Modelling of post-tensioned E-Defense Building

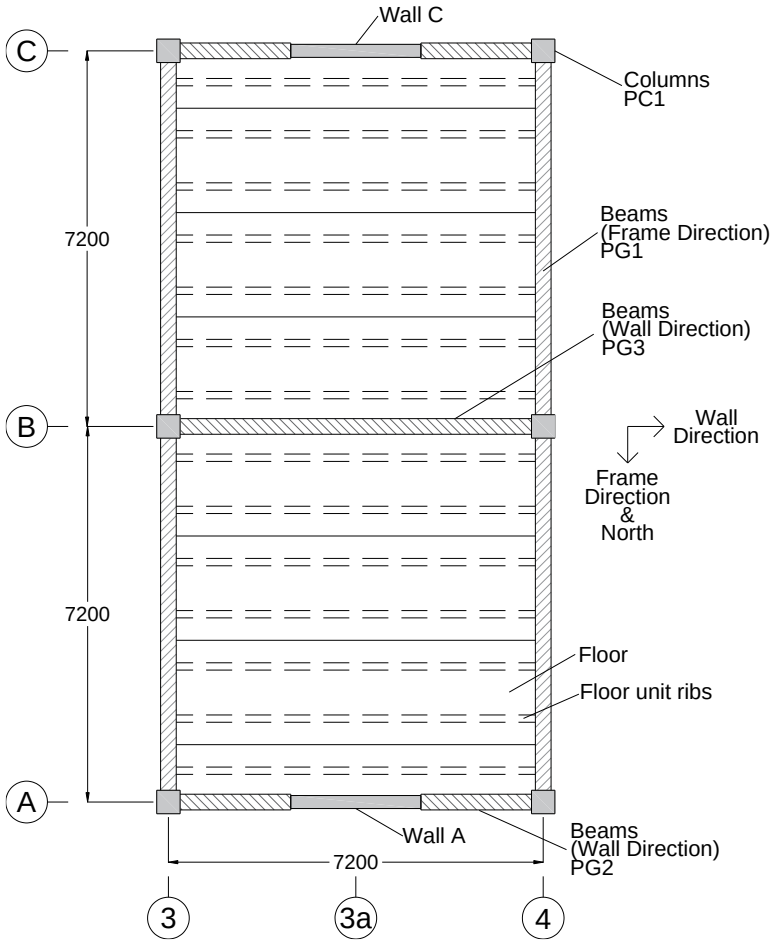
Jonathan Watkins

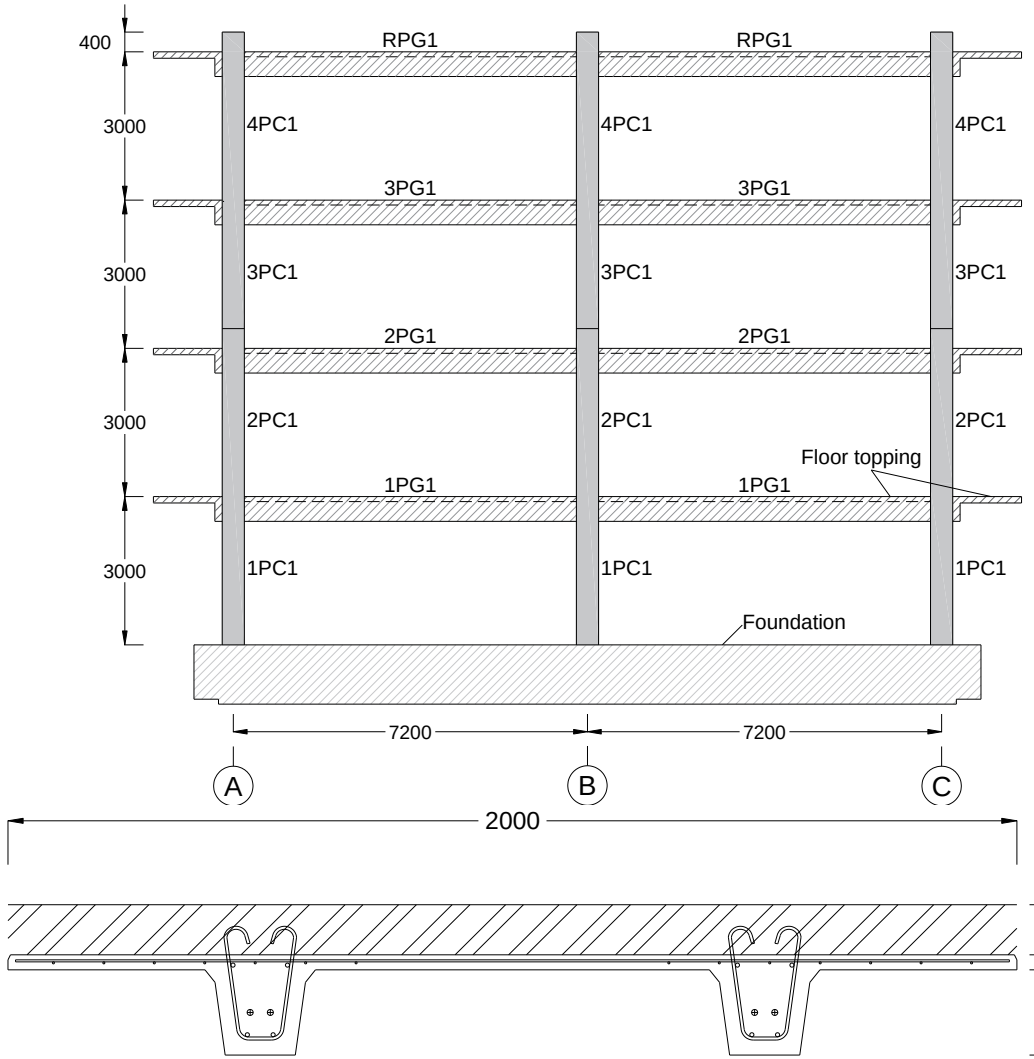
E-Defense Building

