

**Multi-Level Seismic Performance Assessment  
of a Damage-protected  
Beam-column Joint  
with Internal Lead Dampers**

**K. M. Solberg, B.A. Bradley,**

**J.B. Mander,**

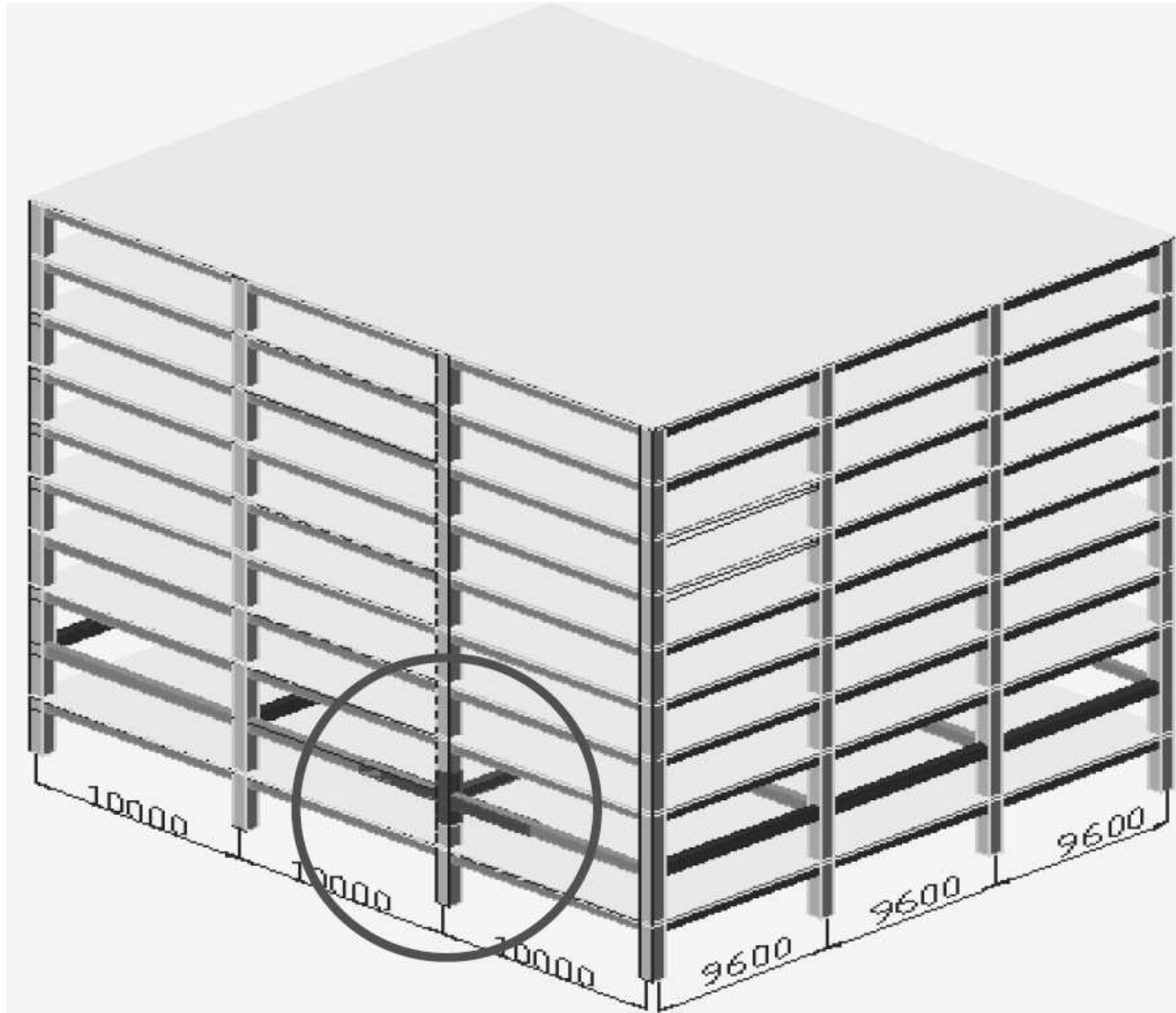
**R. P. Dhakal,**

**G.W. Rodgers, J.G. Chase.**

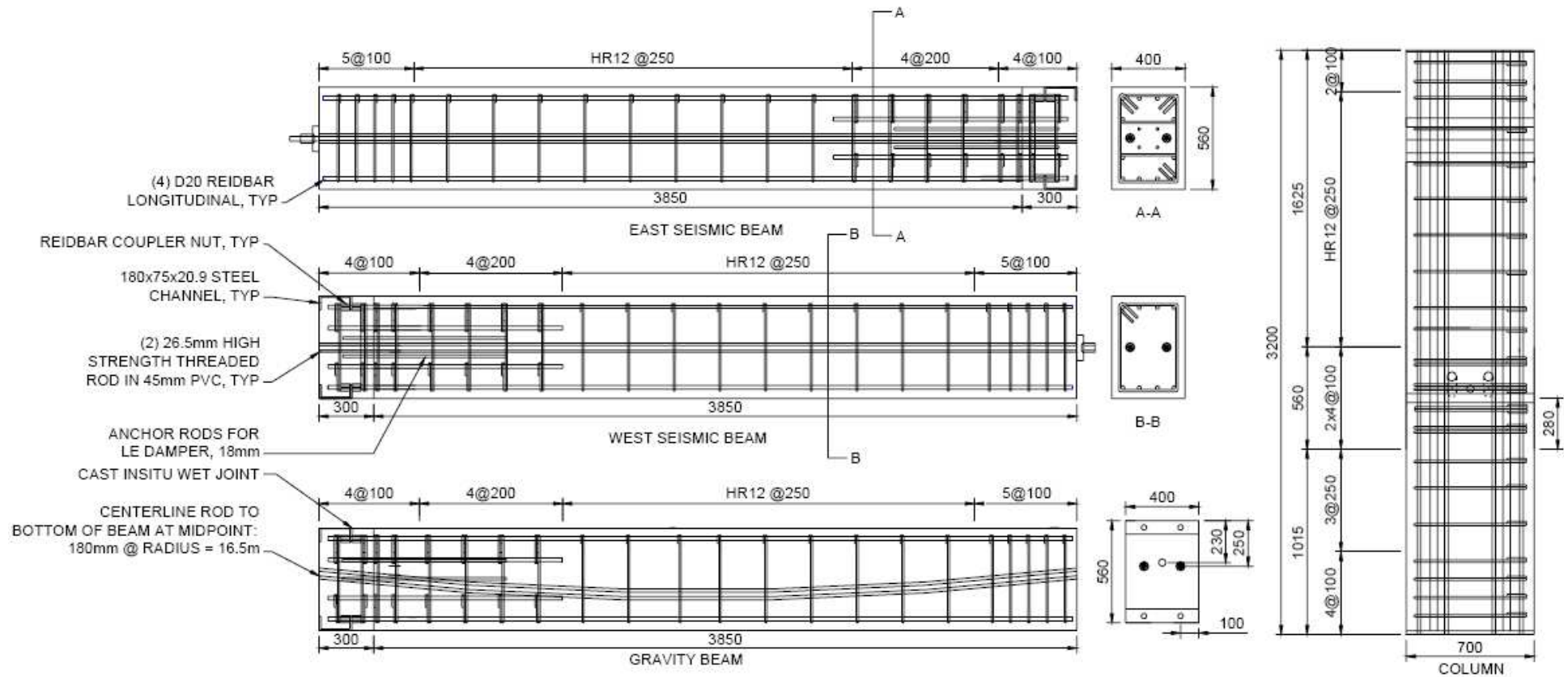
