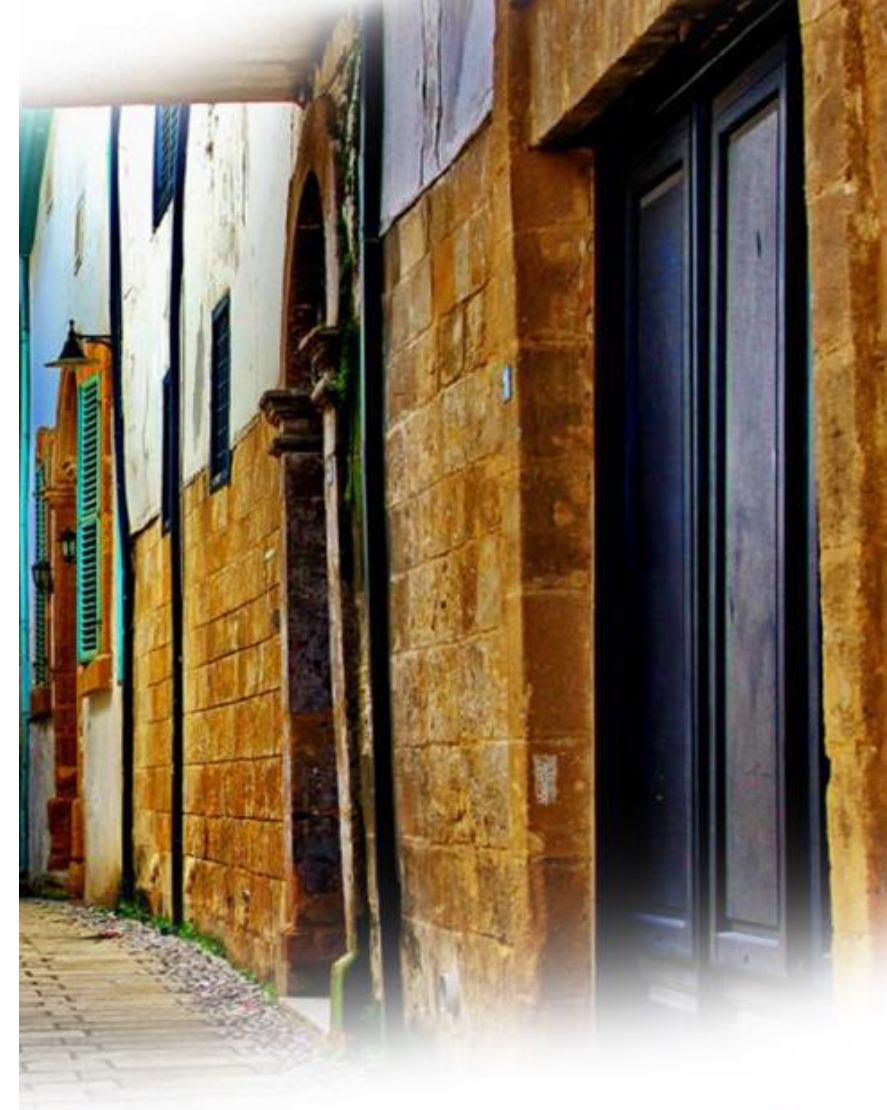


# NUMERICAL CASE STUDIES TOWARDS THE VALIDATION OF AN RC BEAM-COLUMN JOINT N-M INTERACTION MODEL

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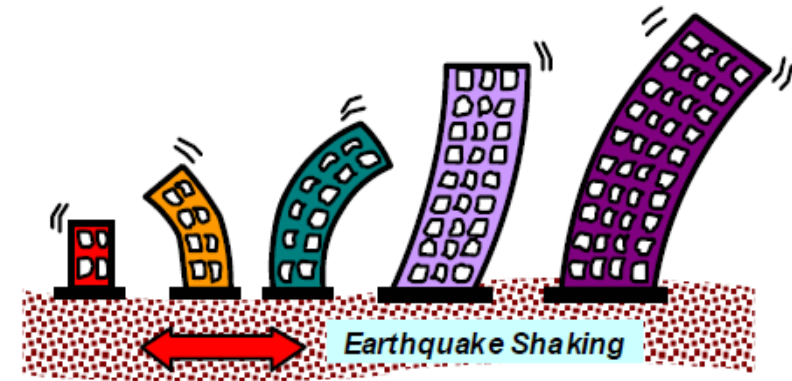