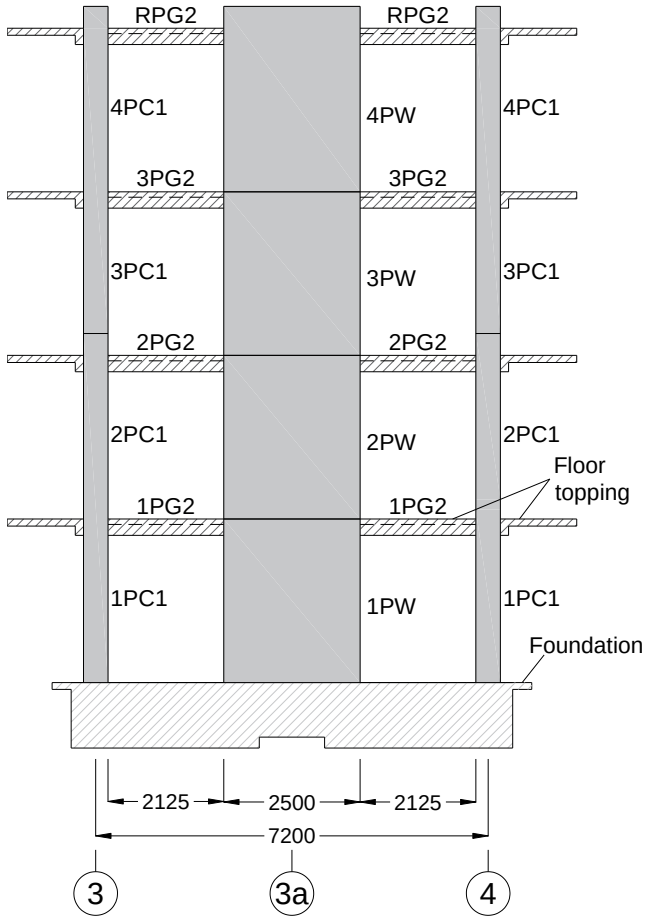
- Four storey
- Full scale
- Post-tensioned
- 3D EQ

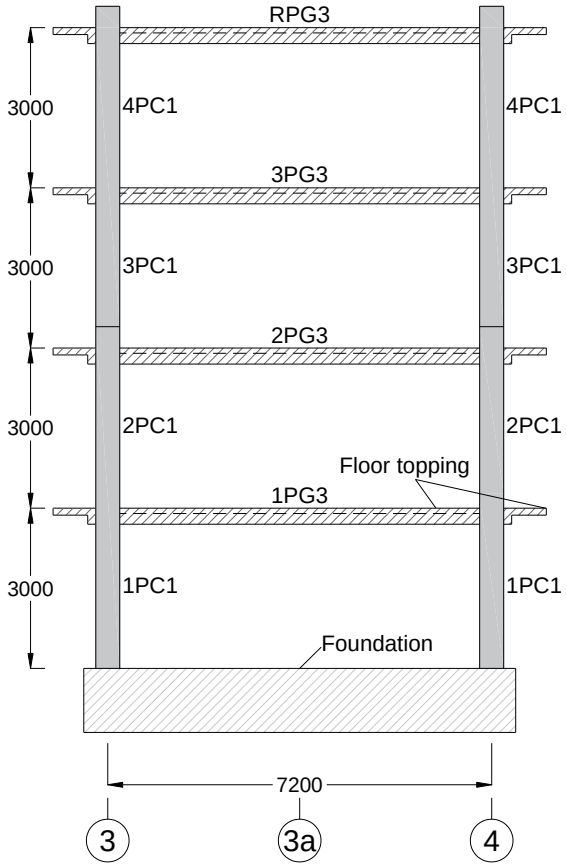
- Focus on wall response & interactions with building