# Outline

- Motivation
- DAD concept
- Experimental specimen development
- Key construction hardware
- Computational modeling using IDA
- QED testing
- Results
- Conclusions

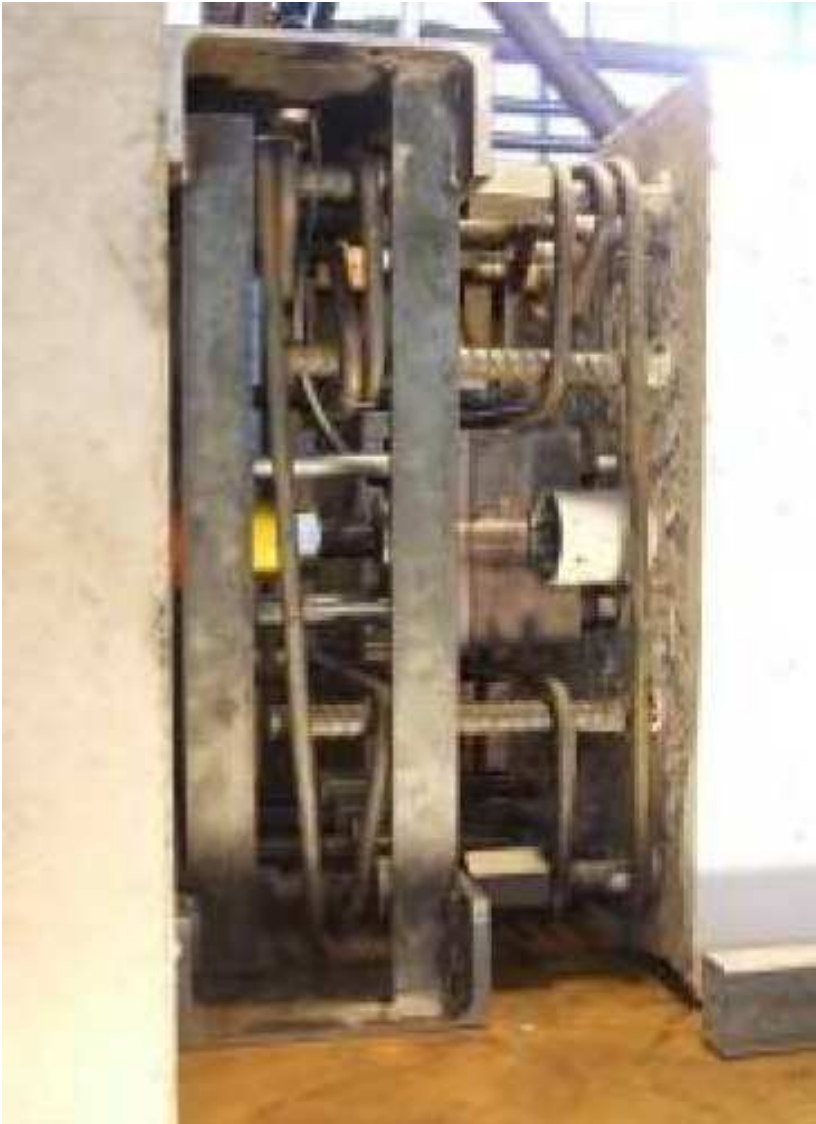
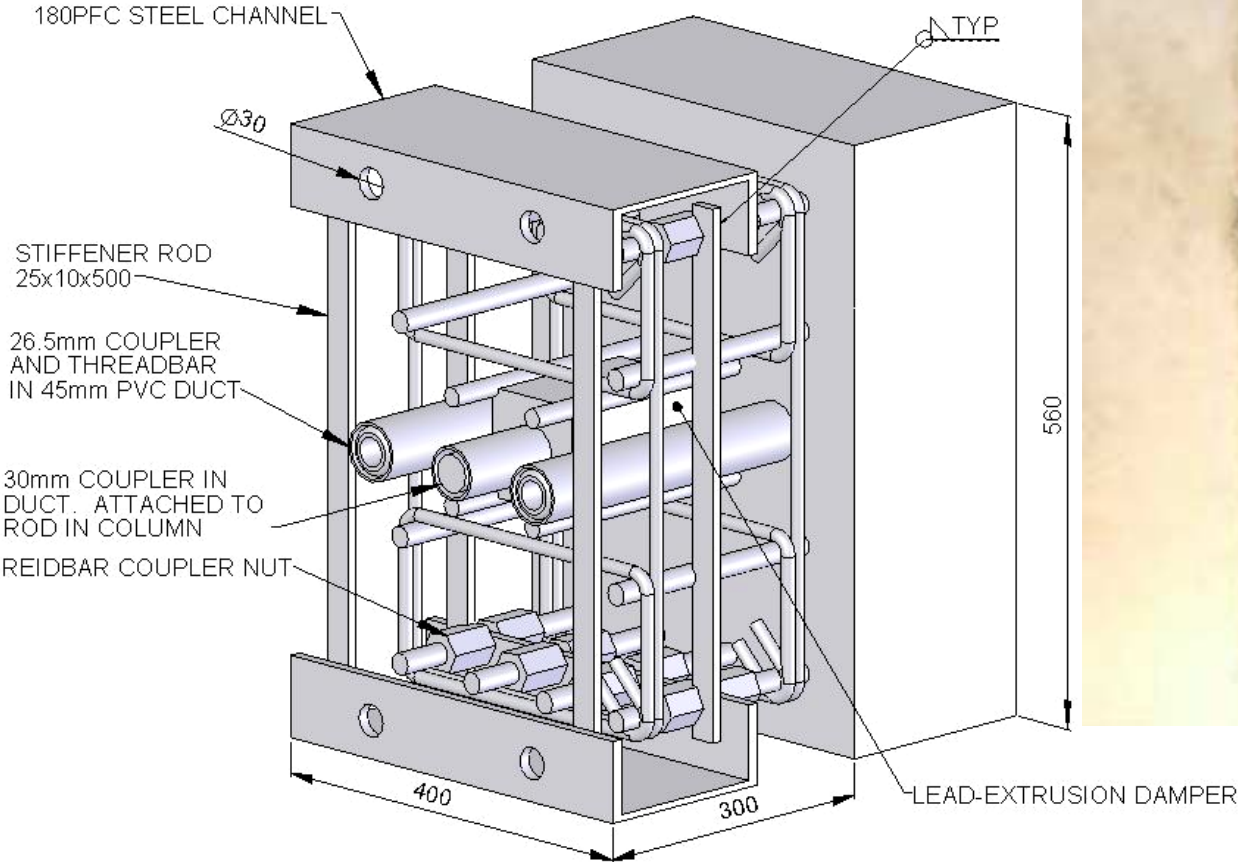
# Development of the experimental specimen