# Outline

- Introduction/Literature Review
- Problem Statement
- Building Information and Modelling
- Discussion of Results
- Conclusion

# Introduction: Beam-Column Joint

- Significant effect on the response
- Crucial for the integrity
- Simplified model (N-M Interaction)
- Implementation to the software



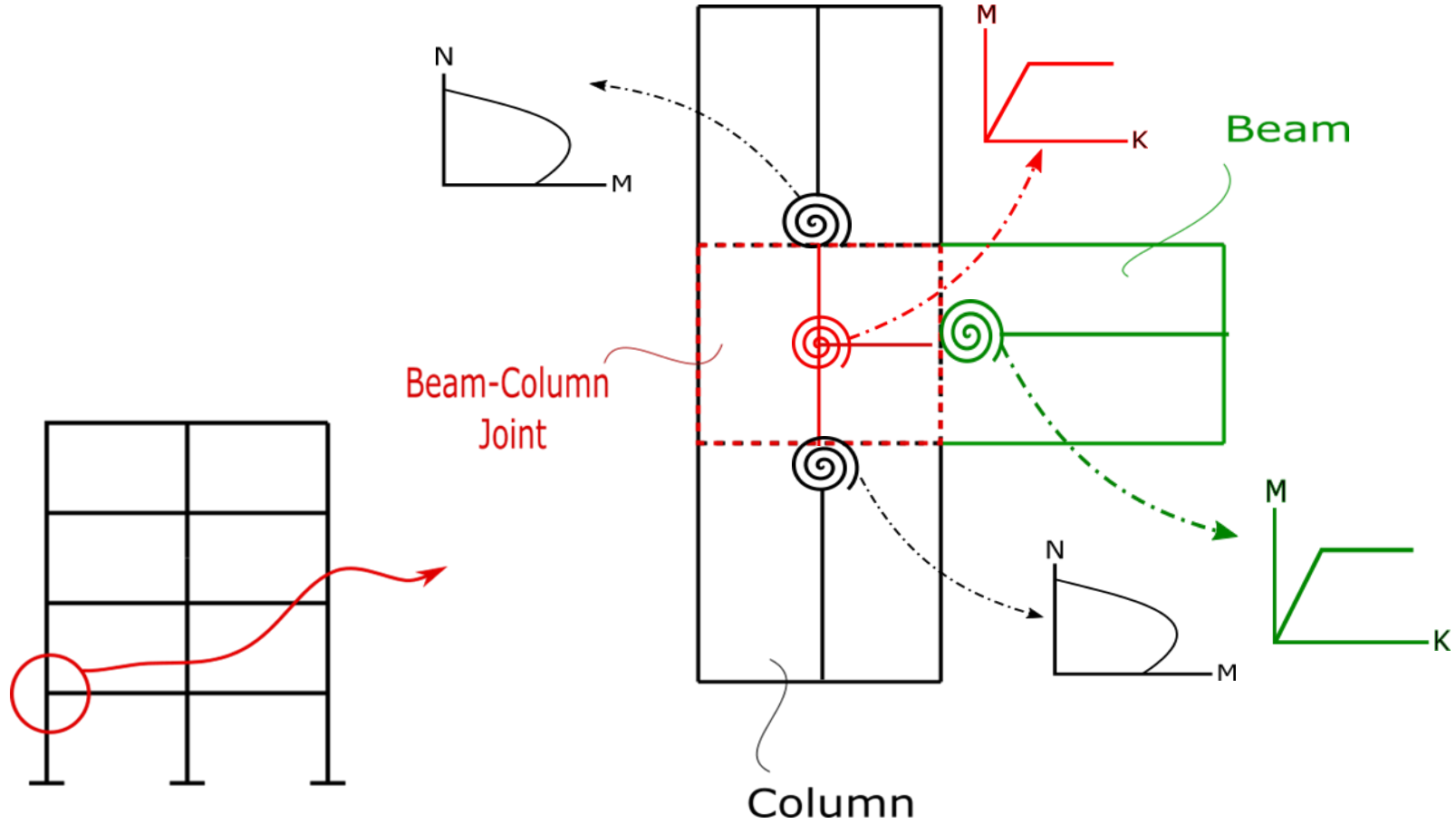
(Jambhale, 2016)

