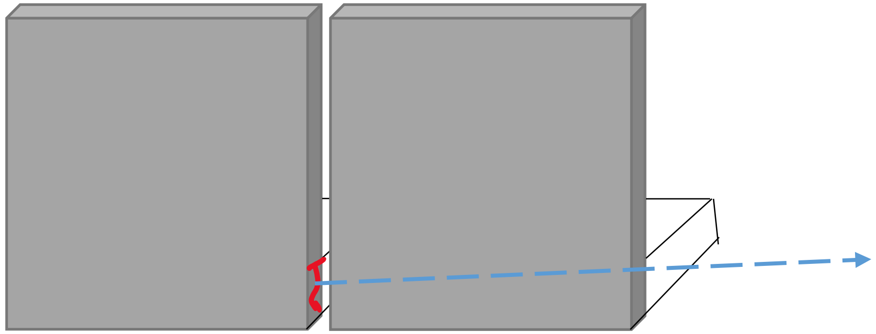
Cranked Bar Detail





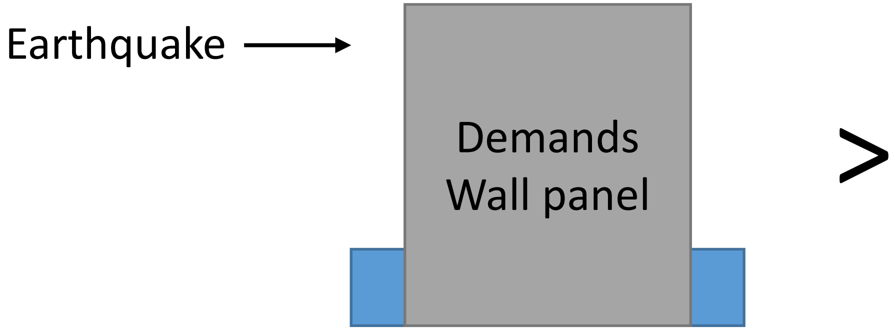


(Han et al., 2020)



Most of the damages are in the sides of the panel

What demands do the buildings are likely to see ?

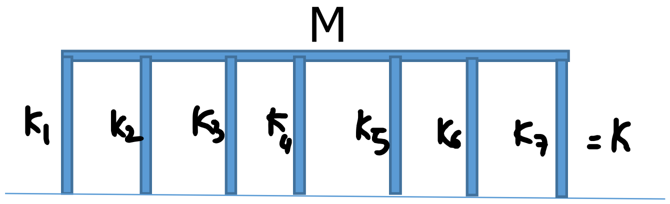


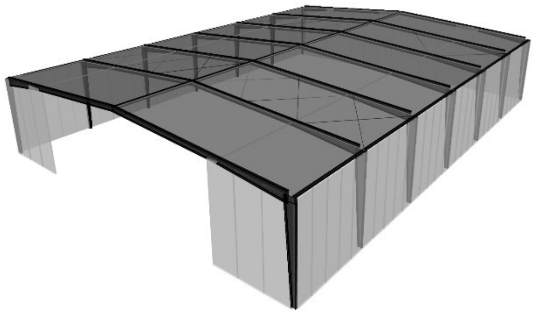
Capacity of the connection

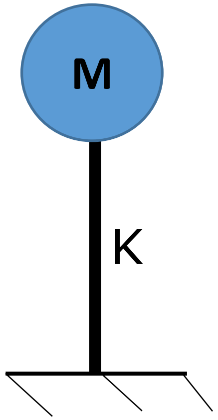
4. Unclear with the response modification coefficient ‘R’

- We need to know the stiffness of the wall (k_{wall}) and determine the period T_{wall} of the wall and determine T_{diaph} of the roof.

