

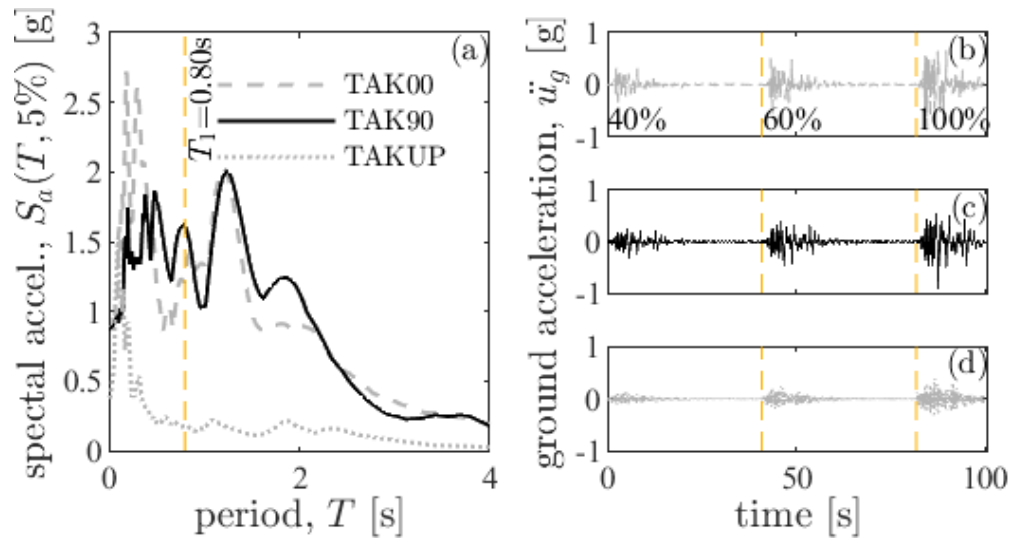
Modelling uncertainties for capacity designed steel MRFs: do they matter?

