Analytical Assessment of Innovative Retrofits for Reinforced Concrete Frames

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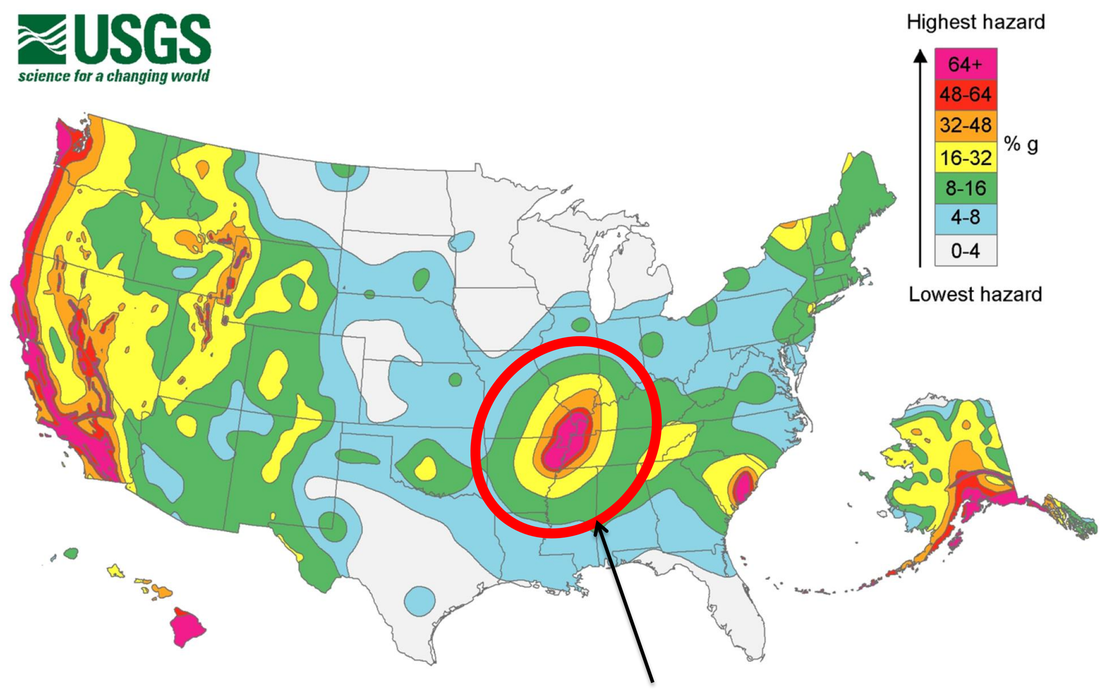
NEES

OVERVIEW

- Non-ductile reinforced concrete (RC) frames present safety and economic problems in areas of moderate seismicity
- Driven by the ongoing shift from focusing solely on life-safety to achieving measurable performance metrics, this study aims to validate retrofit schemes that are practical in design and installation, passive in nature, reduce residual deformation, and require minimal maintenance
- Pending analytical model validation through comparison with results from a companion experimental project, the results from this study indicate that the proposed retrofits can efficiently enhance the seismic performance of low-rise, non-ductile, RC frame buildings

BACKGROUND

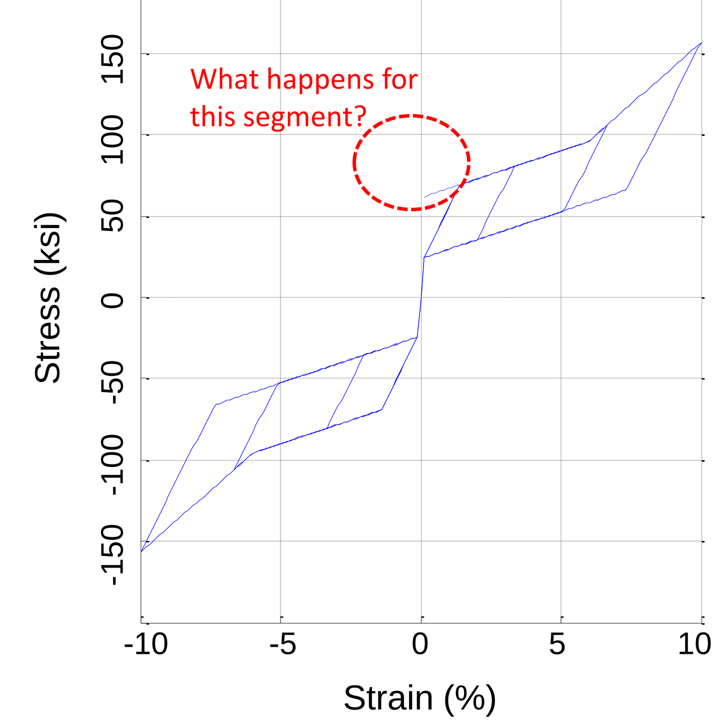


A 7.7 M_w earthquake in the New Madrid Seismic Zone could result in approximately $300 billion in economic losses and nearly 86,000 human injuries and fatalities (Mid-America Earthquake Center)
(Diagram: http://earthquake.usgs.gov/hazards/products/)