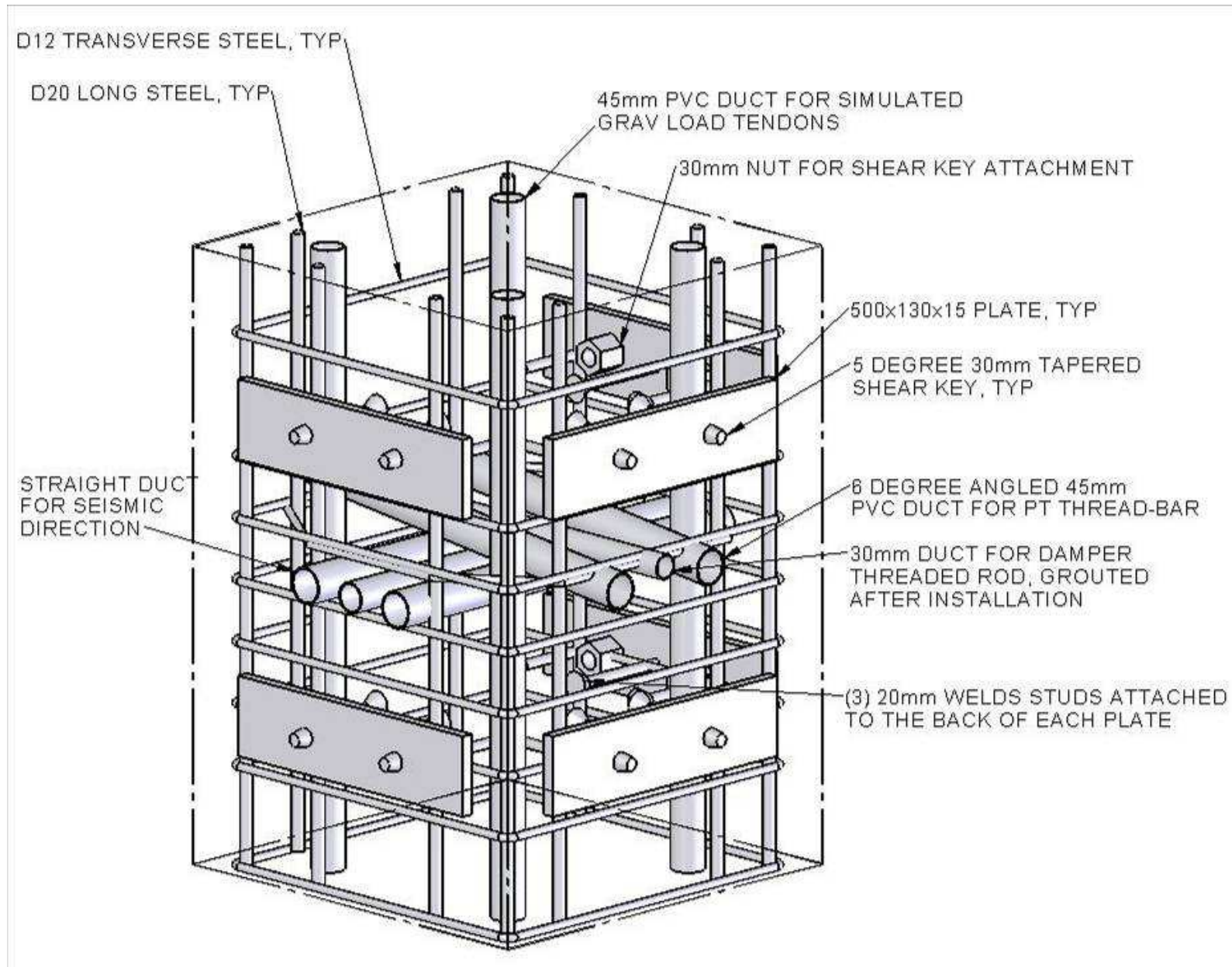
# Reinforcing Details



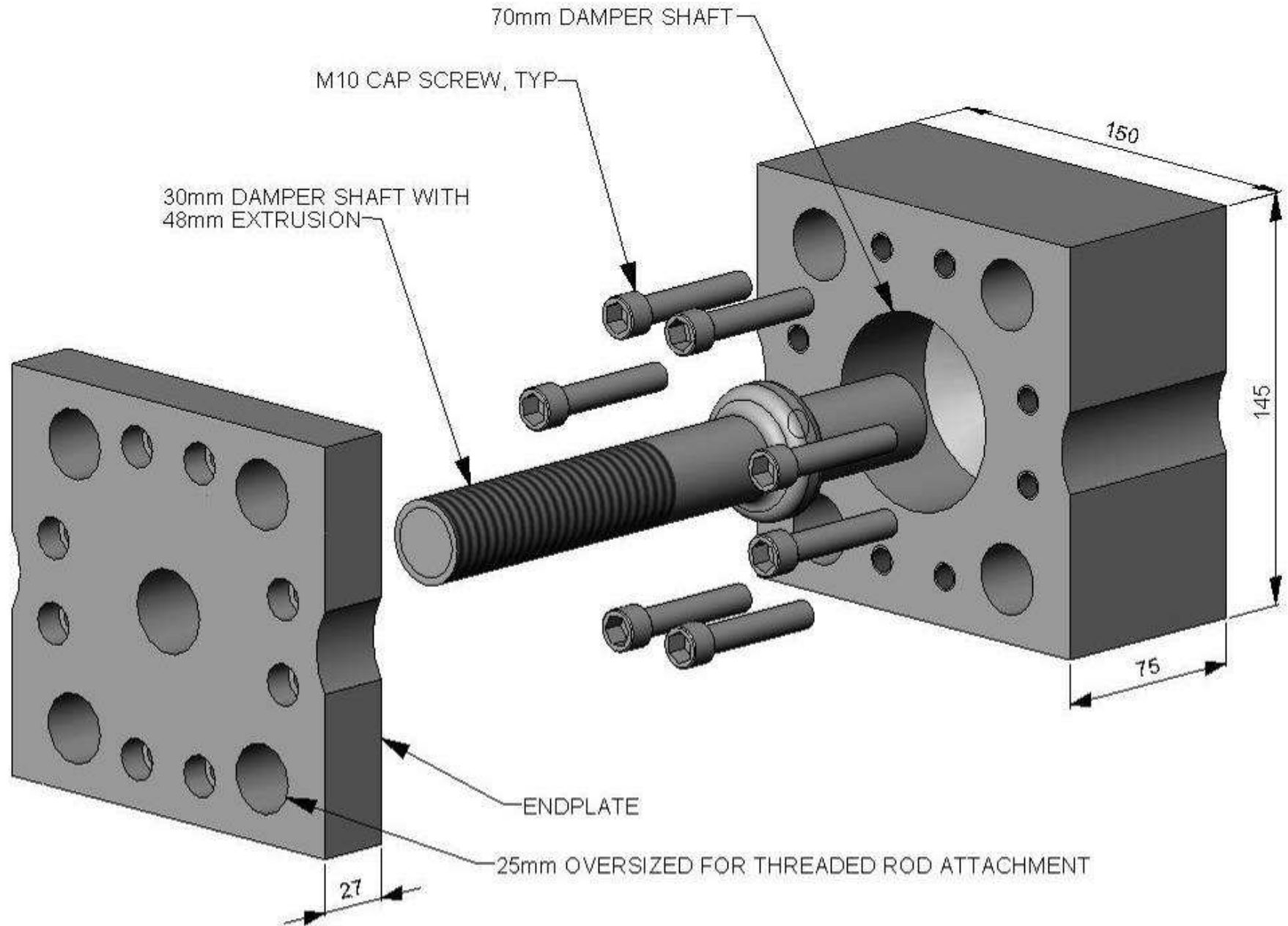
# Beam-end region showing closure pour details and a LED device