Konstantinos Bakalis, PhD

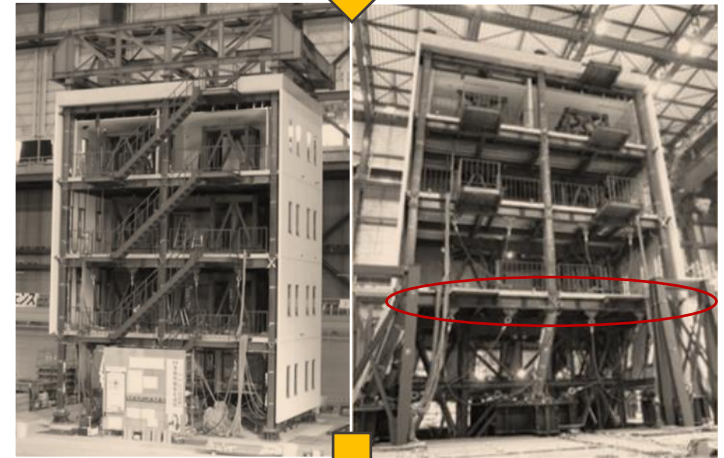
15 June 2023

The 49th Risk, Hazard and Uncertainty Workshop, Hydra 2023

The E-Defense steel MRF collapse test



- 1st storey mechanism
- collapse

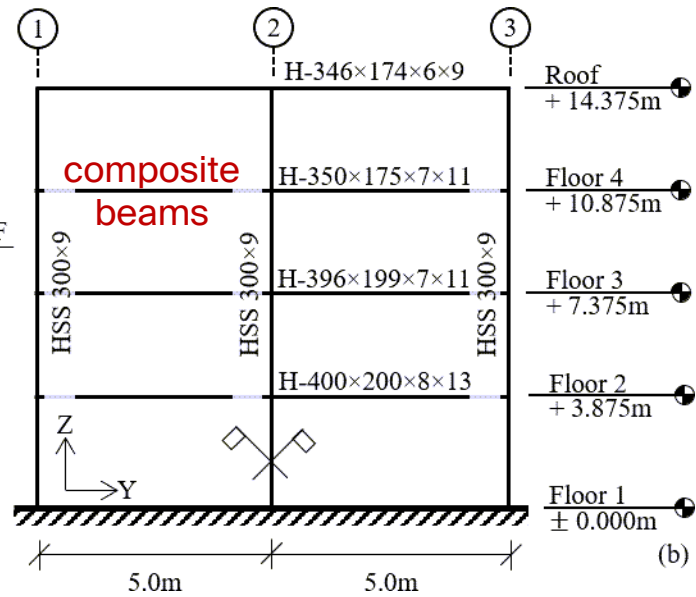
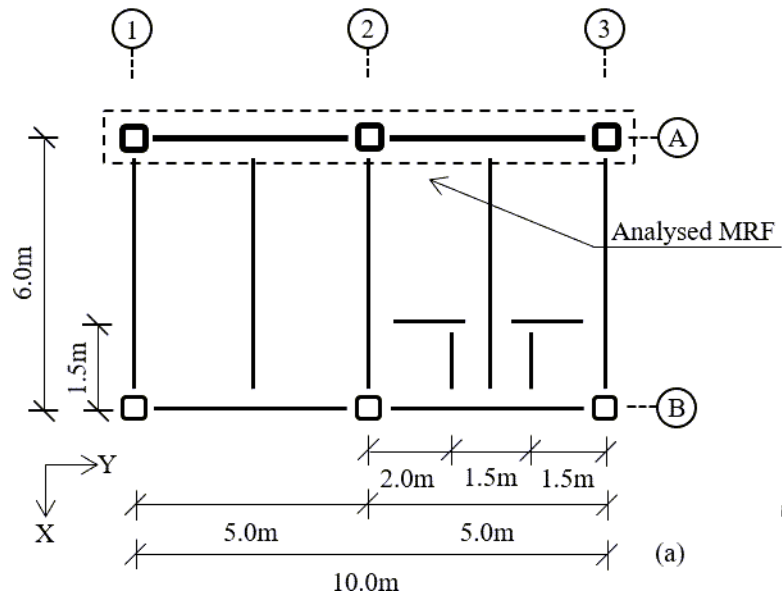