# Literature Review

- Joint model with rotational spring(Unal and Burak, 2013)
  - ✓ Moment-rotation relationship
  - ✓ Comparing experimental data
- Rotational springs combined in series(Birely et al., 2012)
  - ✓ Aims to resolve complexity
  - ✓ Easier implementation
  - ✓ Moment-rotation



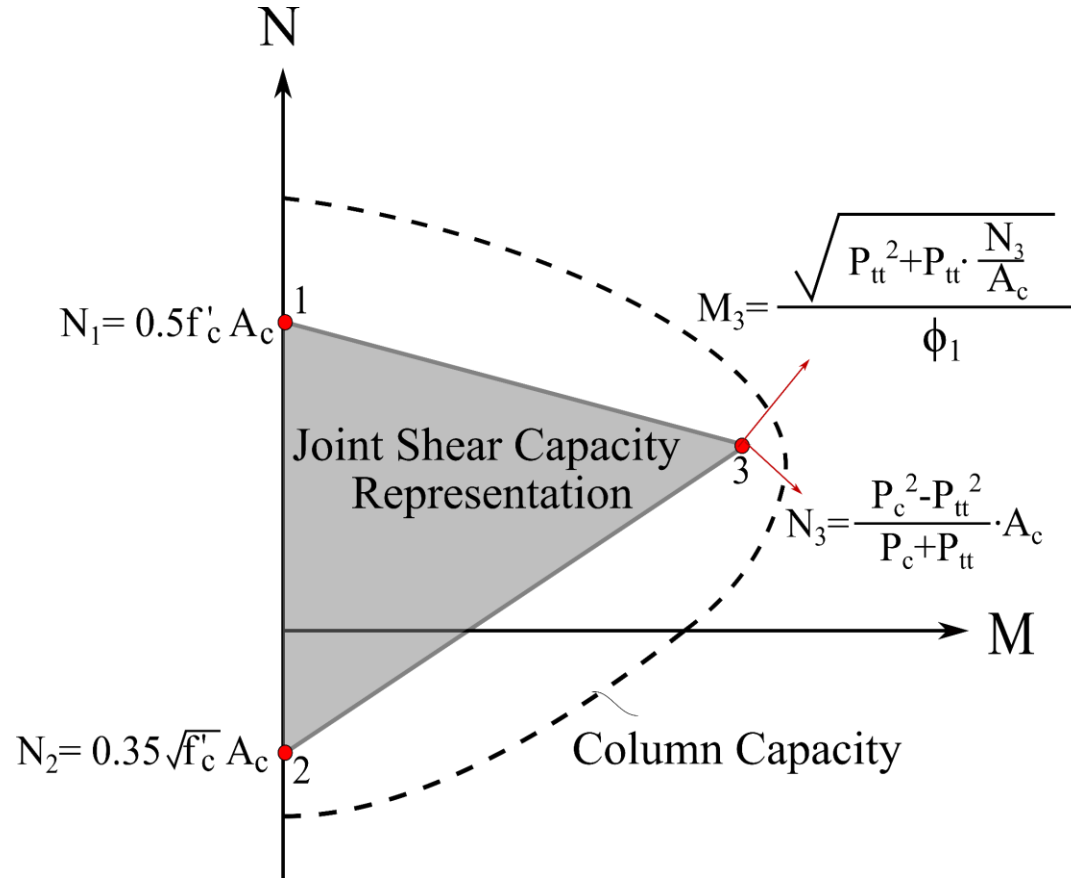
# Literature Review



# Problem Statement

- Axial load range in literature
- Change in behavior
- Shift the failure mode
- N-M interaction model