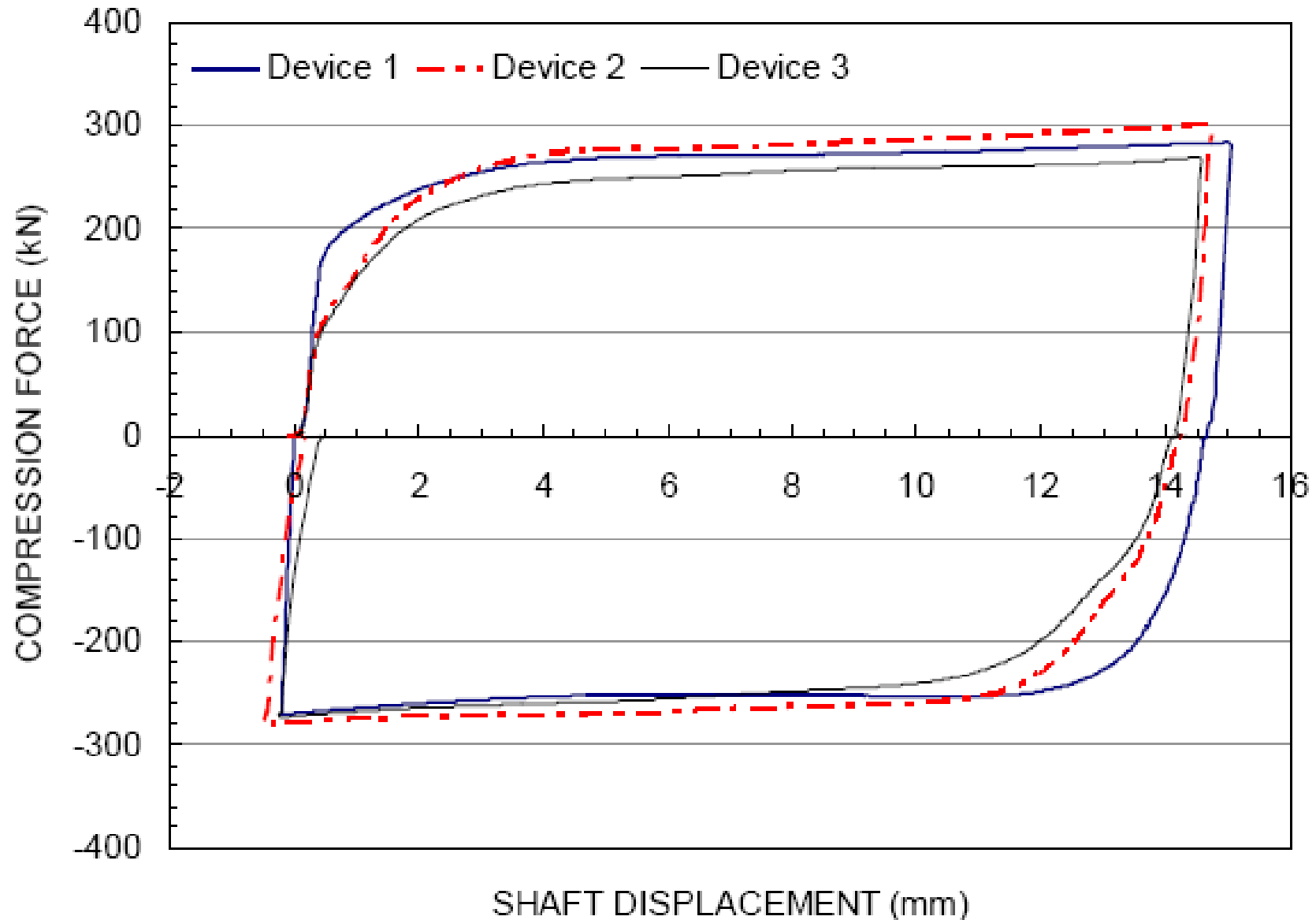
# Column Connection



# LED Device

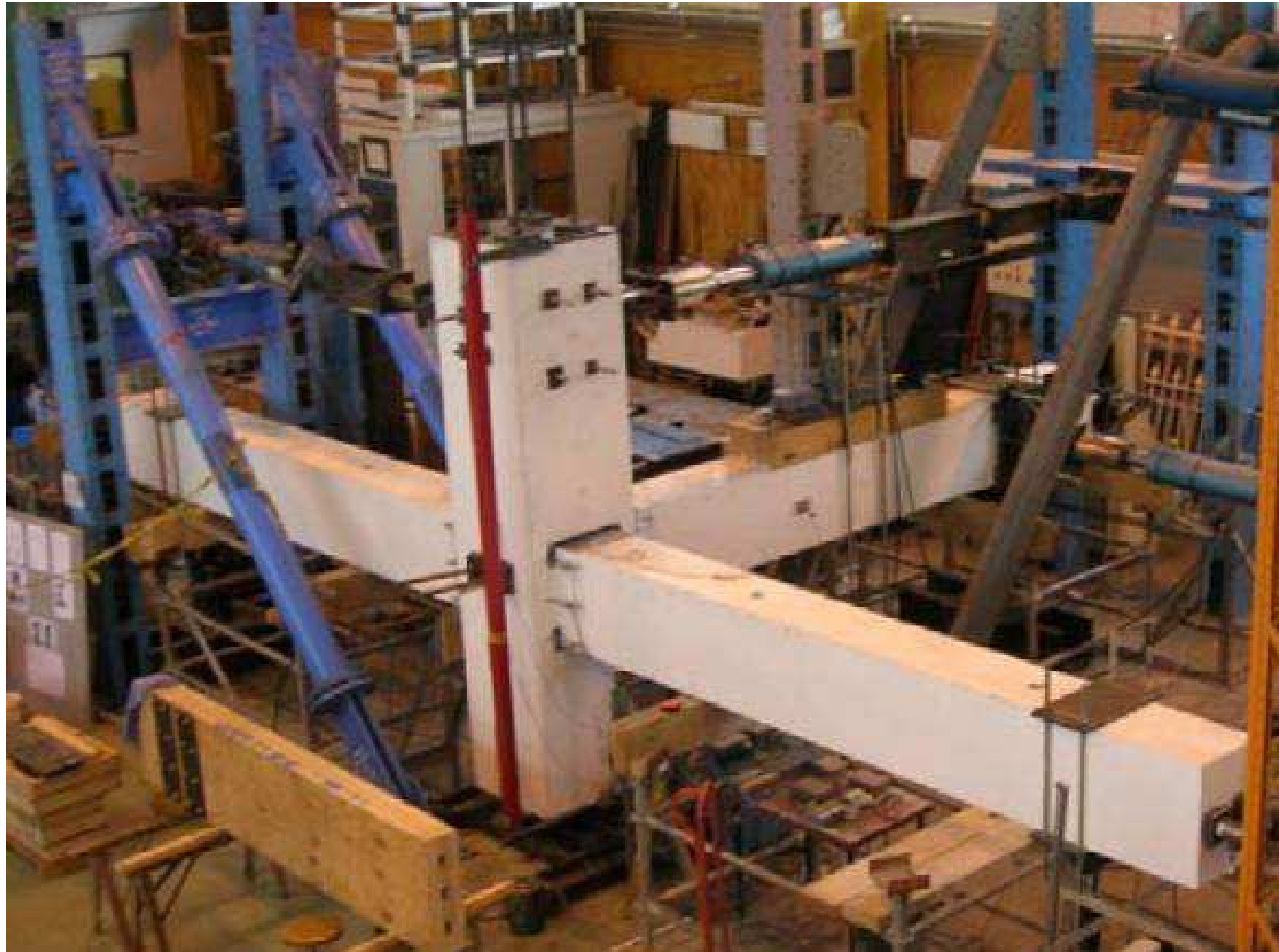


# LED Device Performance

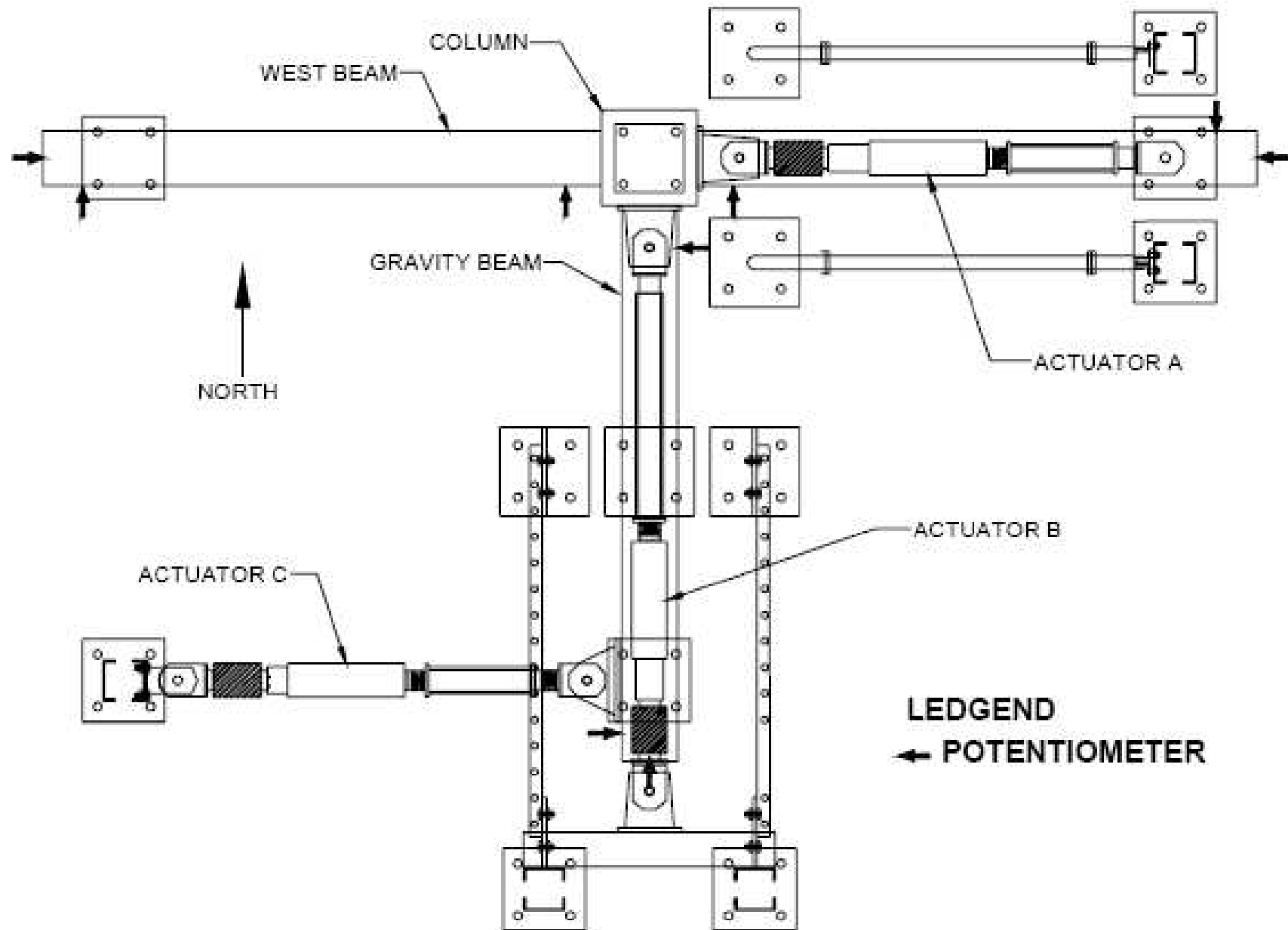