blind analysis contest

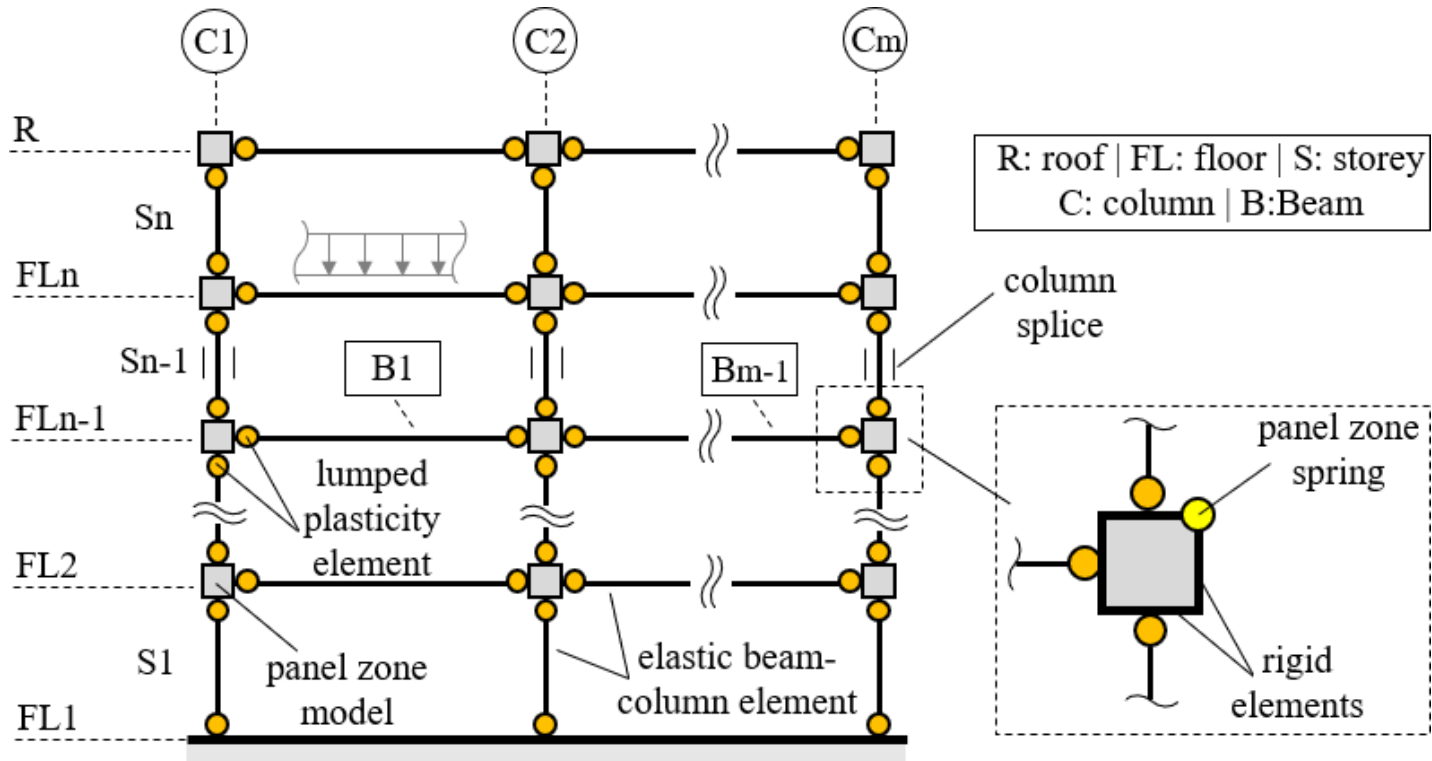
- variability in response prediction
- ~20/47 could not predict collapse!

