Qi Zhang

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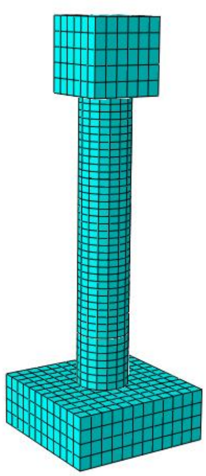
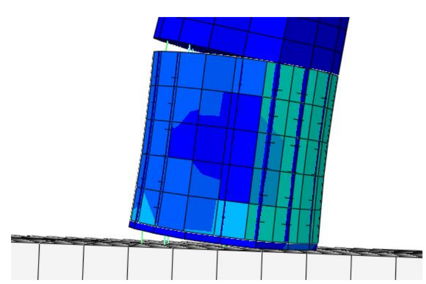
Qi's research topic is the application of precast concrete columns in seismic regions. For many years precast components have been extensively used in bridge superstructures, but the adoption of precast components in substructures has not been uniformly adopted, particularly in low seismic regions. There have been significant research efforts on seismic-resistant precast bridge columns, however the research findings have yet to be accepted by the industry in order to understand the benefits. The overall objective of his research project is to propose practical design guidelines of post-tensioned precast columns using the philosophy of performance-based design, which makes bridge structures more resilient under earthquake events. Qi has been working on the design criteria, simplified design equations, and optimizations of post-tensioned precast concrete columns.

Qi finds that stiff tendons increase vibration frequency of post-tensioned concrete columns. Rocking impacts not only dissipate energy but also reduce the vibration periods. The use of tendons increases vibration frequency thus helping to dissipate energy and reduce rotation amplitude. To avoid negative stiffness of post-tensioned precast concrete columns, total axial load (dead load and post-tensioning load) ratio should be limited to 20%. He has concluded that energy dissipation (ED) bars made of smart materials such as shape memory alloy (SMA) can significantly enhance the serviceability of bridges after earthquakes. The residual drift of columns with SMA ED bars is approximate 40% to 50% of the residual drift of columns with steel bars. The energy dissipation of columns with SMA ED bars is approximate 50% to 60% to that of columns with steel ED bars. The viscous damping of specimens with SMA ED bars ranges from 6% to 20%, whereas the viscous damping of specimens with steel ED bars ranges from 10% to 30%.



Finite element model of the precast concrete column



Gap opening between segments to release seismic demand

Qi has published three peer-reviewed journal publications in the areas of performance-based seismic design and post-tensioned precast columns.

JOURNAL PAPERS

Zhang, Q., and Alam, M. S. (2019). "Performance-based seismic design of bridges: a global perspective and critical review of past, present and future directions" Structure and Infrastructure Engineering, DOI: 10.1080/15732479.2018.1558269.

Zhang, Q., Alam, M. S., Khan, S., & Jiang, J. (2016). "Seismic performance comparison between force-based and performance-based design as per Canadian Highway Bridge Design Code (CHBDC) 2014" Canadian Journal of Civil Engineering, 43(8): 741-748

Zhang, Q., and Alam, M. S. (2015). "Evaluating the Seismic Behavior of Segmental Unbonded Post-tensioned Concrete Bridge Piers Using Factorial Analysis" Journal of Bridge Engineering, 21(4), 04015073.