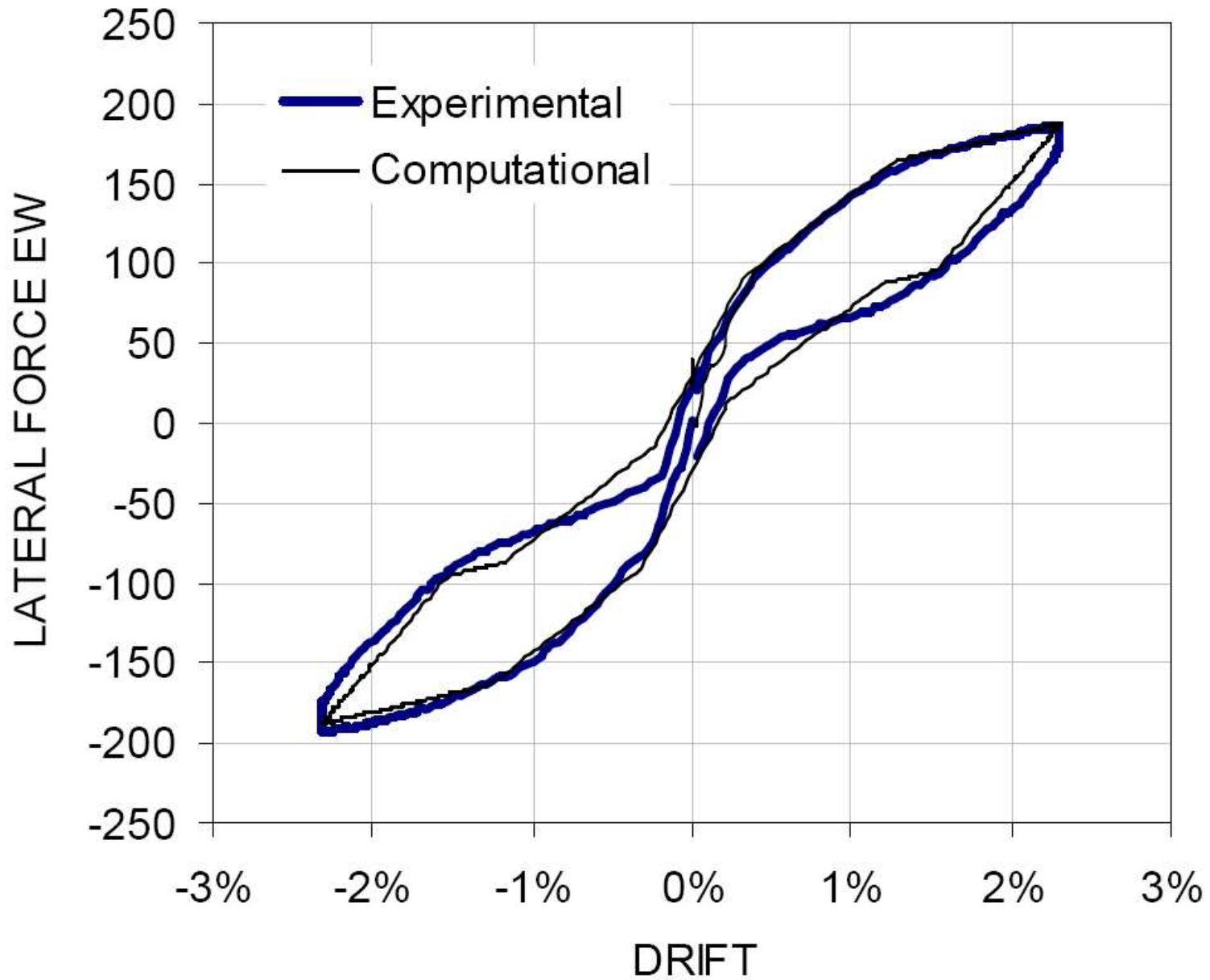
# Experimental Setup



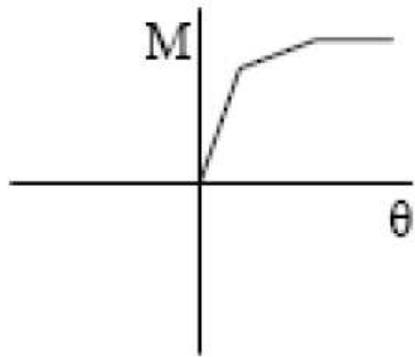
# Plan view of experimental setup



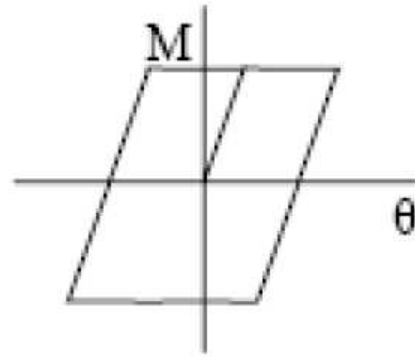
