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SEISMIC PERFORMANCE OF WEAK-BASE STRONG-COLUMN FRAME SYSTEMS

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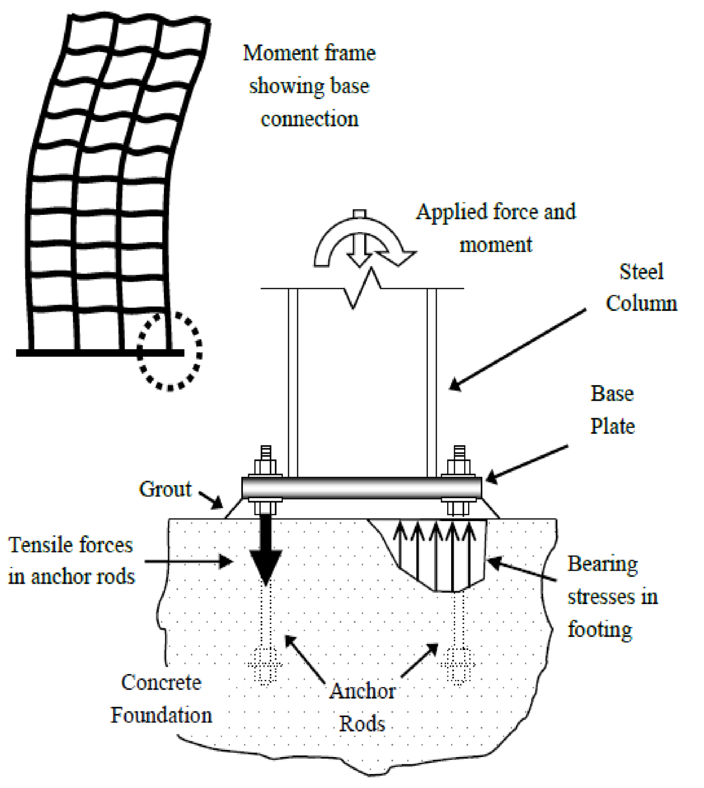
PROJECT OBJECTIVES

1. Investigate the performance of Weak-Base Strong-Column frames
2. Test the versatility of this approach in exposed base connections
3. Define the importance of the proper characterisation of true base response with respect to the current modelling assumptions

1. INTRODUCTION



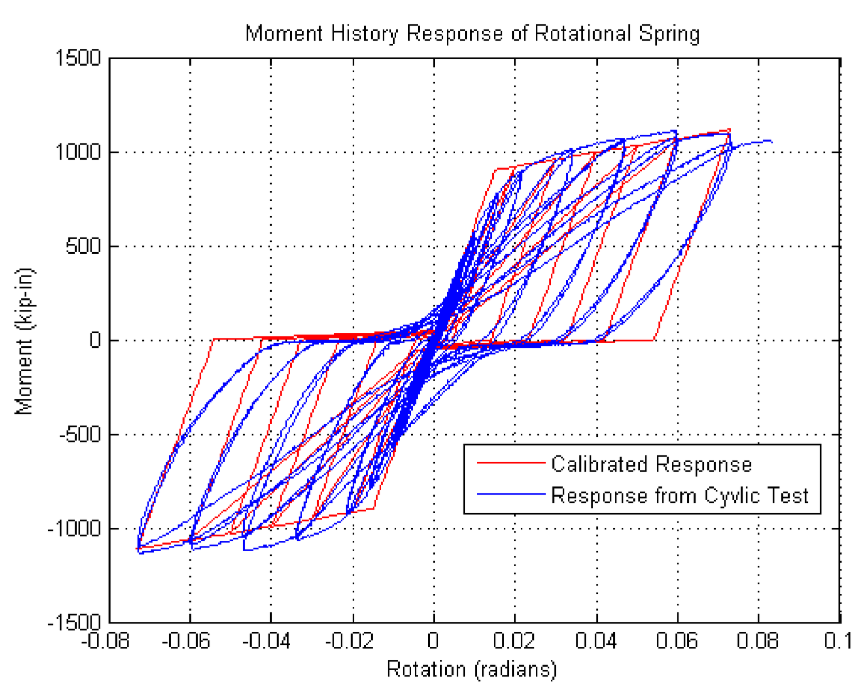
- Current design practice for Steel Moment Resisting Frames (SMRFs): Strong-Base Weak-Column
- Large scale tests [2] reveal excellent dissipative properties of exposed base connections
- Appealing approach for seismic design: Weak-Base Strong-Column
- Explore the effect of change in connection strength on structural performance
- Need to characterise connection's response