### $P_{tt}$ Calculation

$$P_{tt} = P_t + P_{ts}$$

$$P_{ts} = \frac{F_{jts}}{b_c \sqrt{h_c^2 + h_b^2}}$$

$$F_{jts} = \Sigma F_{wx} \cdot \sin\theta + \Sigma F_{wy} \cdot \cos\theta$$

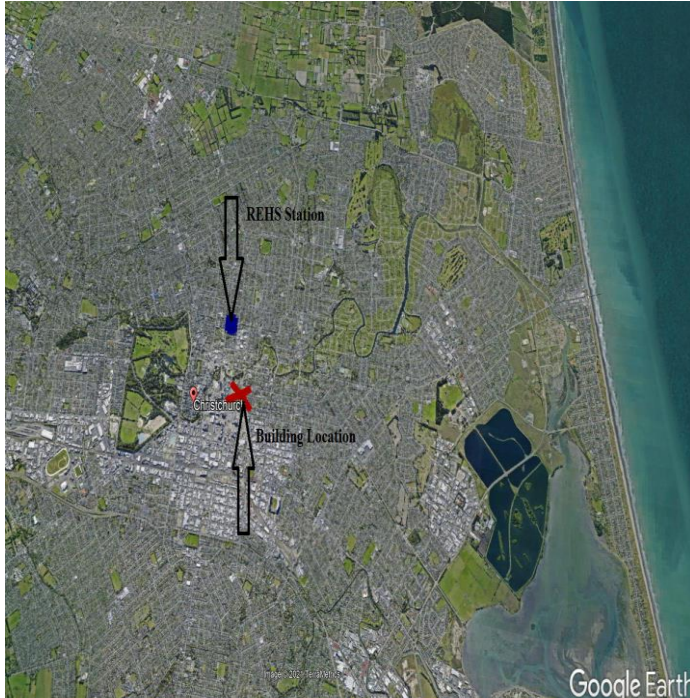
$$\Sigma F_{wx} = n \Sigma [f_{yw} A_0 \cos\alpha]$$

$$\Sigma F_{wy} = m f_y A_1$$

- n: Number of set of transverse reinforcement in the joint
- m: Number of intermediate longitudinal steel in the column
- $A_0$ : Area of a single transverse steel
- $A_1$ : Area of a single longitudinal intermediate steel in the column
- $f_{yw}$ : Yield strength of the transverse steel in the joint
- $f_y$ : Yield strength of the longitudinal reinforcement in the column
- $\theta$ : Approximate diagonal cracking angle
- $A_c$ : Gross area of the column
- $f'_c$ : Compressive strength of concrete
- $P_c$ : Principle compression capacity
- $P_{tt}$ : Principle tensile capacity

(Tasligedik, 2020)