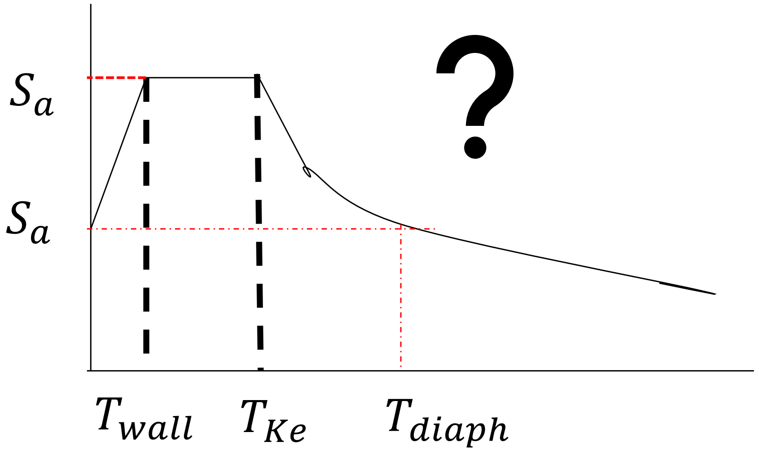
- $\frac{1}{K} = \frac{1}{k_{wall}} + \frac{1}{k_{diaph}}$



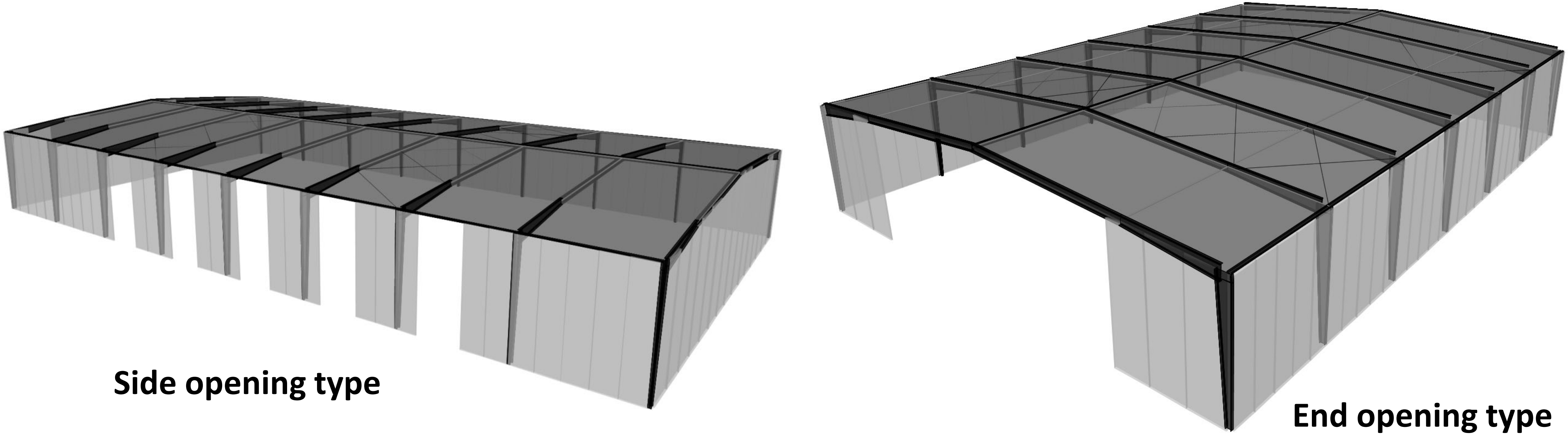




- Additional studies are needed to develop an appropriate response modification coefficient ‘R’