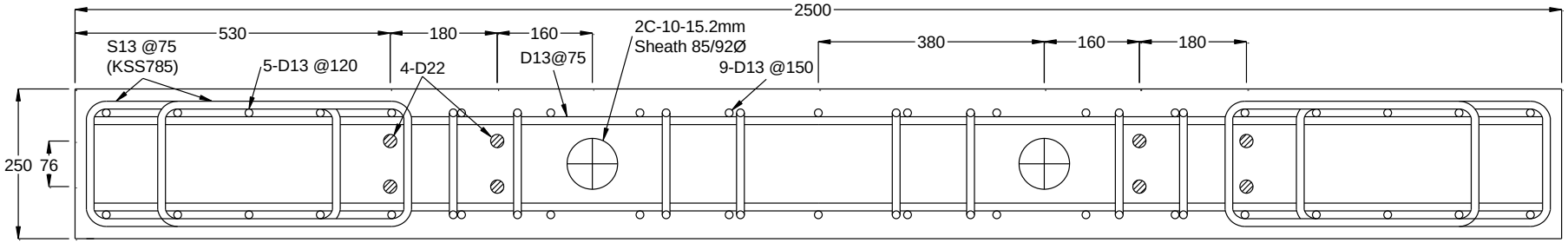
Building Overview



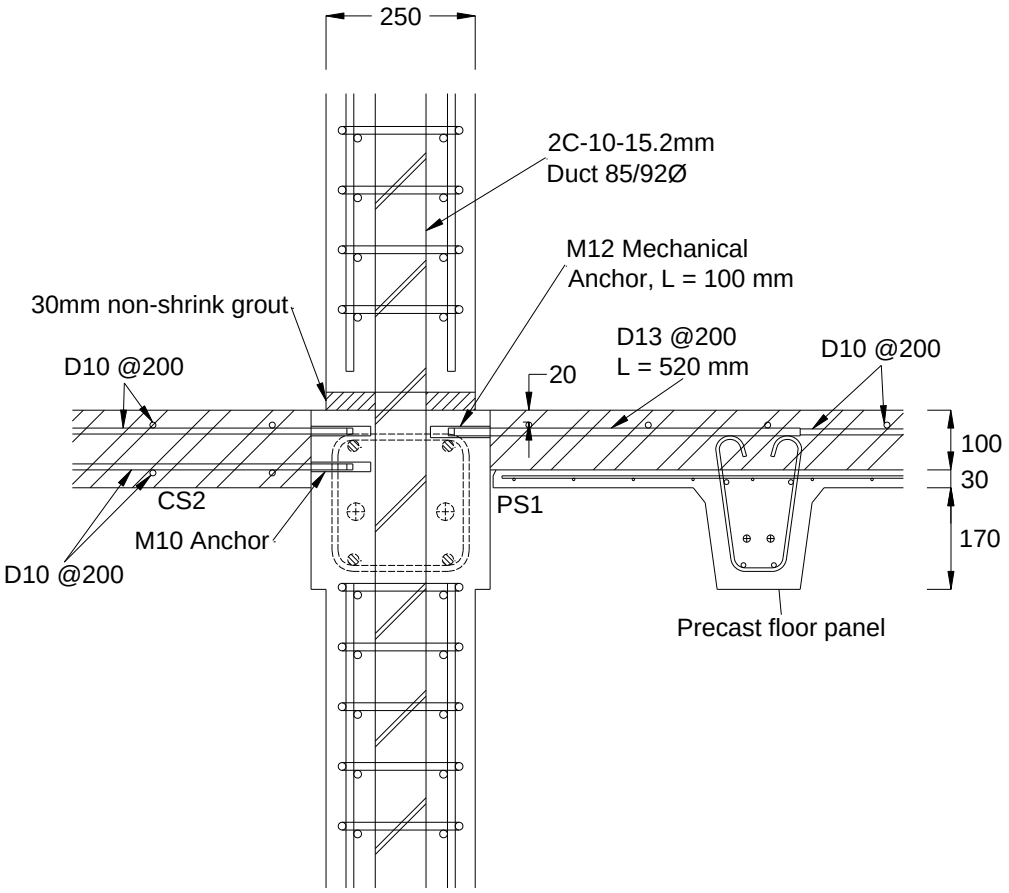



RPG2
RPG2
4PC1
4PW
4PC1
3PG2
3PG2
3PC1
3PW
3PC1
2PG2
2PG2
2PC1
2PW
2PC1
Floor
topping
1PG2
1PG2
1PC1
1PW
1PC1
Foundation
2125
2500
2125
7200
3
3a
4

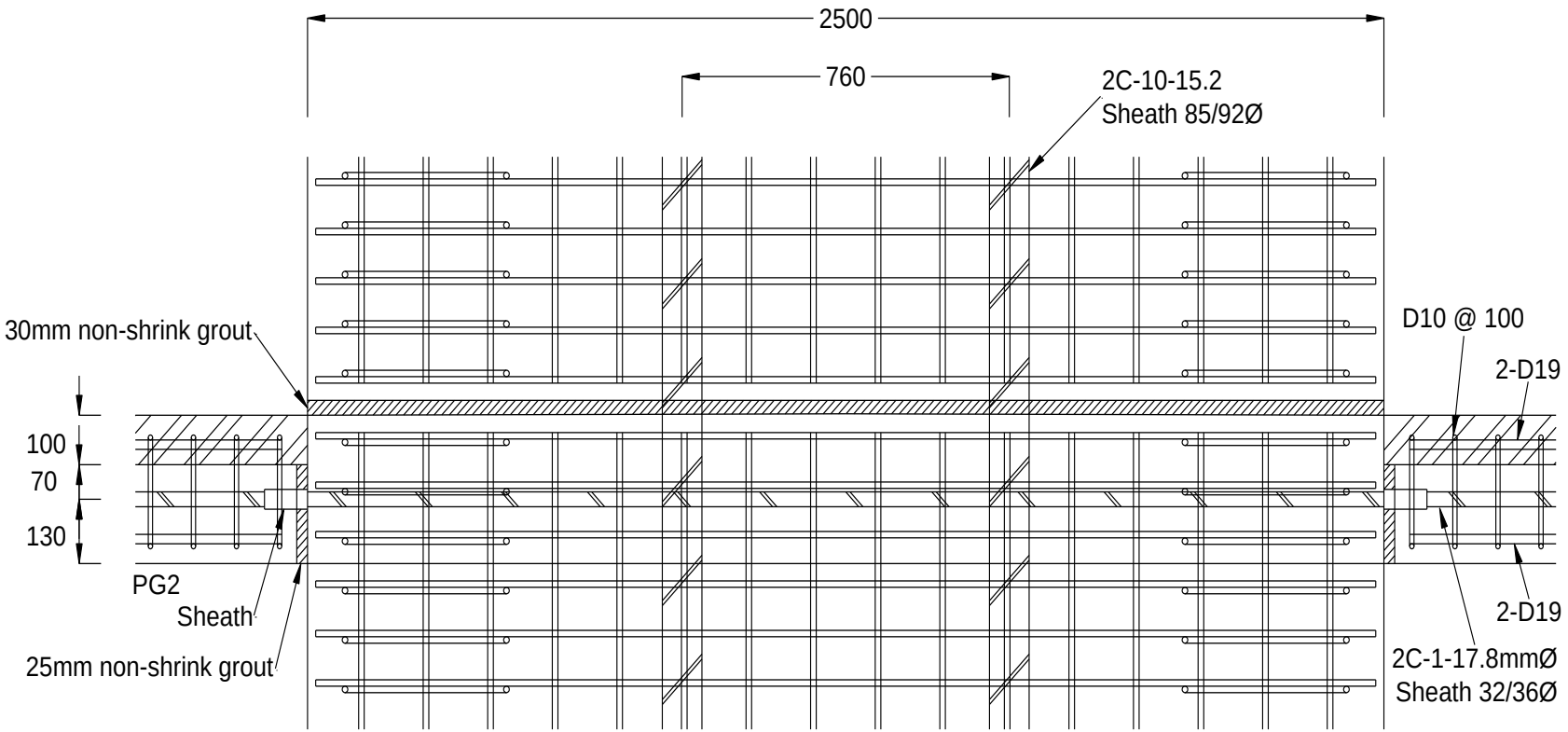

RPG3
3000
4PC1
4PC1
3PG3
3000
3PC1
3PC1
2PG3
3000
2PC1
2PC1
Floor topping
1PG3
3000
1PC1
1PC1
Foundation
7200
3
3a
4


2500
530
180
160
380
160
180
S13 @75
(KSS785)
5-D13 @120
4-D22
D13@75
2C-10-15.2mm
Sheath 85/92Ø
9-D13 @150
250
76