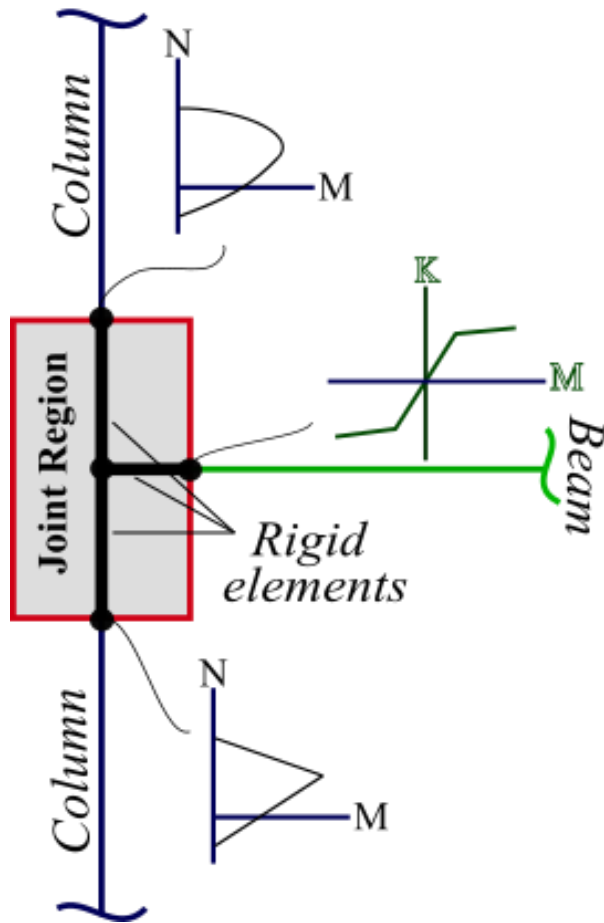
# Building Information and Modelling



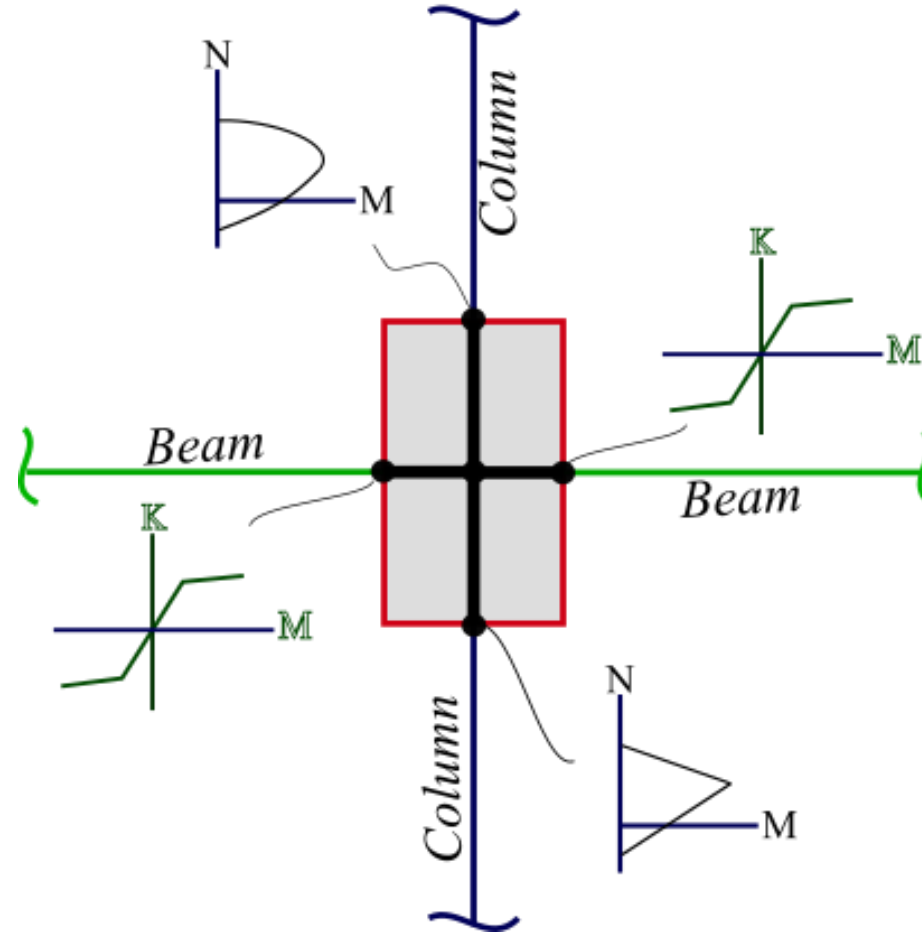
(Courtesy of A.S Tasligedik, 2011)