Hikino et al. (2010), Lignos et al. (2013)

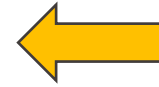
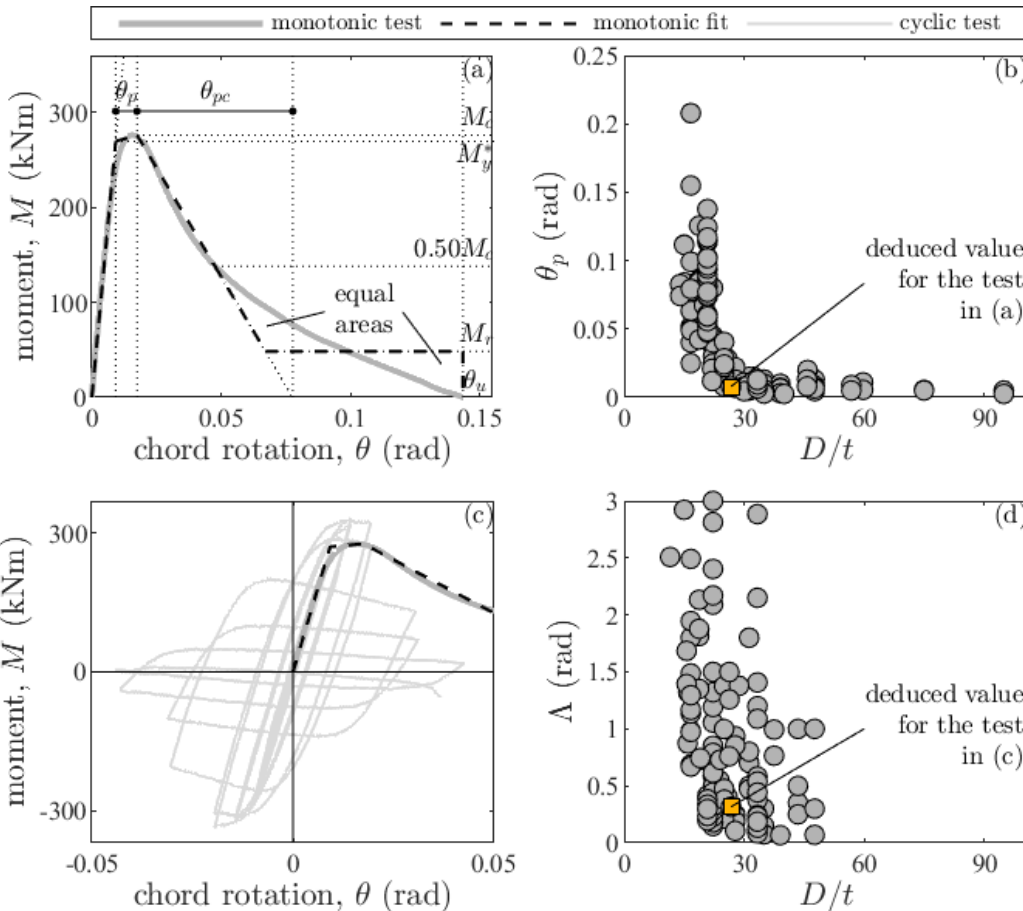
The E-Defense steel MRF collapse test