2. CONNECTION STRENGTH LEVELS

Properties	Fix $\rho = \infty$	S1 $\rho = 1$	S0.8 $\rho = 0.8$	S0.5 $\rho = 0.5$	S0.3 $\rho = 0.3$	Pin $\rho \approx 0$
K_{ext} [kip-in] x10^6	∞	1.38	1.38	1.38	1.38	0.0009
K_{int} [kip-in] x10^6	∞	2.76	2.76	2.76	2.76	0.0009
M_{yext} [kip-in] x10^4	∞	44.72	35.78	22.36	13.42	0.027
M_{yint} [kip-in] x10^4	∞	57.83	46.27	28.92	17.35	0.027

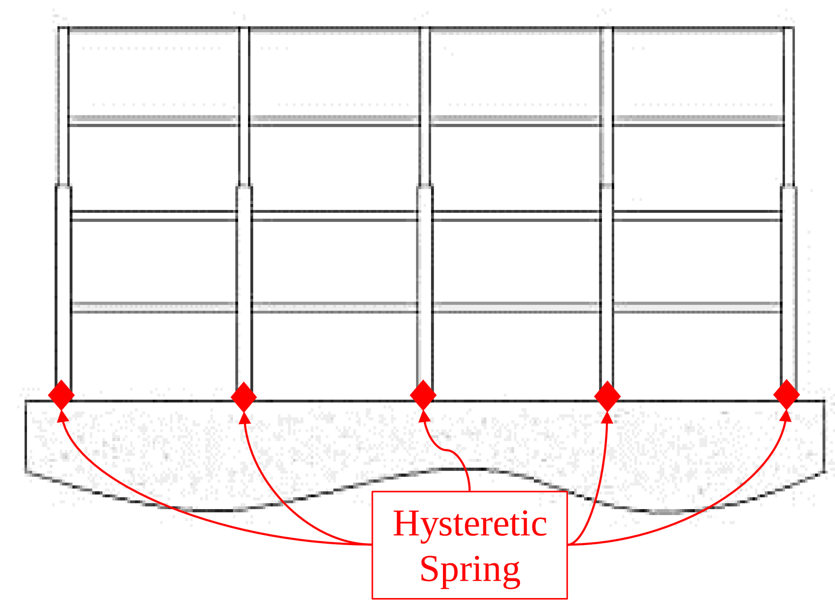
- Strength levels defined by ratio ρ between M_{yx} and M_{yS1}
- Fixed and Pinned included for comparison between real response and modelling assumptions
- S1, S0.8, S0.5 and S0.3 modelled by hysteretic spring (calibrated to cyclic tests [2]) in OpenSEES

3. CALIBRATION OF HYSTERETIC MODELS



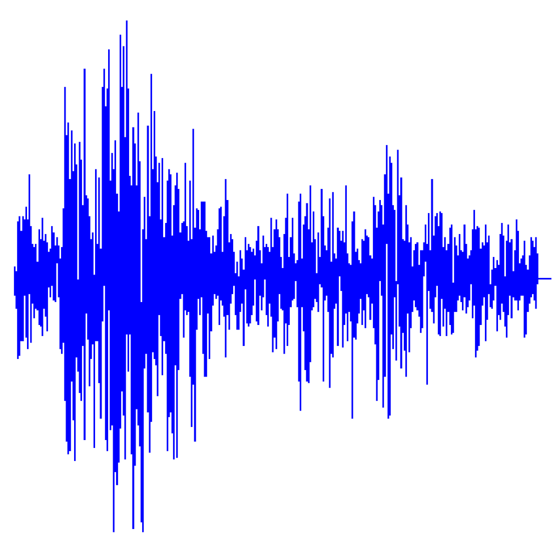
- Calibration of Cyclic test data [2] to ModIMK Pinching Model in OpenSEES
- Implemented in column bases of 4 storey building model
- Important to capture real behaviour of bases and assess the true structural response

4. PERFORMANCE LEVELS & 4 STOREY FRAME

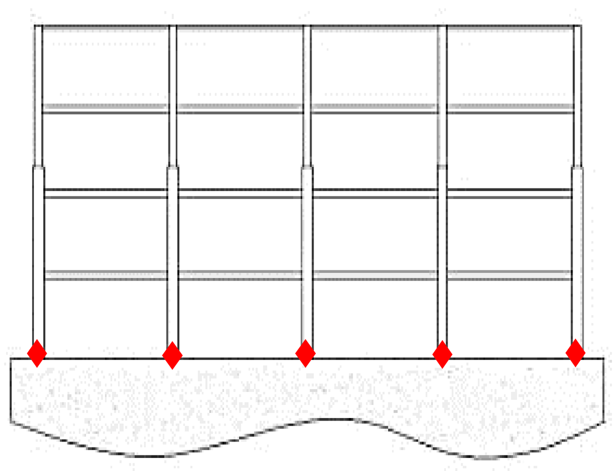


Performance Level	Damage State	Drift %
Immediate Occupancy	No Damage	0.2
Operational	Repairable	0.5
Life Safe	Irreparable	1.5
Near Collapse	Severe	2.5
Near Collapse	Severe	5
Collapse	Collapse	10