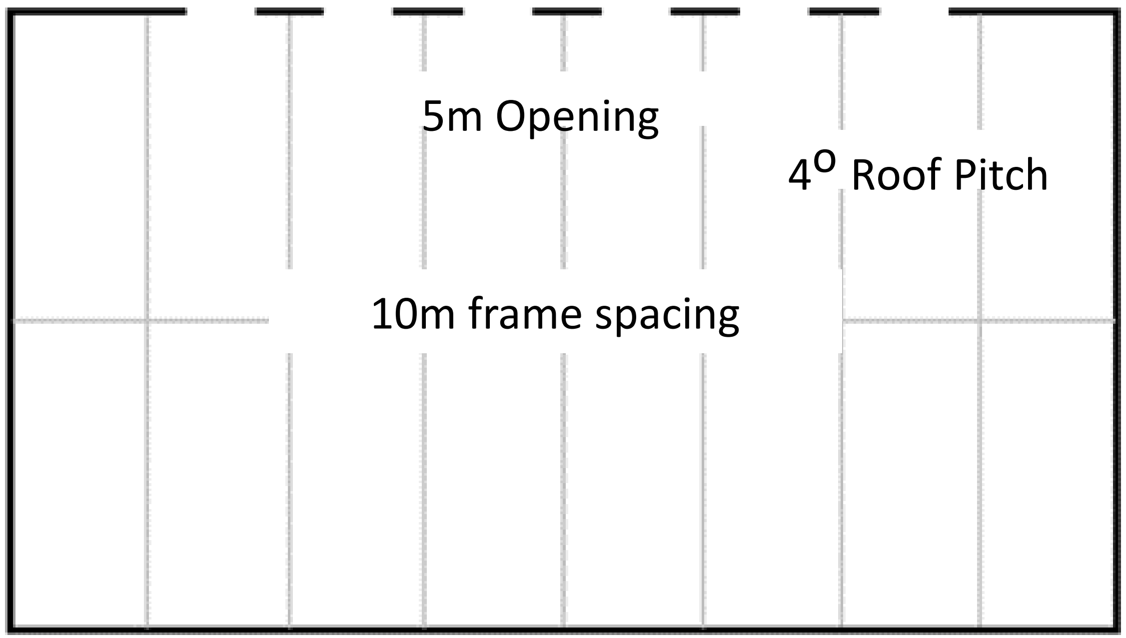


3D view of the building typology

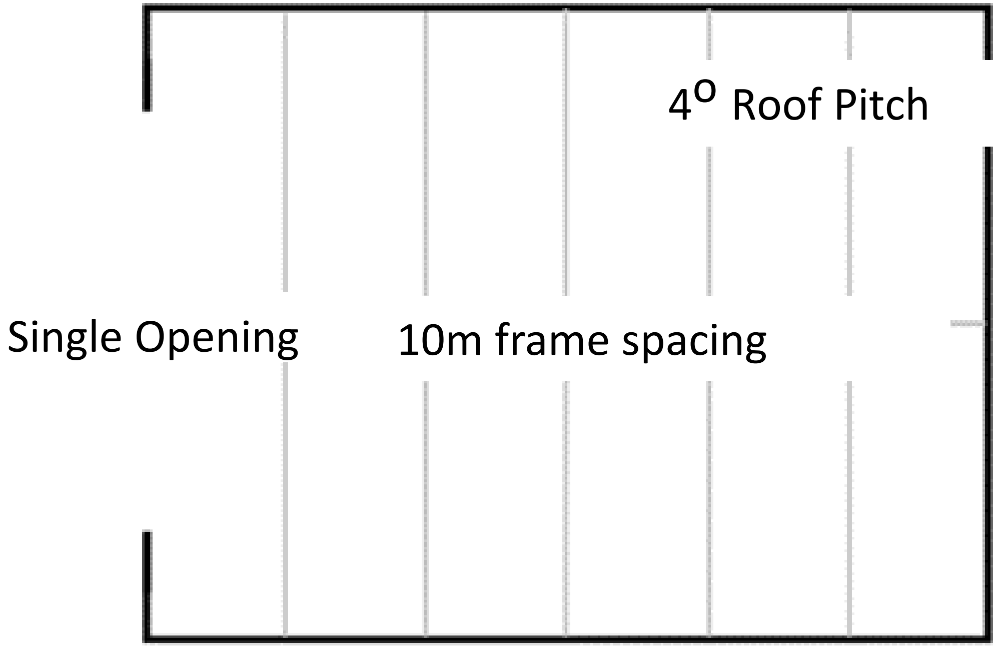


Building typology (Hofmann et al., 2016)