# Results from quasi-static cyclic tests



# QED: Structural modeling

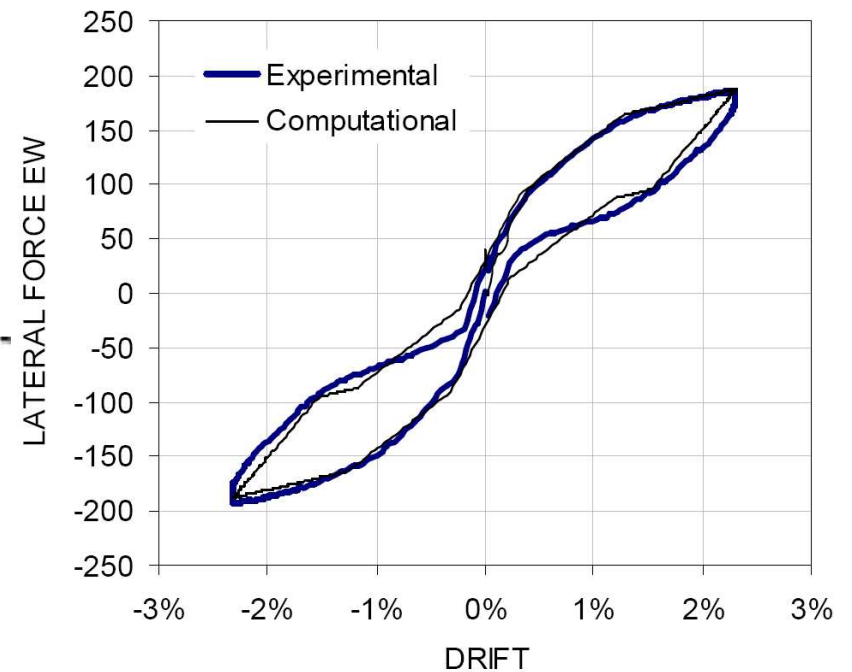
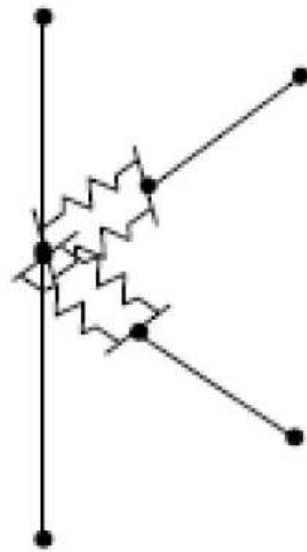