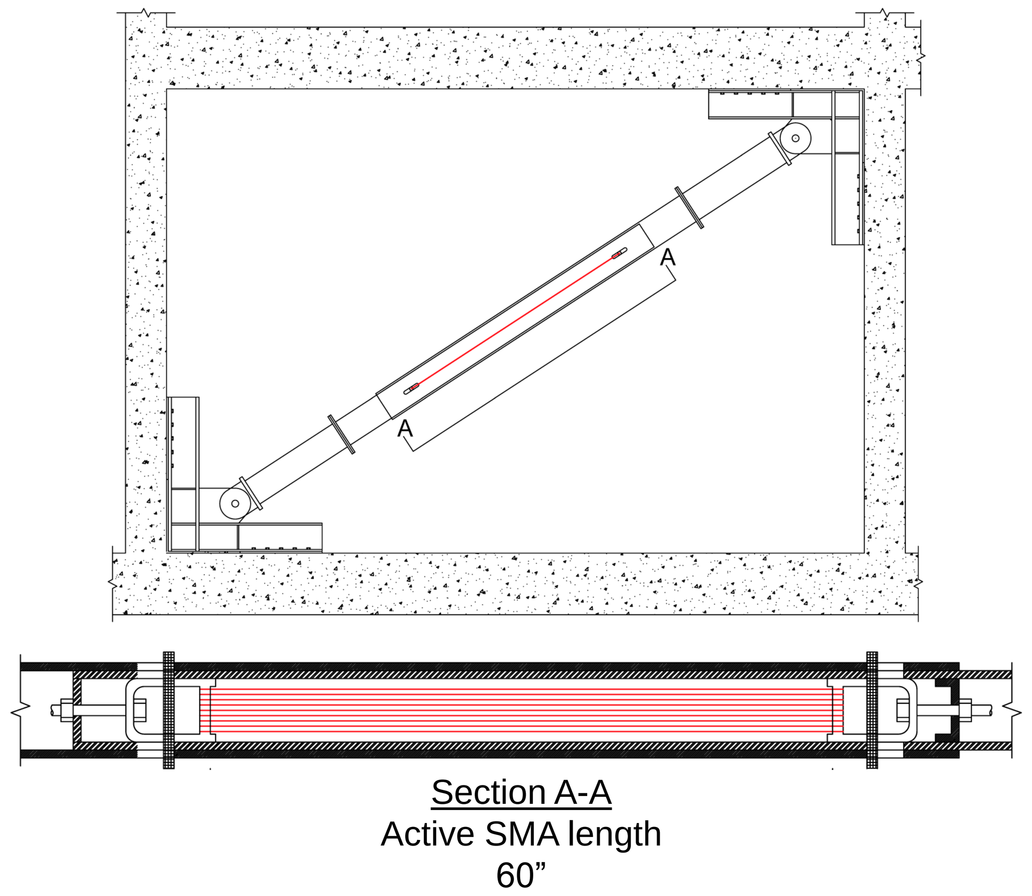
Georgia Tech test structure, designed using the 1963 ACI-318 as part of a companion study. Design parameters and details did not consider seismic loading, which is typical of older RC construction in the central US.