Proposed building typology



Side opening type



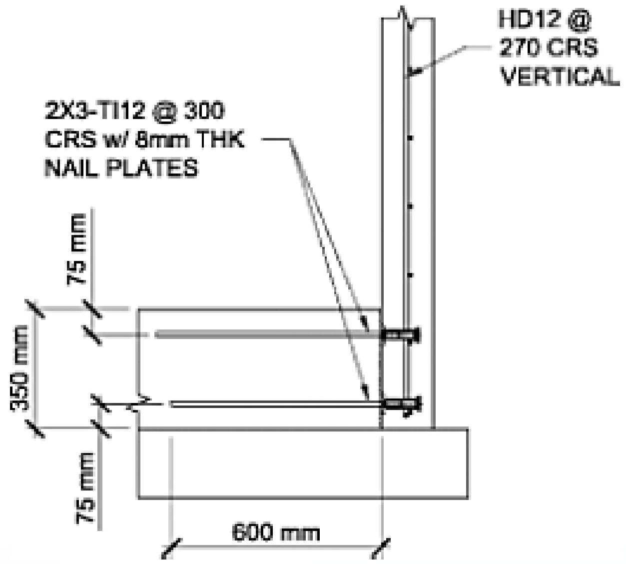
End opening type

	Short span	Mid span	Large span
Side	15m	45m	65m
End	30m	45m	75m

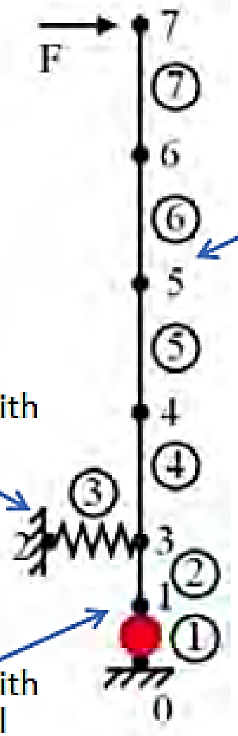
Eave height	Bay spacing	Roof slope	Eave conn
10m	10m	4%	300 PFC

Building typology (Hofmann et al., 2016)