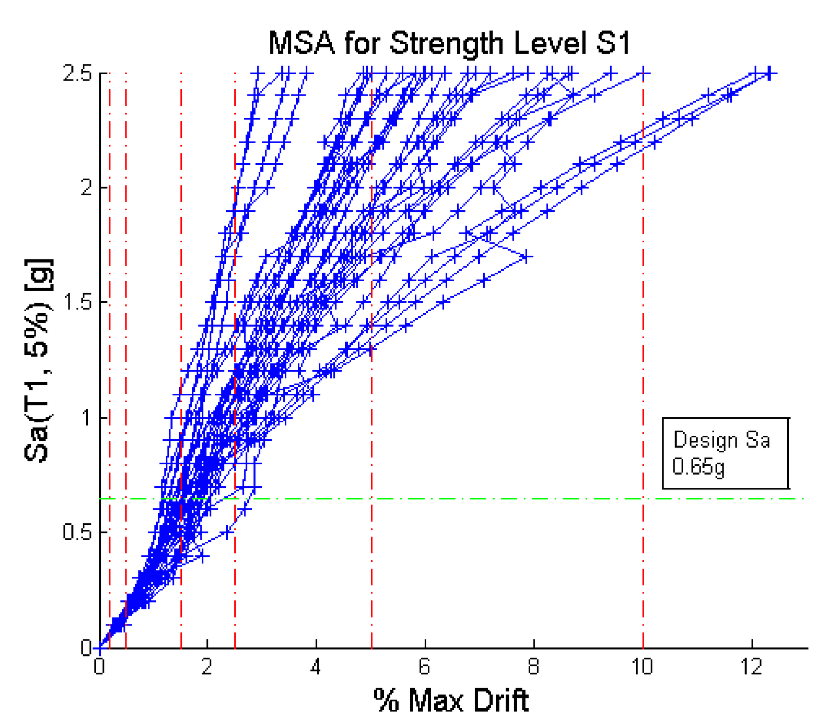
5. MULTIPLE STRIPE ANALYSIS



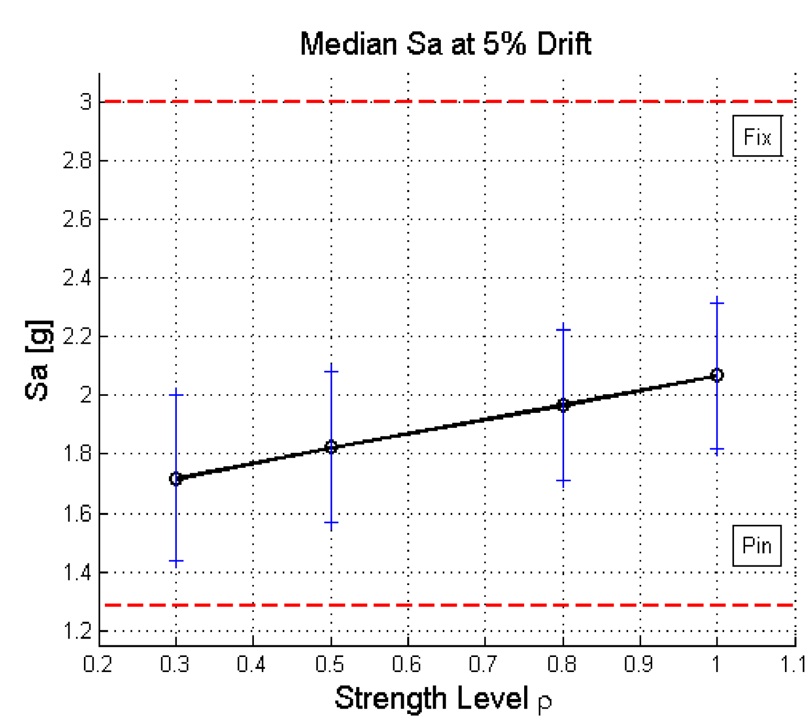
32 Ground Motions scaled to 25 intensity levels



4 storey frame with hysteretic bases



Results from non-linear response history analysis (one for each strength level)



Probabilistic estimates from MSA

6. CONCLUSIONS

- Connections with 80% of strength show comparable performance to connections designed to current codes (S1 strength level)
- Fixed assumption overestimates response and could compromise serviceability and safety while Pinned is overconservative
- Ductility increase in building if connection designed to yield
- Soft story like collapse for weak bases approach
- Weak base design leads to economic savings (smaller and cheaper base connections)

REFERENCES

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[2] Gomez, I.R., Deierlein, G.G. & Kanvinde, A., 2010. Exposed column base connections subjected to axial compression and flexure.

[3] Zareian, F. & Kanvinde, A., 2013. Effect of column-base flexibility on the seismic response and safety of steel moment-resisting frames. *Earthquake Spectra*, 29(4), pp.1537–1559.