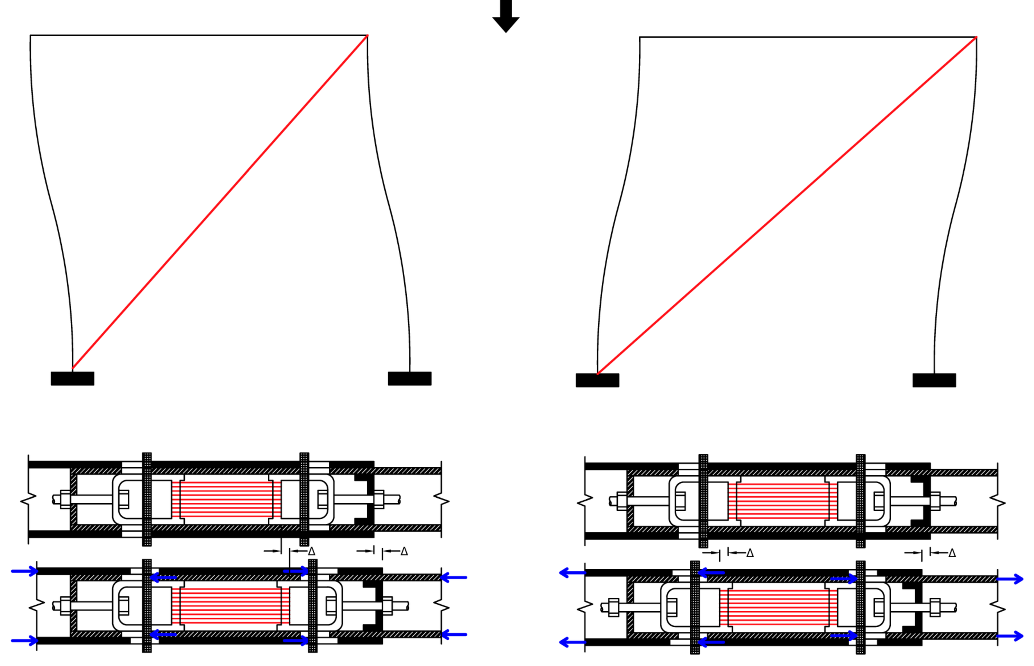
METHODOLOGY

Brace model with post-tensioned superelastic shape-memory alloy (SMA) material :

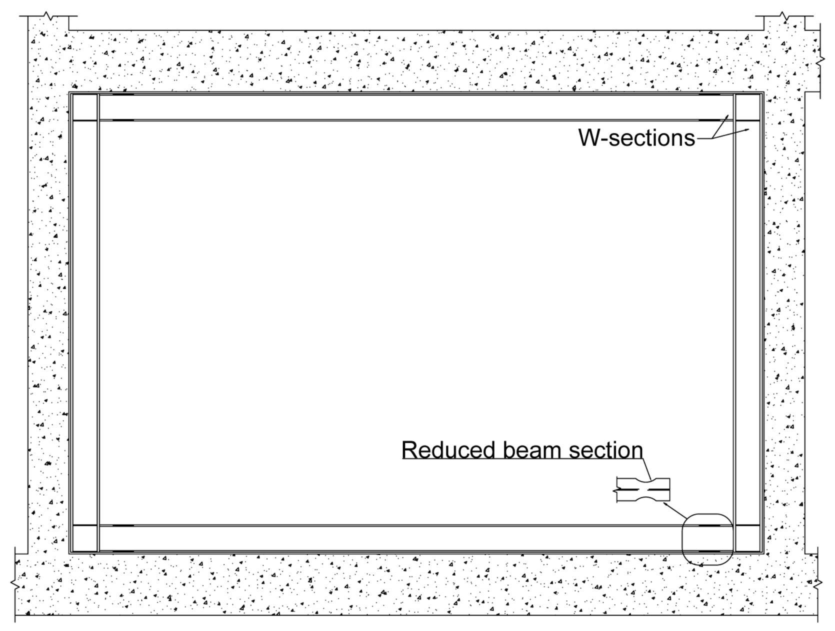


SMA brace retrofit*:



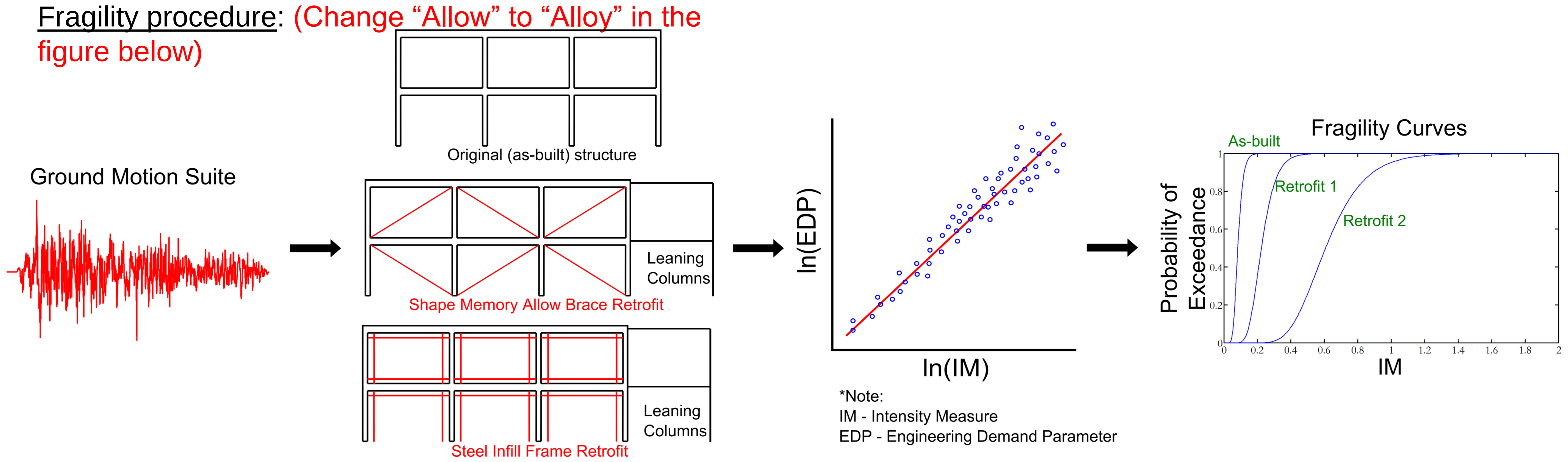


Steel infill frame retrofit*:



* Steel infill and SMA brace retrofits were designed using AISC design specs and procedures

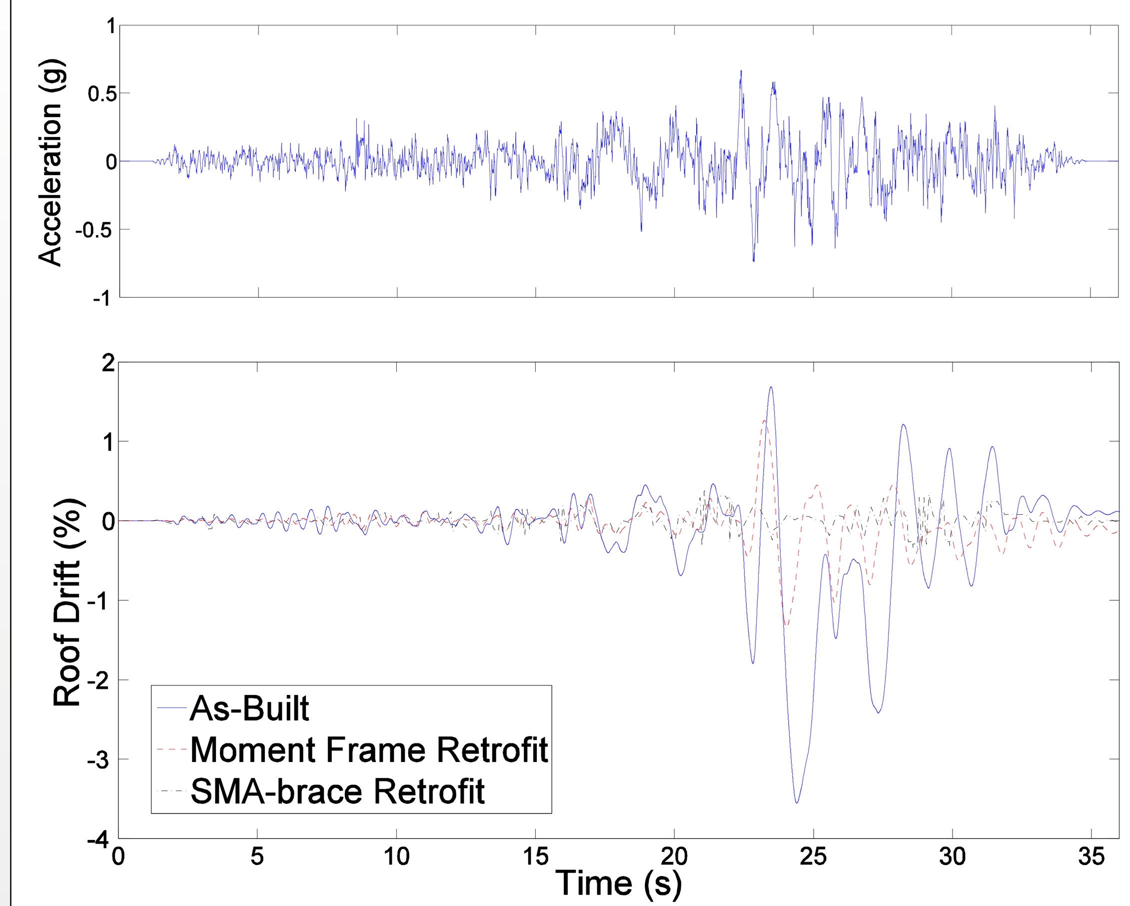
Fragility procedure: (Change "Allow" to "Alloy" in the figure below)