5. System level performance



Zerolength element with
tension-only material

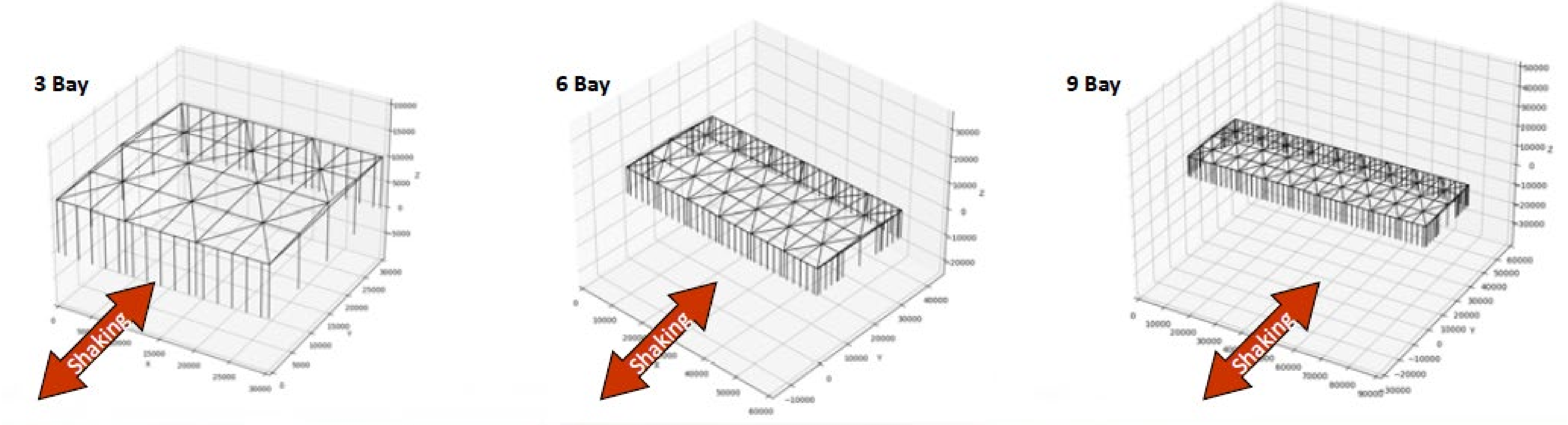


Displacement-based
beamcolumn element
with fiber section

Zerolength element with
Modified IMK material

System level performance by (Liu et al., 2022)

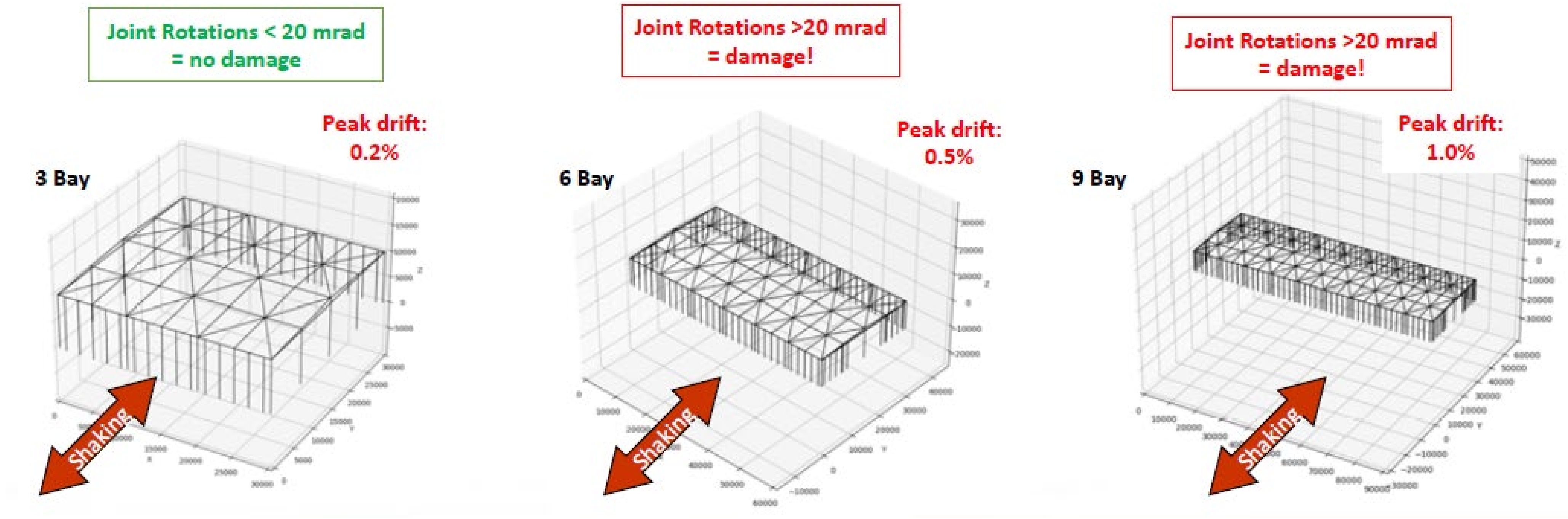
System level performance



- Typical warehouse size 10 m bays, 10m high panels
- Portal frames modeled with lumped hinges
- Flexible diaphragms
- Uniaxial shaking

System level performance by (Liu et al., 2022)

System level performance



Joint rotations > Story drift

System level performance by (Liu et al., 2022)

6. Further investigation

- Alternative connection testing for bi-axial.
- Numerical modelling with the experimental test.
- System level for the different typology of the building model under different loading protocols.

Thank you