Tri-linear elastic spring

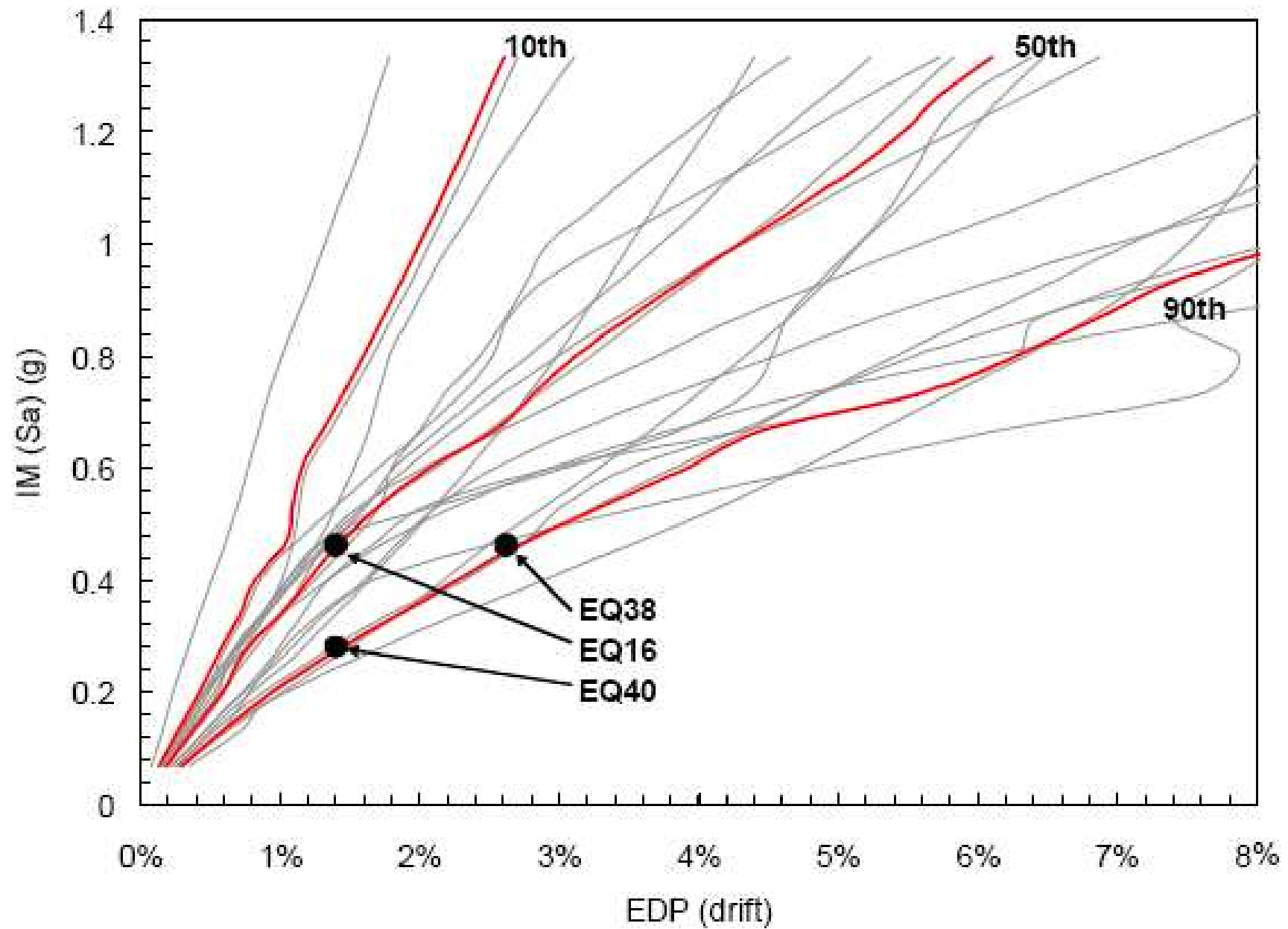


Elasto-plastic spring