Wall connection details



Wall connection details



Building Performance

Wall A

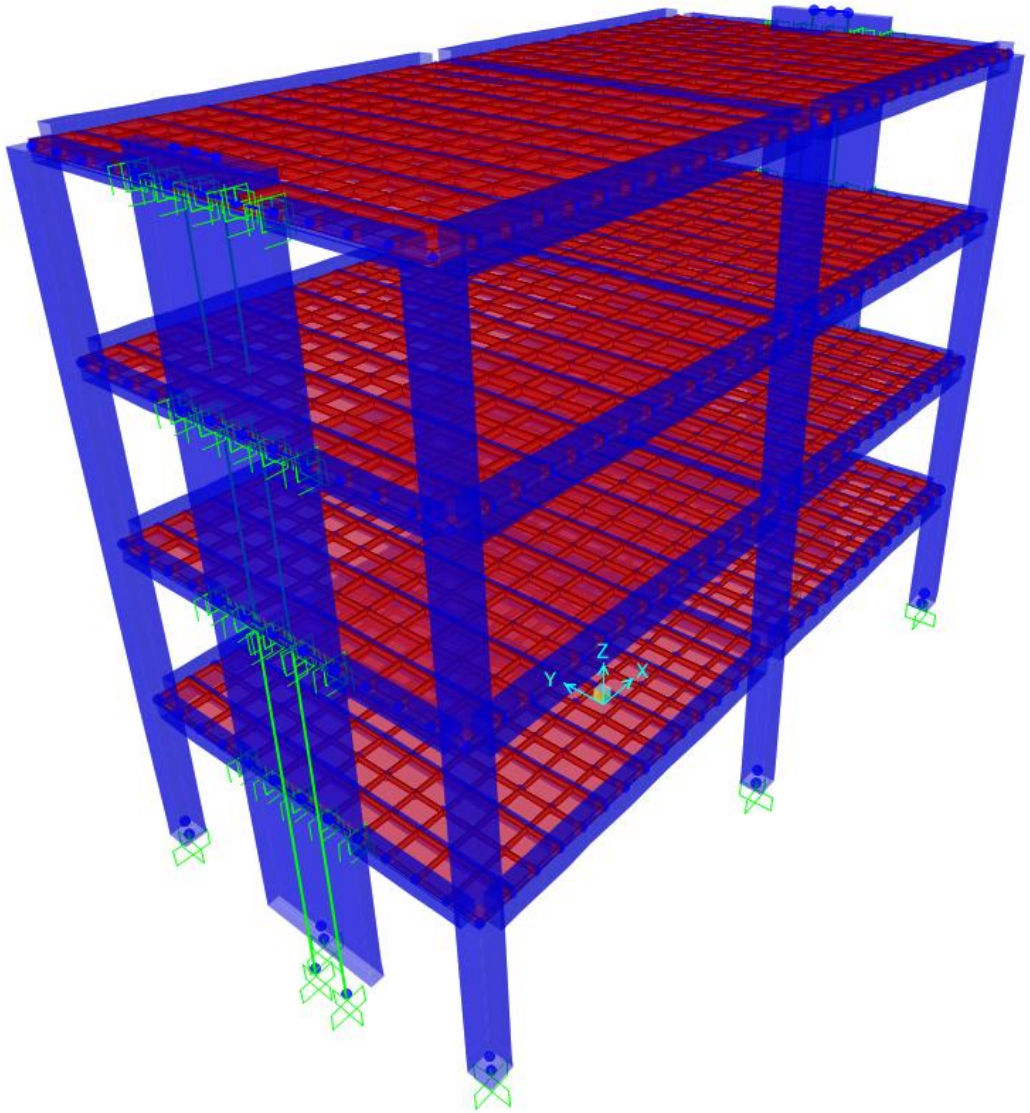
Wall C

Building Performance

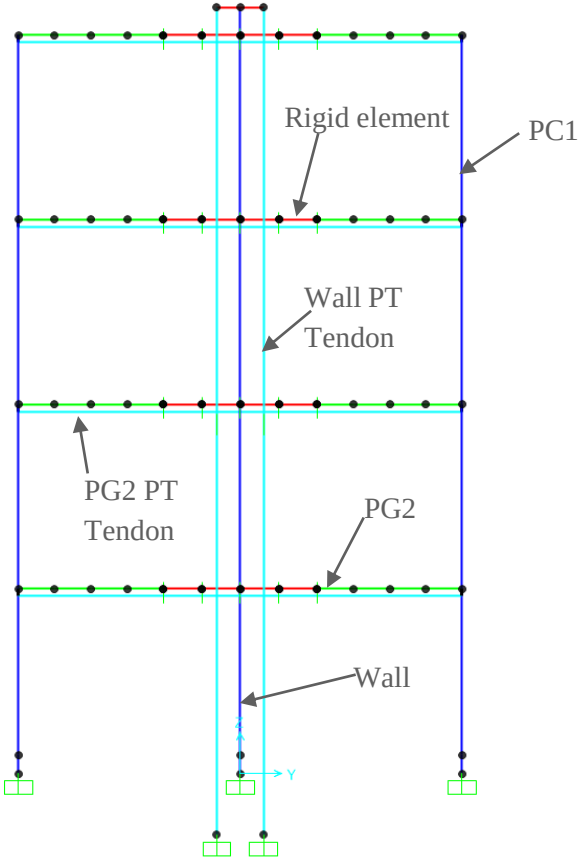
PG2 to Wall Joint

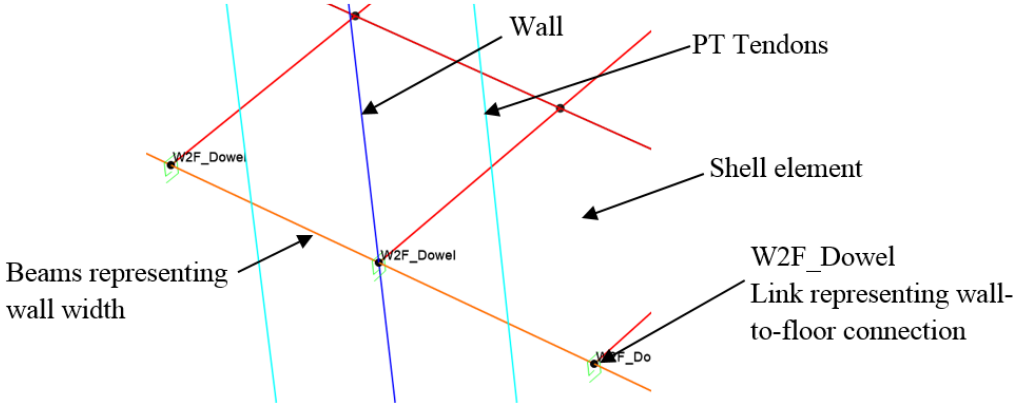
Frame 1st floor beam-column joint

Building Model



