Global Sensitivity Analysis of a Bridge Column Featuring SMA and ECC Under Seismic Loading

Considering variations in seismic demand and material properties

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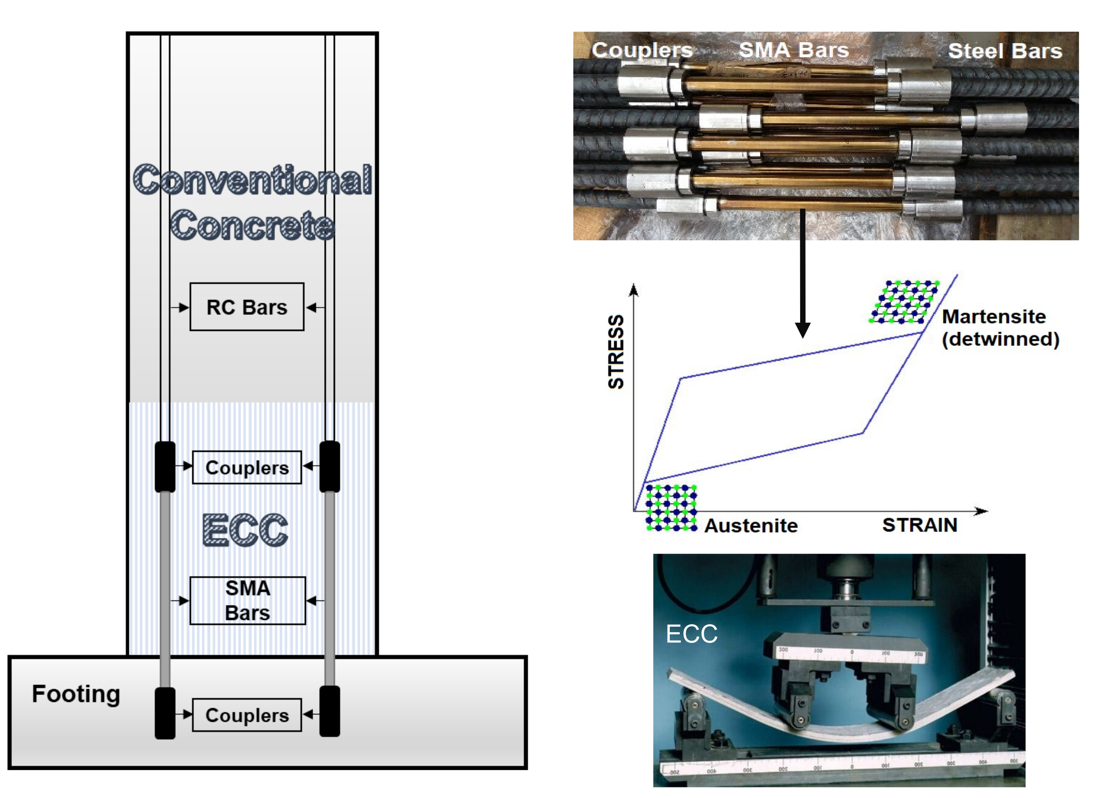
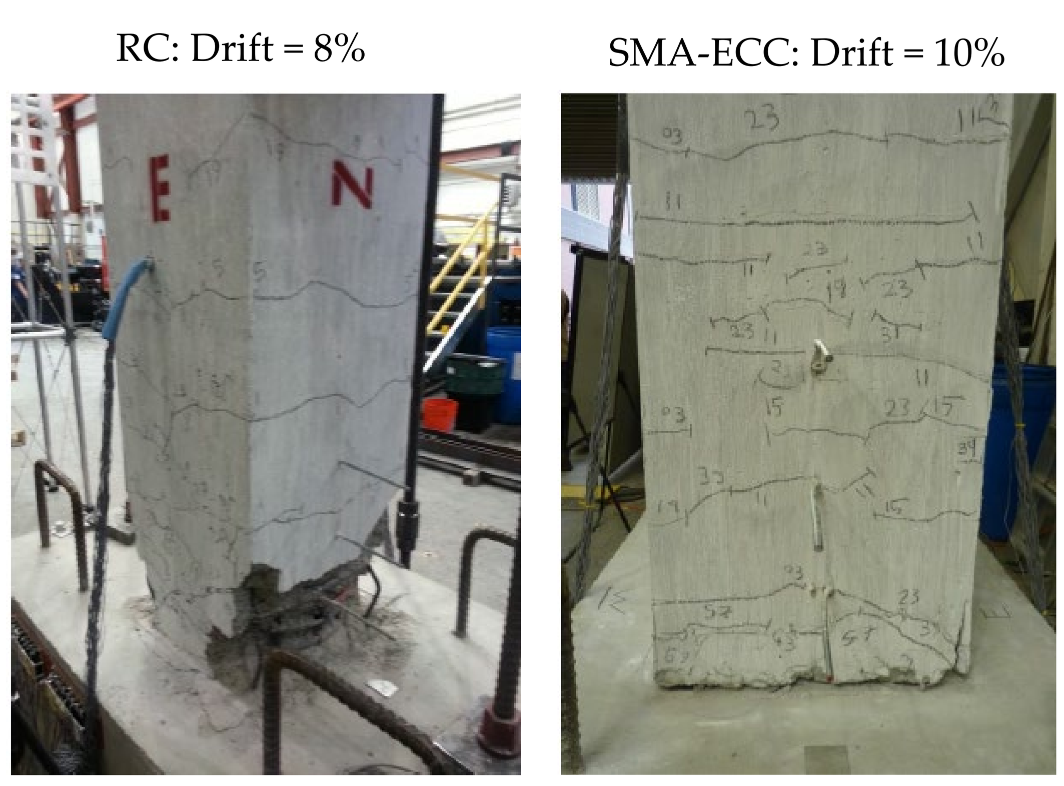
The compressive strength of ECC and Austenite modulus of SMA are the most important mechanical properties in controlling the drift response of an SMA-Reinforced ECC Column.