## External Joint



## Internal Joint

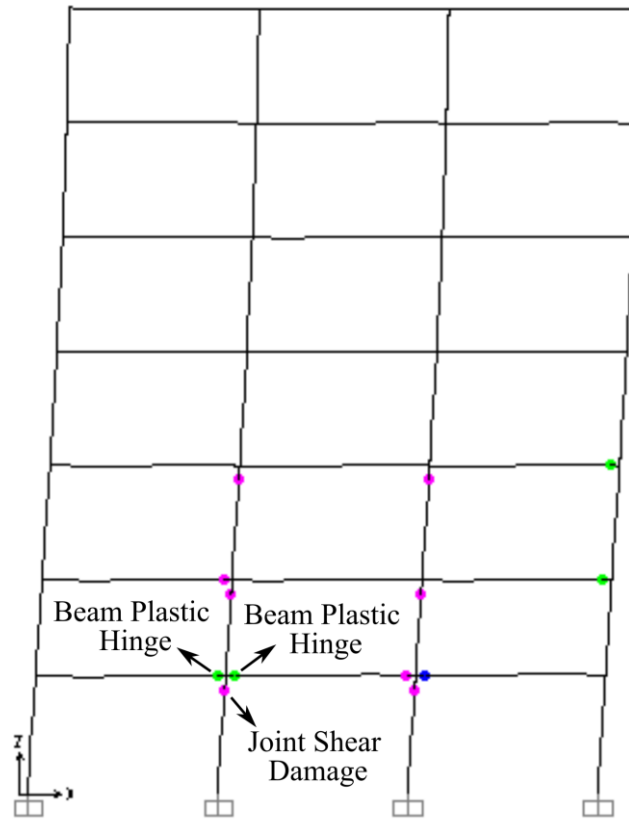


# Analysis

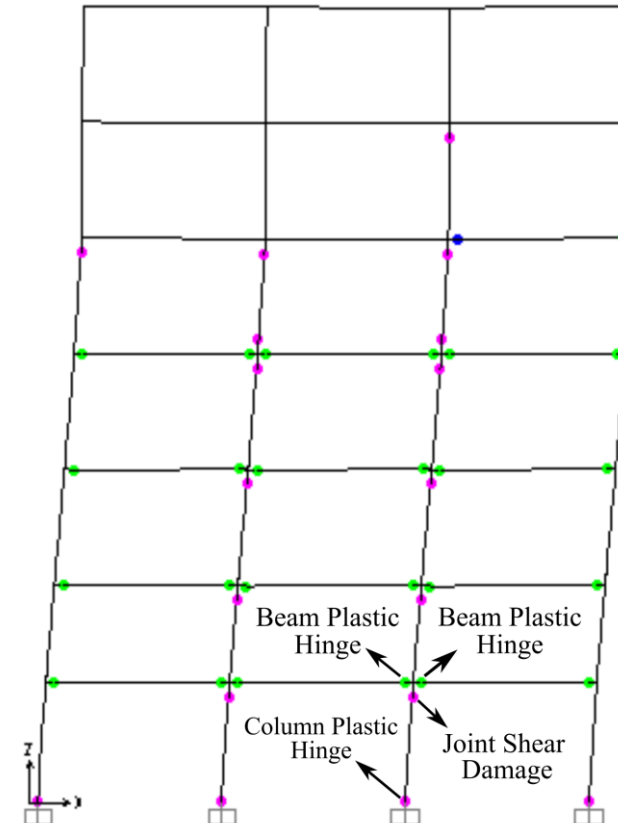
- 2D Model for selected frame
- Non-linear static analysis in SAP2000
- The Capacity Spectrum Method
- Potential performance point