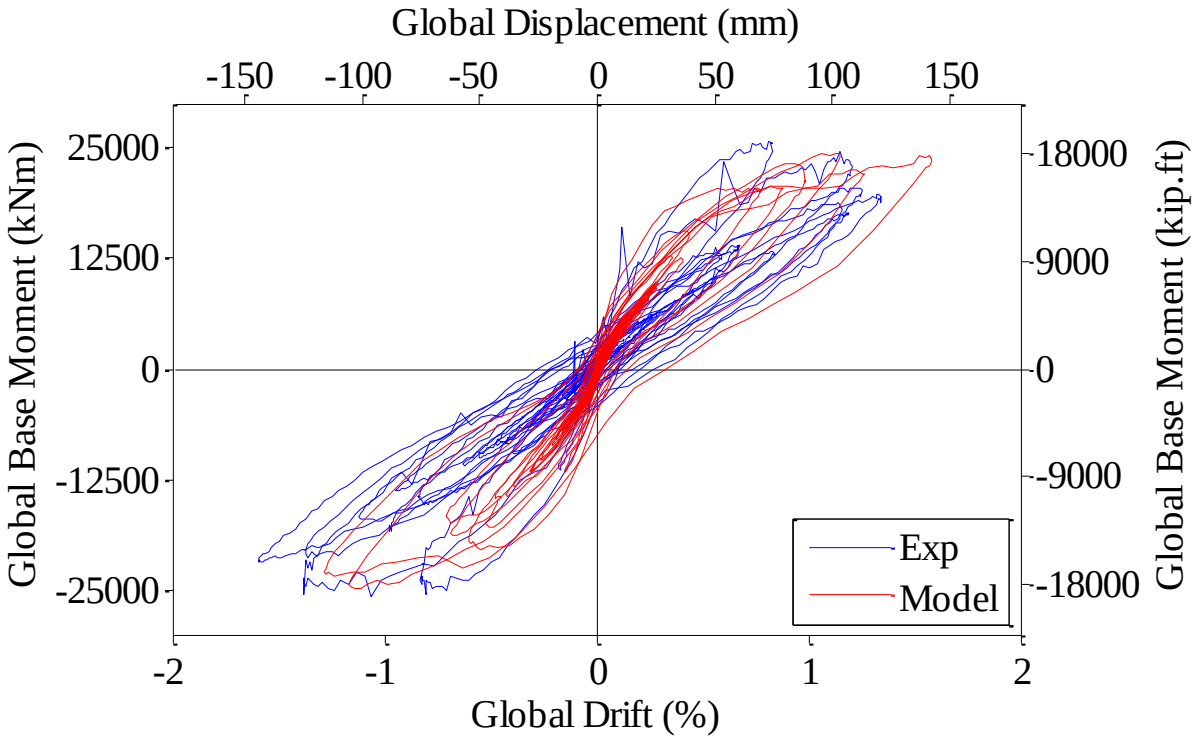
Wall & floor representation



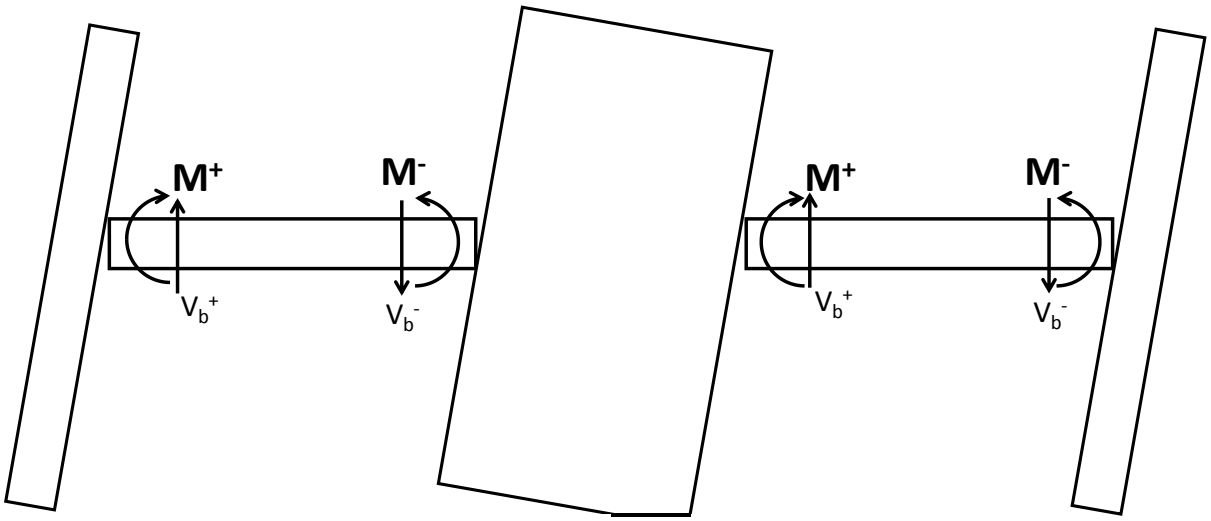


Building Model

- Wall-to-floor interaction
  - Increased building lateral-load capacity by 25%
  - Wall base shear increased 50% compared to isolated wall
  - Dynamic loading increased base shear by a further 40%