Introduction

- The development of advanced materials that are more ductile, damage-tolerant, and have self-centering capabilities over conventional ones has led to the design of novel bridge columns incorporating advanced materials to improve the resiliency of bridge systems from large earthquakes.
- One of the successful applications of novel column bridge designs is where advanced materials such as Shape Memory Alloy (SMA) and Engineered Cementitious Composite (ECC) are included in the plastic hinge region of the column.



SMA-ECC Column Concept [1-3]

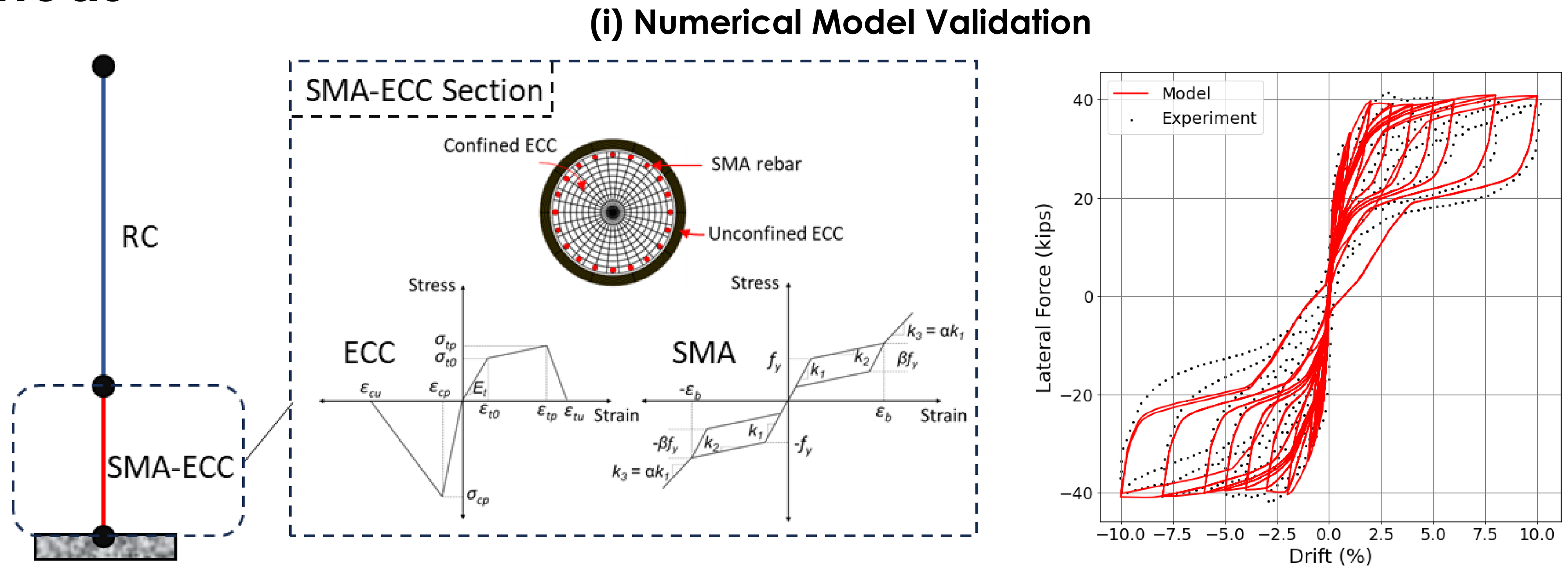


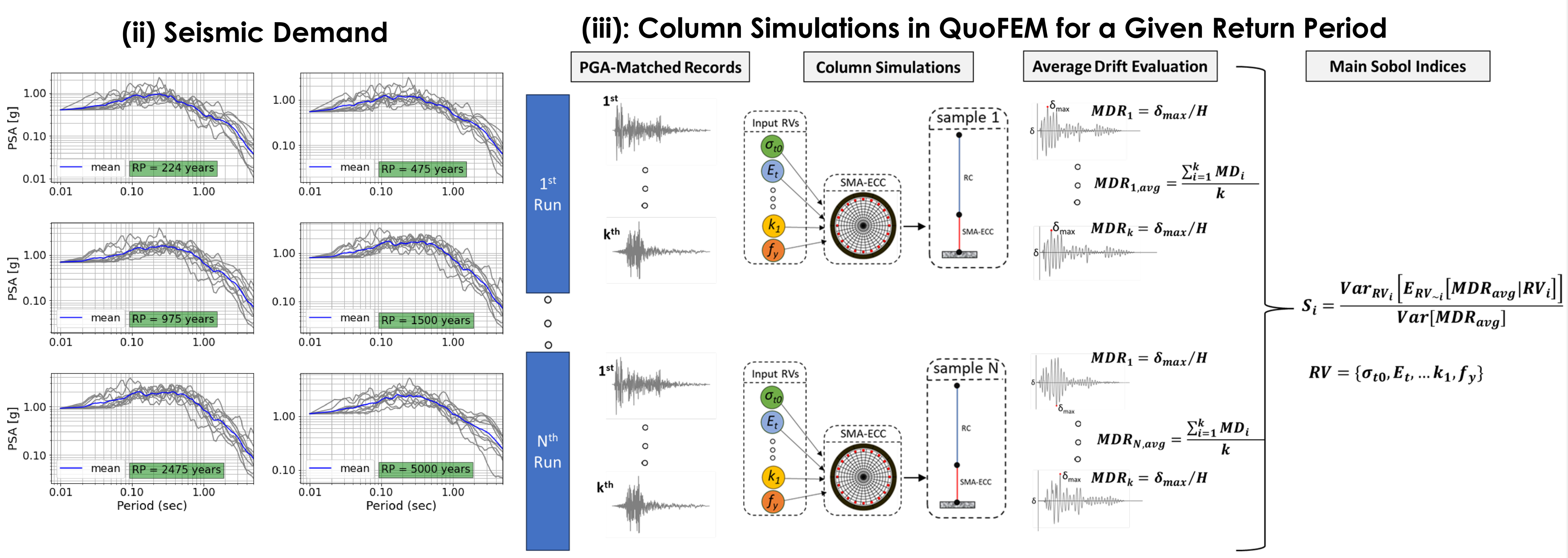
Post-Test Damage Pictures [4]

- The purpose of this study is to investigate the effect of variation in mechanical properties of SMA and ECC on the seismic response of a bridge column featuring SMA and ECC materials in its plastic hinge region.