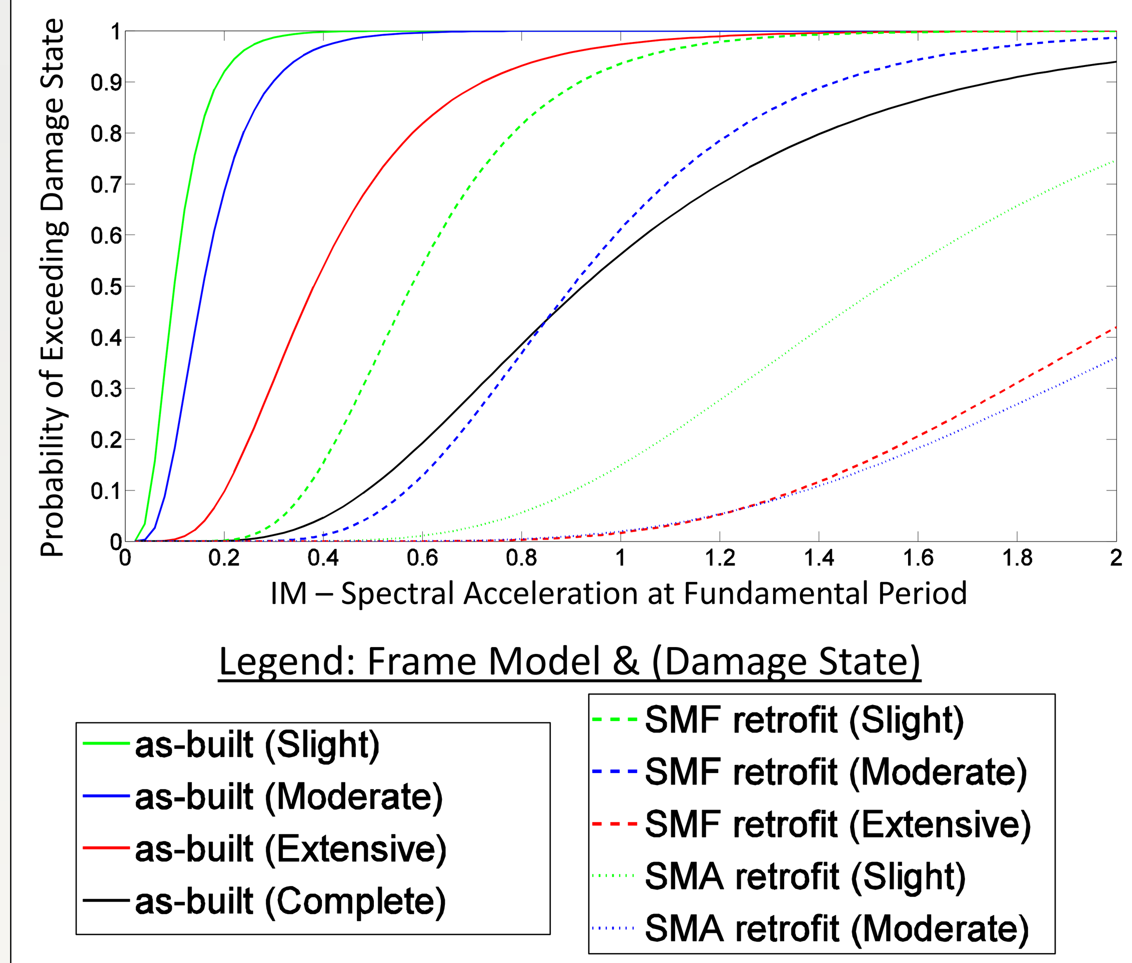


Notes on fragility methodology:

1. A suite of *N* ground motions (GMs) is selected to represent seismic hazard.
2. *N* nominally identical and statistically significant frame models are generated by sampling on geometric and material variables using Latin Hypercube sampling. The frame models include an as-built frame and two retrofit models (SMA-brace and infill steel moment-frame retrofits).
3. The *N* frame models are randomly paired with the *N* GMs. Nonlinear time-history analysis is performed on each frame-GM pair and story drifts are recorded. Peak drifts are plotted against the IM to develop the probabilistic seismic demand model.
4. The demand distribution is then convolved with capacity models to formulate the fragility.

RESULTS





CONCLUSIONS

FOR MORE INFORMATION

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ACKNOWLEDGEMENTS

This research is supported by the National Science Foundation under Grant CMMI-1041607.
The presenting author has also been supported by the Georgia Tech Goizueta STEM (GoSTEM) program and the Georgia Tech Center for International Strategy, Technology, and Policy.

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