Framing Action

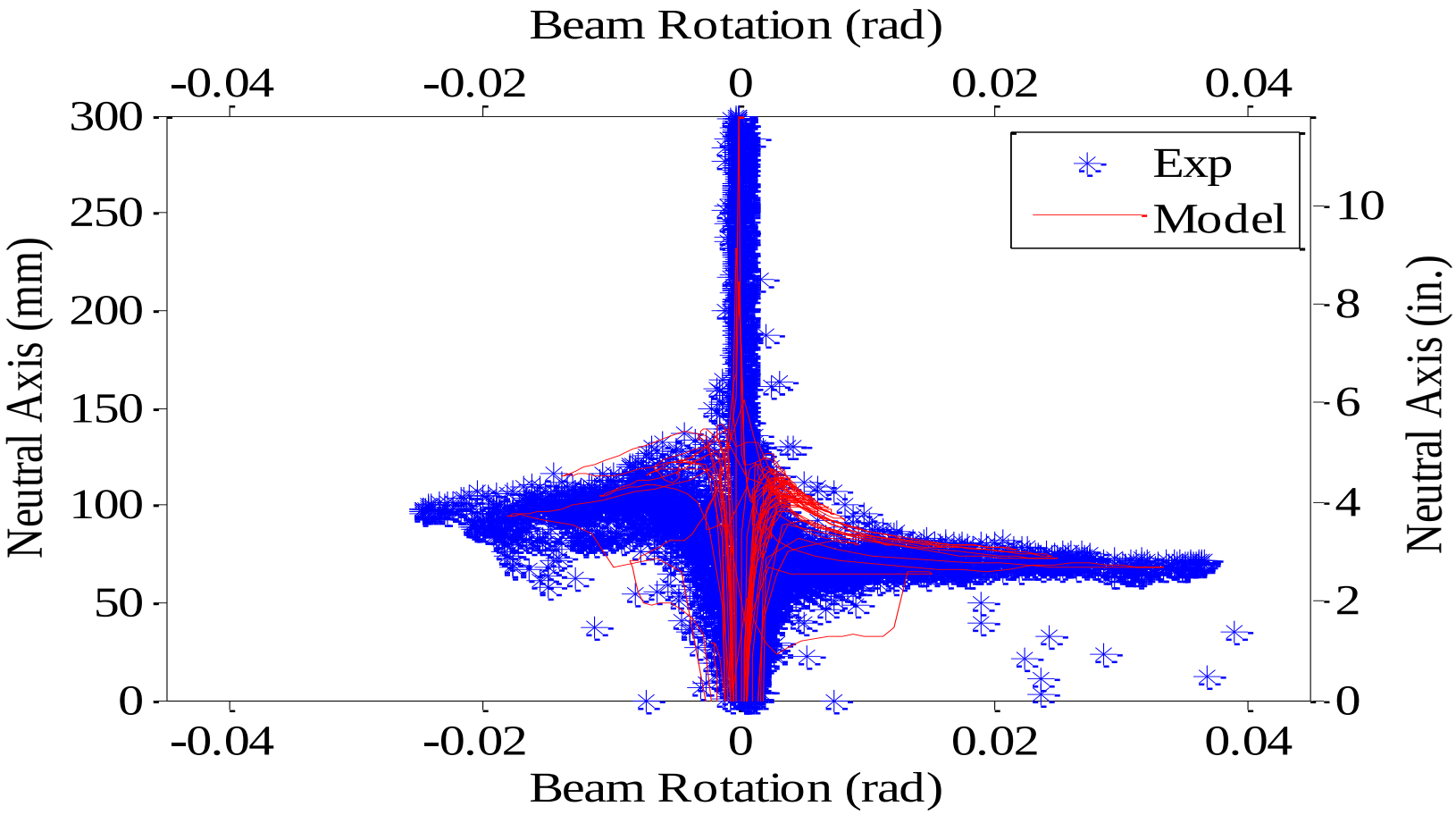


$$V_{b,beam} = \frac{(M^{+}_{beam} + M^{-}_{beam})}{L_{beam}}$$

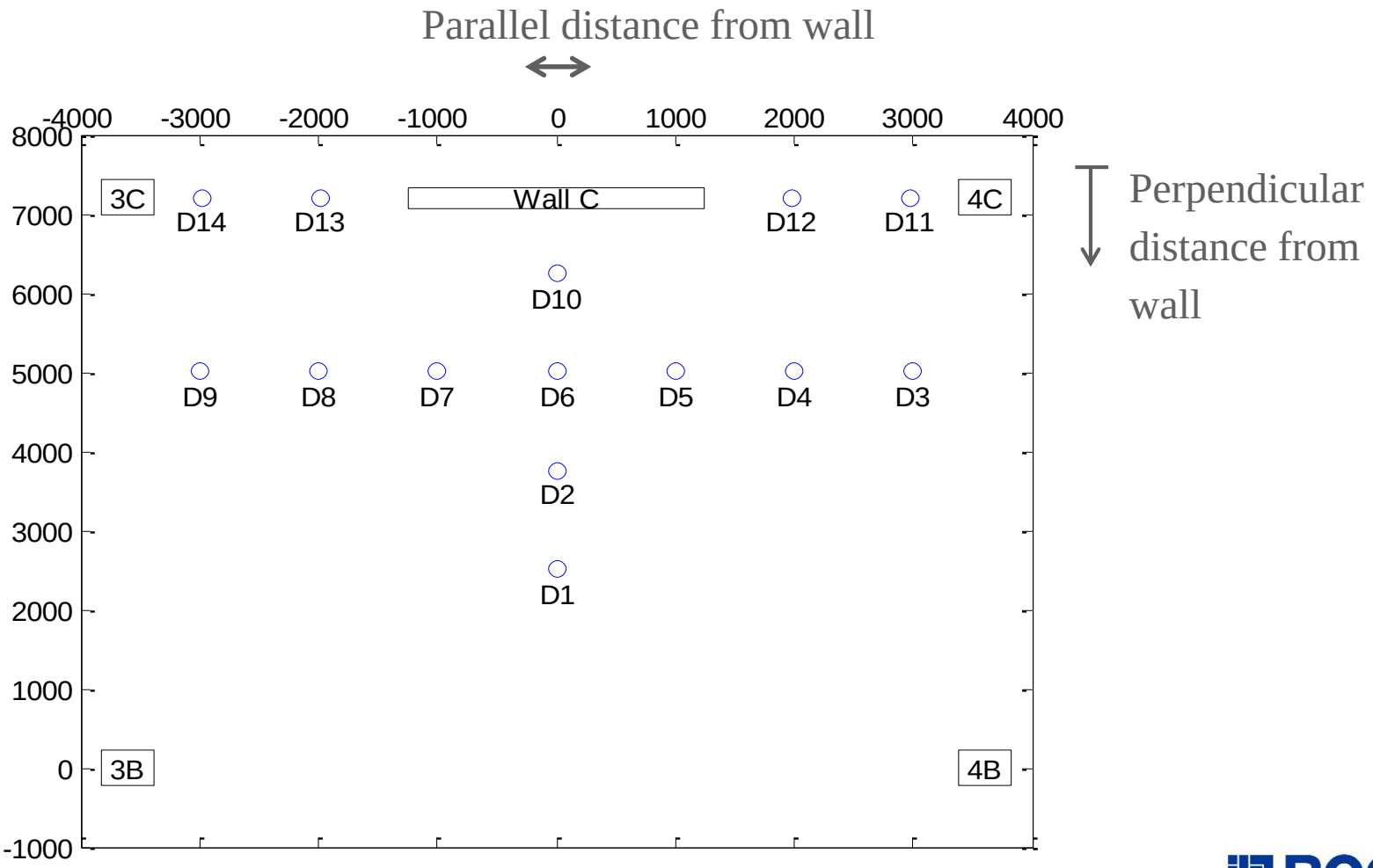
$$M_{framing} = Num.stories * V_{b,beam} * Distance\ between\ exterior\ columns$$