Methods

(i) Numerical Model Validation

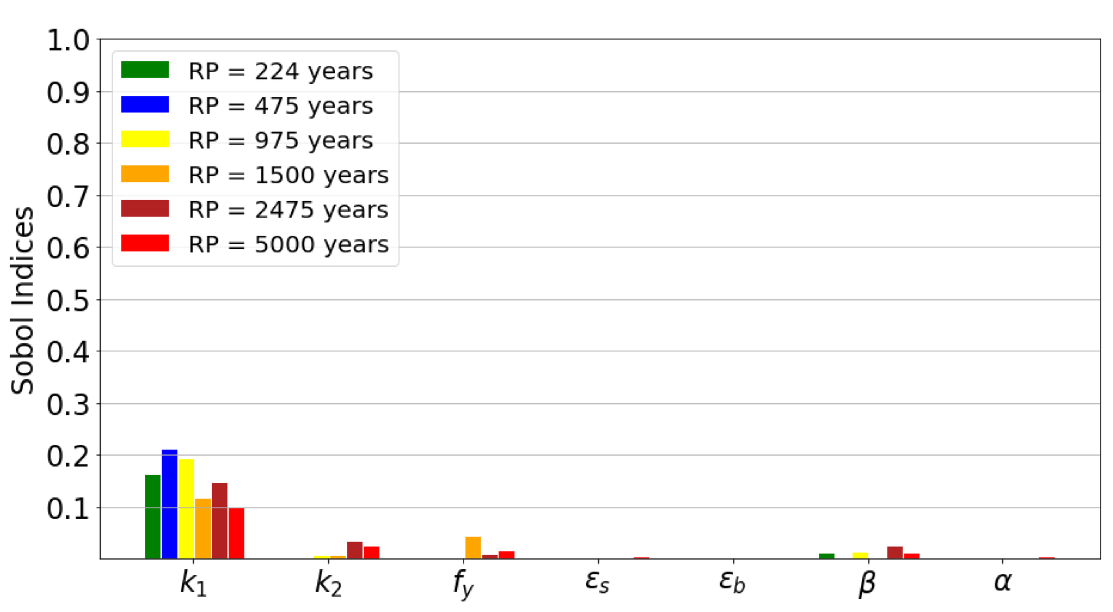




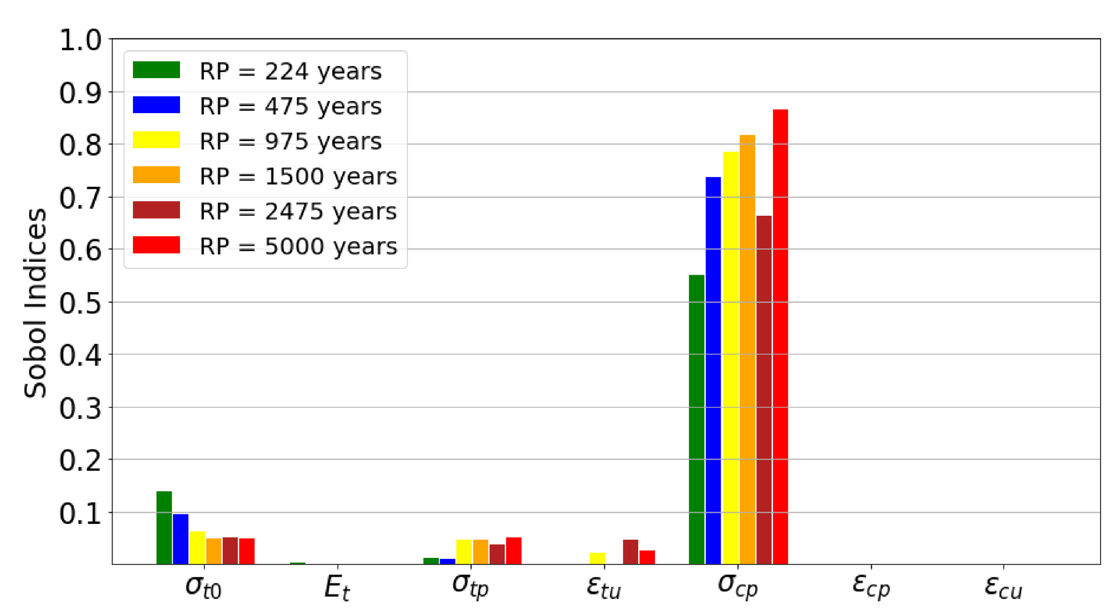
Workflow carried out for the sensitivity study

- The type of SMA used is Nickel Titanium (NiTi) SMA.
- Uncertainties about SMA and ECC parameters are based on Ref. [1] and [3].
- For a given return period, 50 random samples are drawn for each random variable associated with SMA and ECC.

Results



Sobol Indices for SMA Parameters



Sobol Indices for ECC Parameters

Conclusions

- Austenite modulus, k_1, has the most effect on the column's drift response among other SMA parameters.
- Variability in ECC peak compressive stress, σ_{cp}, significantly affects the drift response of the column response across all intensity levels.
- The effect of variability in ECC tensile crack strength, σ_{t0}, on the column's drift response reduces as the intensity of the earthquake becomes larger.
- The results of this study provide useful input to understand the extent of material uncertainties that need to be considered for seismic design and analyses of structures featuring SMA and ECC

Acknowledgements

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References

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