Modelling of steel MRFs

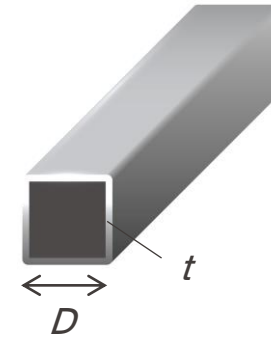


Component modelling: hollow structural section (HSS) database



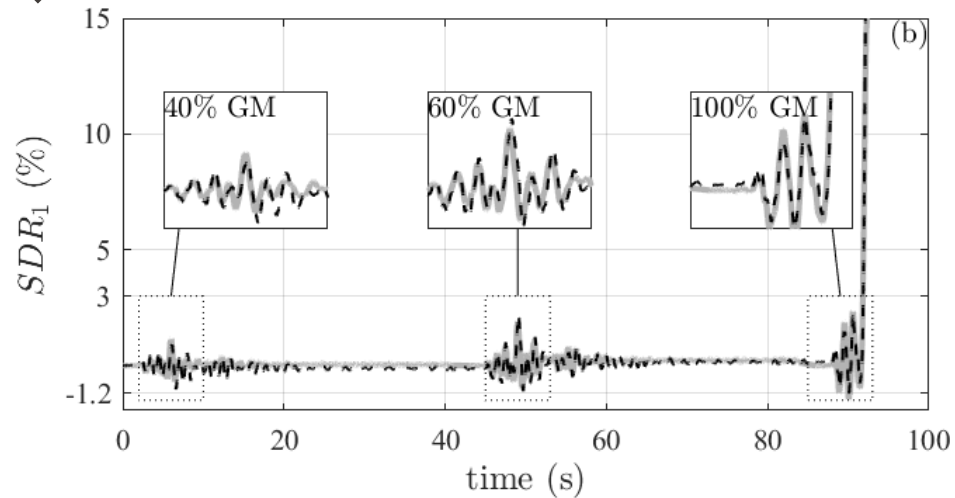
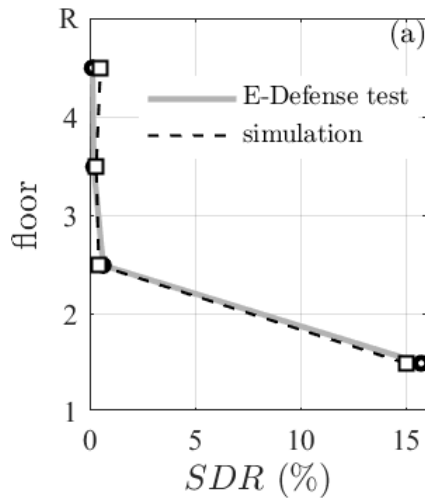
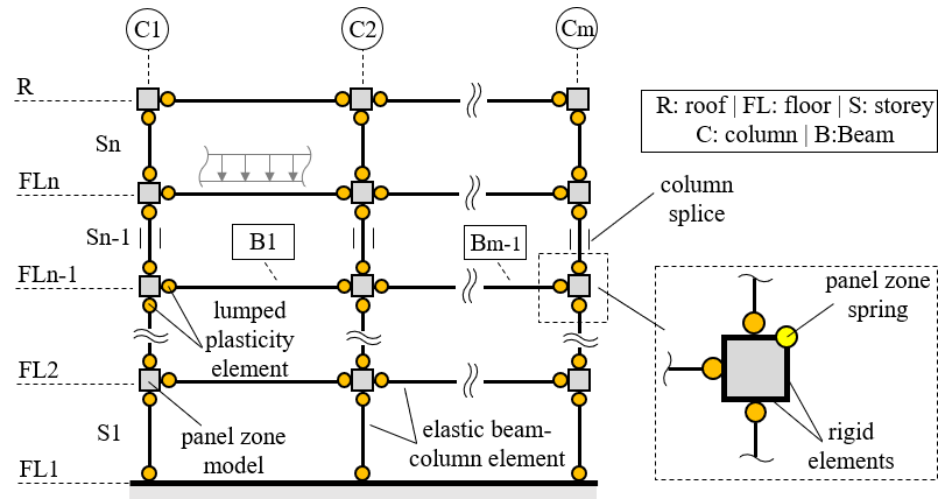
HSS database:

- 284 tests (digitised!)
- 135 monotonic loading
- 149 cyclic loading
- the vast majority from Japanese researchers, *in Japanese...*



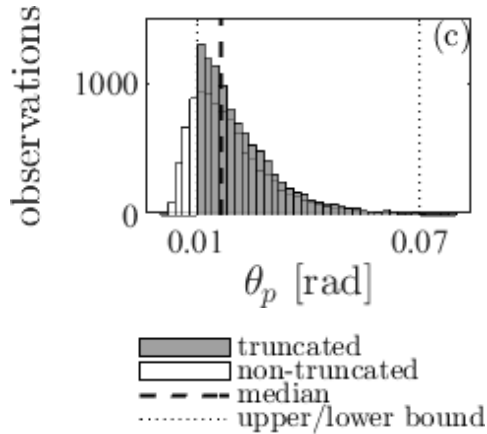
prediction equations
for component model
parameters!