Framing Action

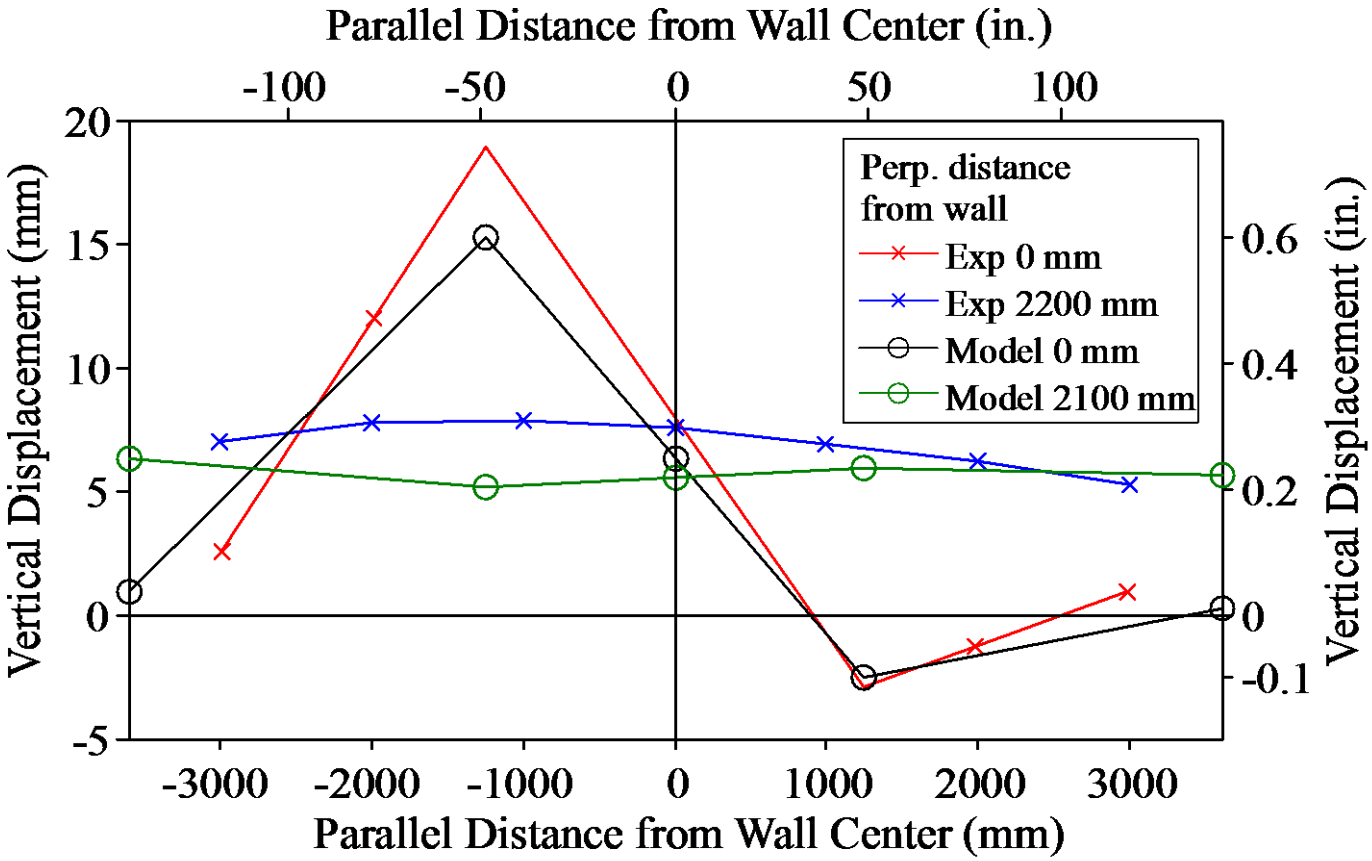
- Floor decrease neutral axis length positive rotation (in compression)
- Floor increase neutral axis length negative rotation (in tension)