# Discussion of Results



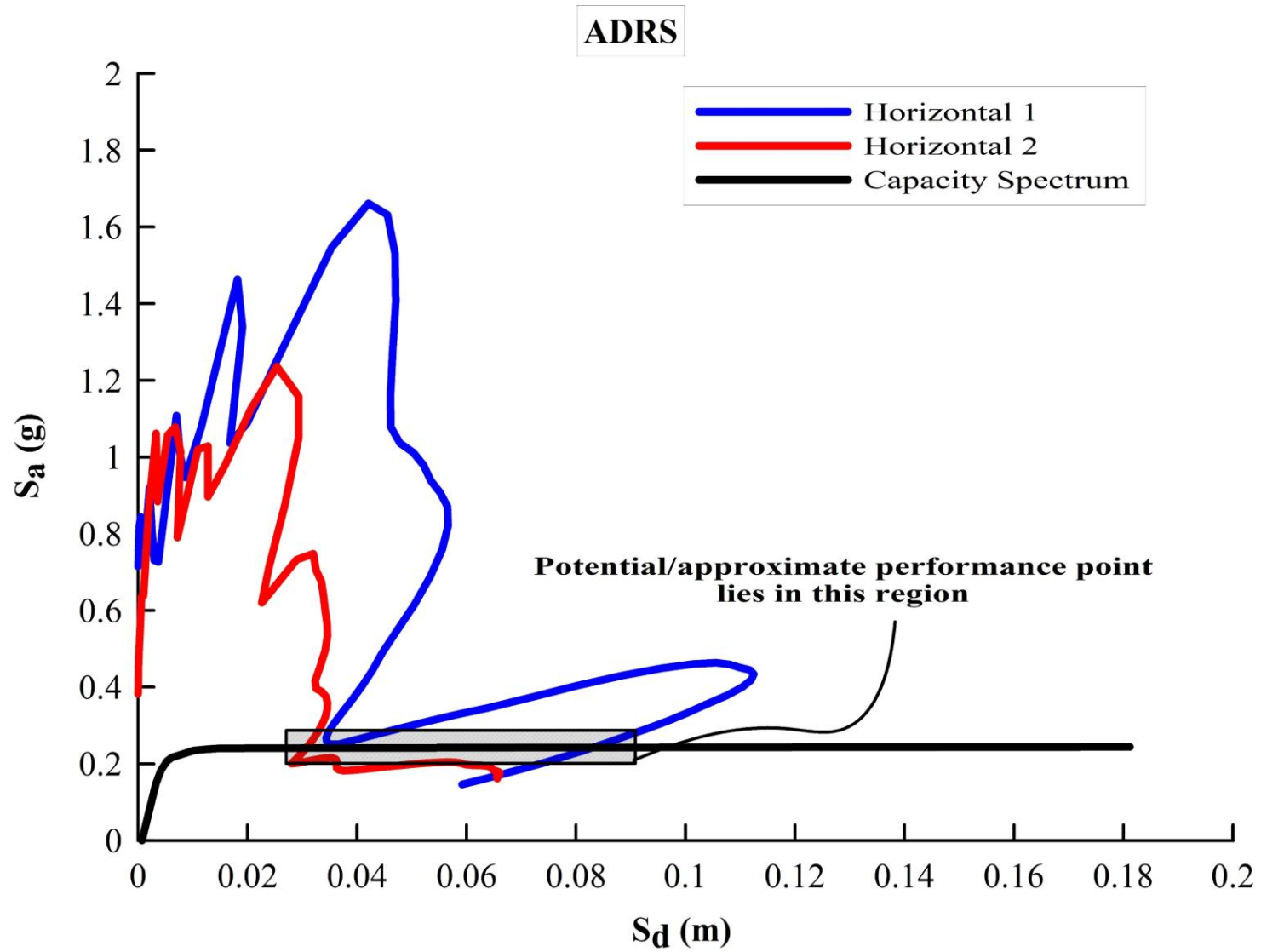
a)



b)

# Joint Failures





# Conclusion

- Represent two types of joint shear mechanism
- Consider various axial load levels
- Accurately simulates the joint shear damage



# References

Birely AC, Lowes LN, Lehman DE (2012). A model for the practical nonlinear analysis of reinforced-concrete frames including joint flexibility. *Engineering Structures* **34**: 455-465.

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Tasligedik AS (2020). Shear capacity n-m interaction envelope for rc beam-column joints with transverse reinforcement: A concept derived from strength hierarchy. *Journal of Earthquake Engineering*: 1-31.

Unal M, Burak B (2013). Development and analytical verification of an inelastic reinforced concrete joint model. *Engineering Structures* **52**: 284-294.

# Thank You

# Any Question