Simulation VS test results

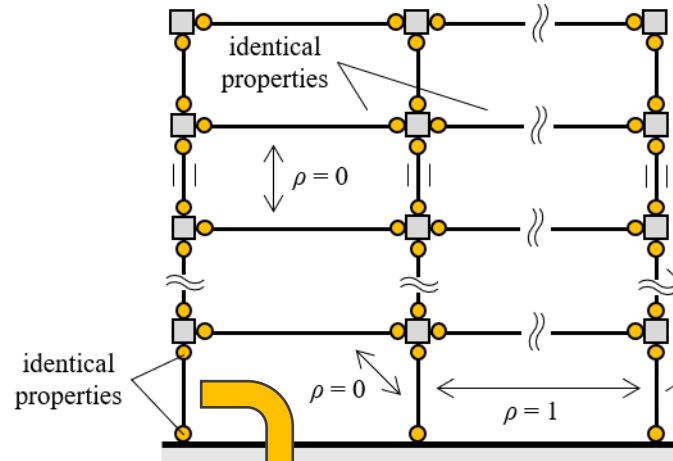


Parameter distributions, correlations and sampling

parameter distributions



inter-component correlations



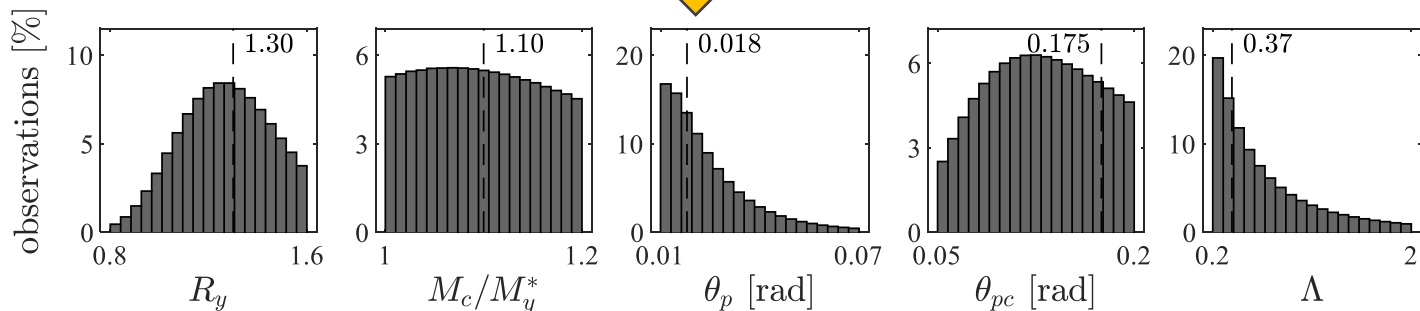
intra-component correlations

| | R_y | M_c/M_y^* | ϑ_p | ϑ_{pc} | Λ |
|------------------|-------|-------------|---------------|------------------|-----------|
| R_y | 1 | 0 | 0 | 0 | 0 |
| M_c/M_y^* | | 1 | 0 | 0 | 0 |
| ϑ_p | | | 1 | 0.50 | 0.69 |
| ϑ_{pc} | | | | 1 | 0.54 |
| Λ | | | | | 1 |

HSS columns

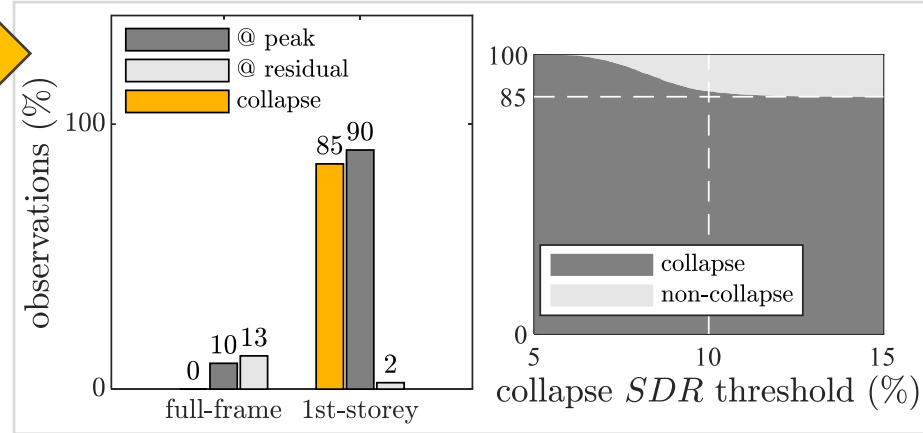
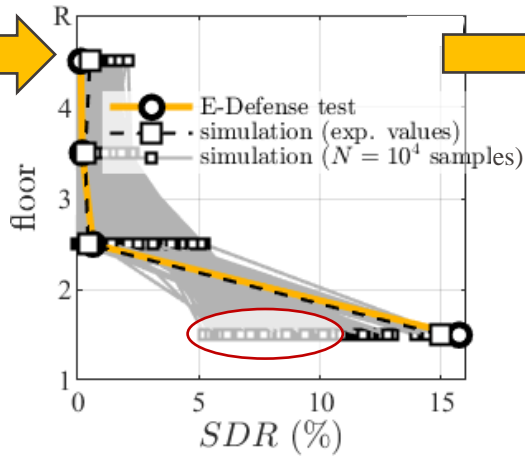
$$\begin{cases} R_y^j = R_y^1 \\ \theta_p^j = f(\theta_p^1) \\ \theta_{pc}^j = f(\theta_{pc}^1) \\ \Lambda^j = f(\Lambda^1) \end{cases}$$