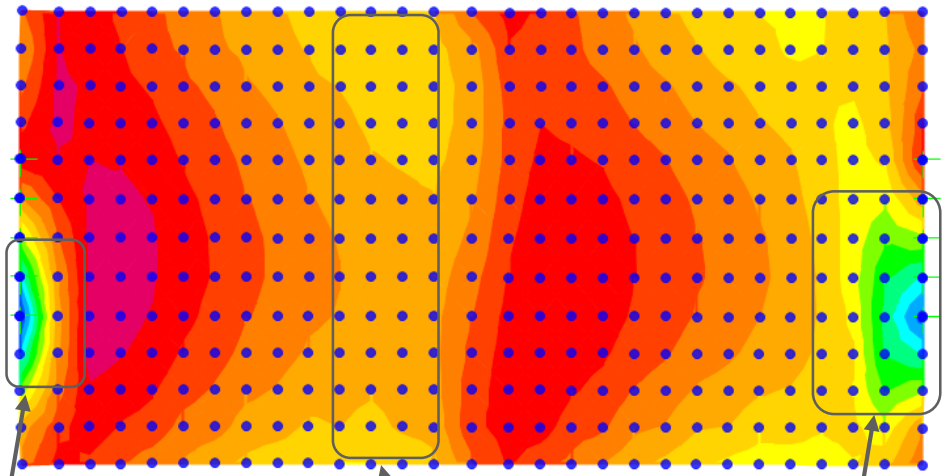
1st Floor Displacement



1st Floor Displacement



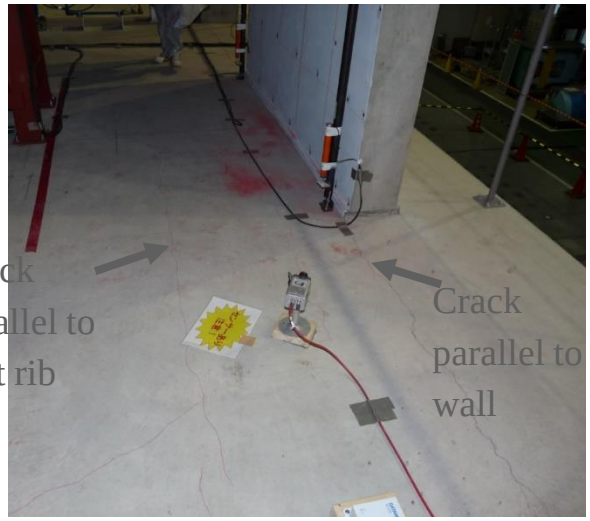
Building Model



Wall A uplift, no column uplift

Uplift due to column rotation

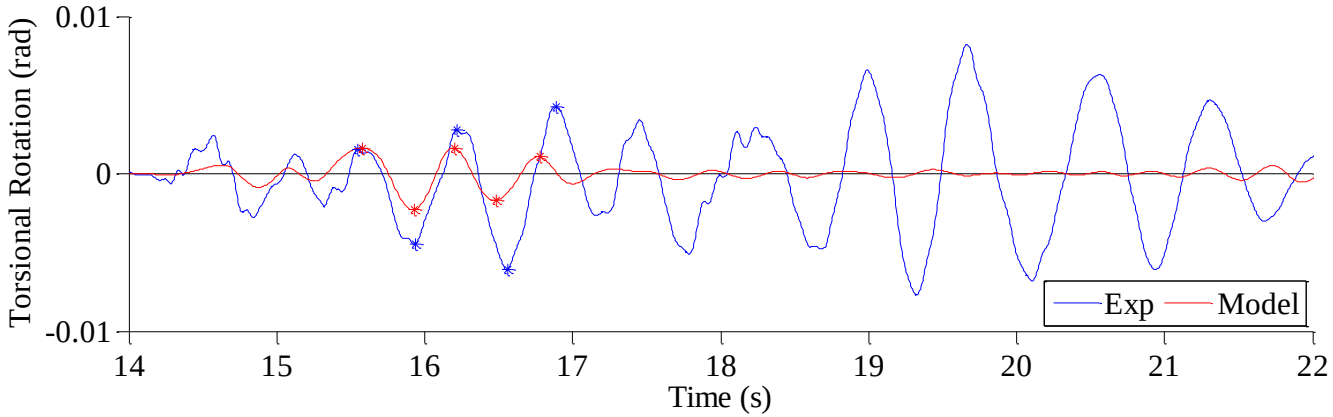
Wall C and column uplift



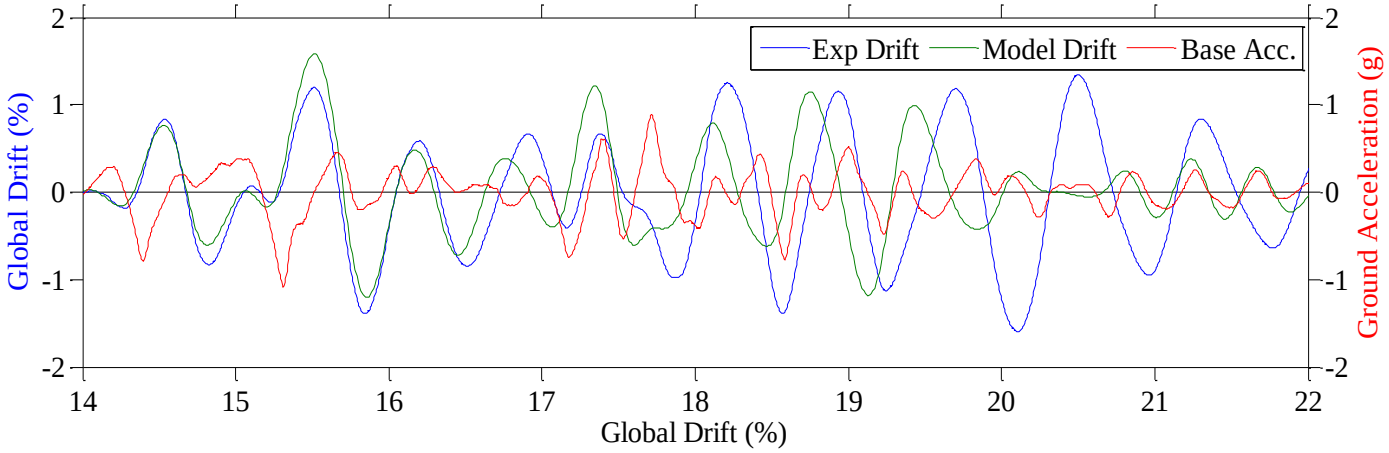
Crack parallel to first rib

Crack parallel to wall

Non-linear torsional response



Model vs experiment, 100% Kobe



Further Reading/Alternative Theories

- Gavridou, S., et al. "*Shake-table test of a full-scale 4-story precast concrete building. I: Overview and experimental results*" Journal of Structural Engineering 143.6 (2017)
- Gavridou, S., et al. "Shake-table test of a full-scale 4-story precast concrete building. II: Analytical studies." Journal of Structural Engineering 143.6 (2017)
- Tanyeri, A. *Seismic performance and modeling of reinforced concrete and post-tensioned precast concrete shear walls*. University of California, Berkeley, 2014.
- Watkins, J., et al. "*Computational Modelling of a Four Storey Post-Tensioned Concrete Building Subjected to Shake Table Testing"* Bulletin of NZSEE, 50(4), (2017)

Acknowledgements

IOWA STATE UNIVERSITY

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B.S.Italia®
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