- truncated multivariate lognormal
- LHS sampling

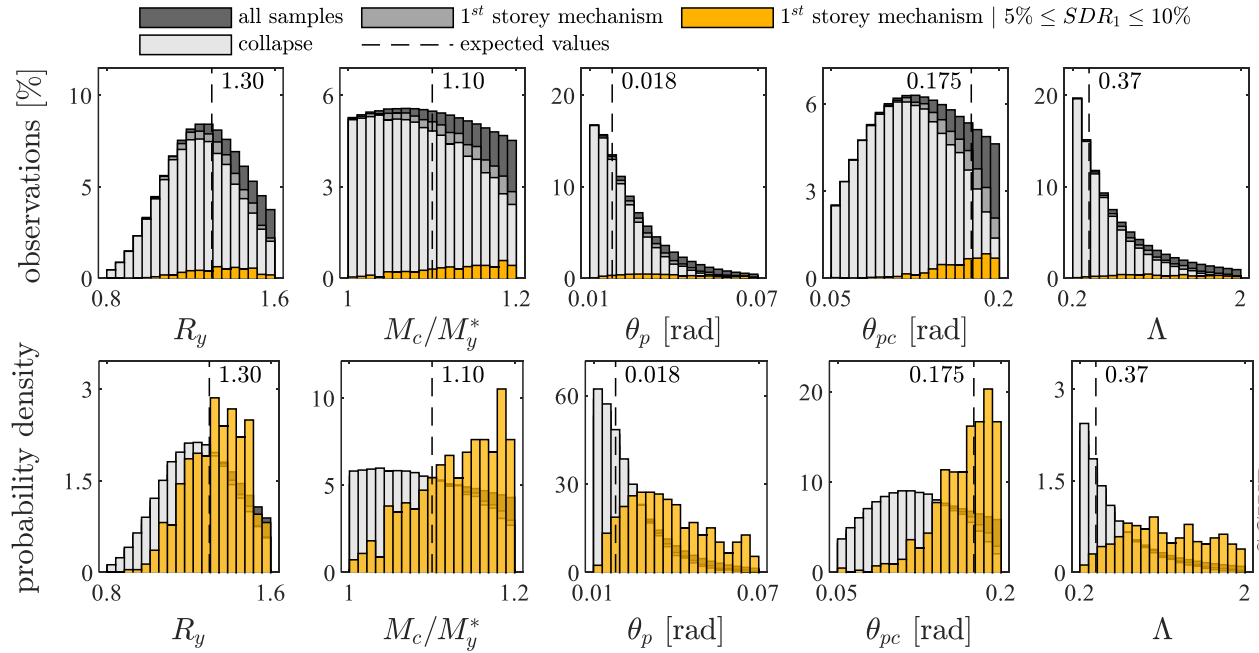


1st storey
column
samples

Results



1st storey column (exterior)



- Do subsets conform to the original distributions?
- Any parameters that "control" the response?

Conclusions

- ❑ Are modelling uncertainties important for capacity designed steel MRFs?
 - From a global deformation point of view, no...
 - 10% of building samples do not capture the plastic mechanism
 - 15% does not capture collapse
 - Local response?
 - Ground motion variability?

Questions?



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