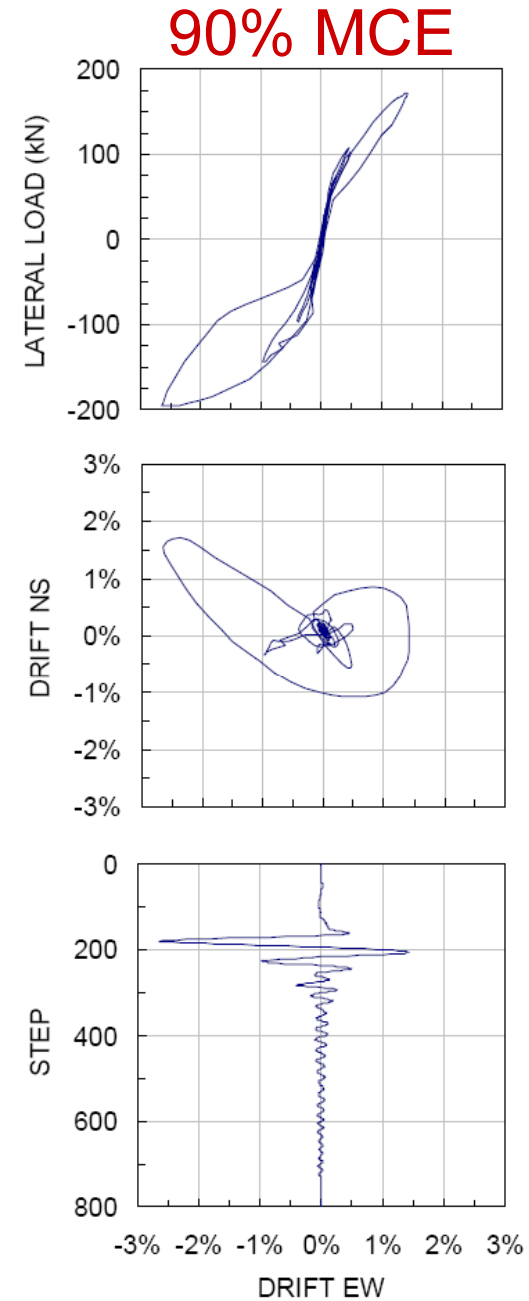
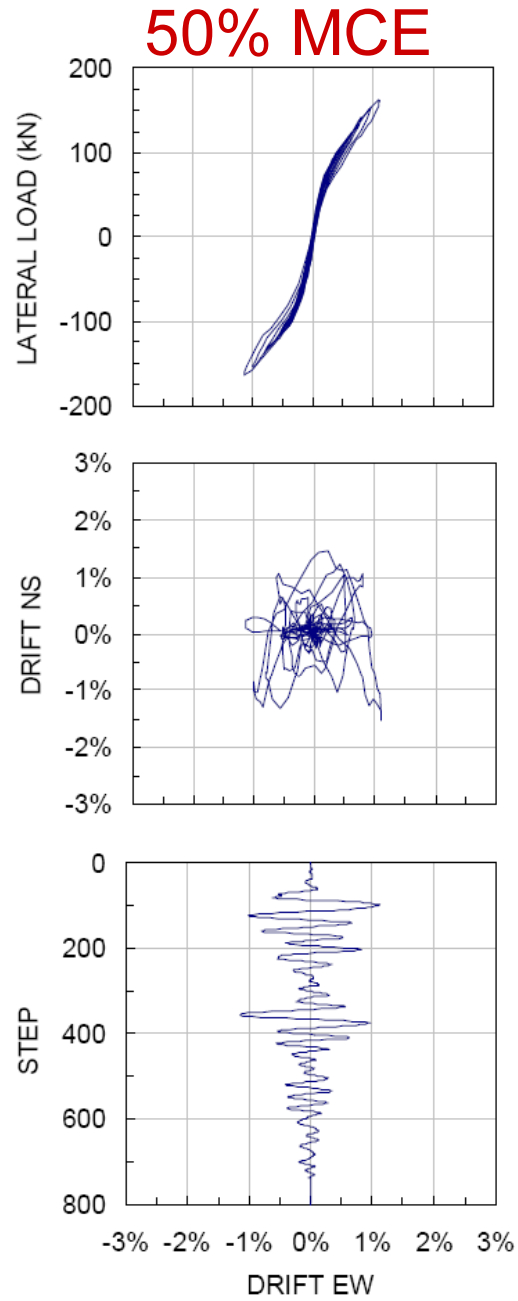
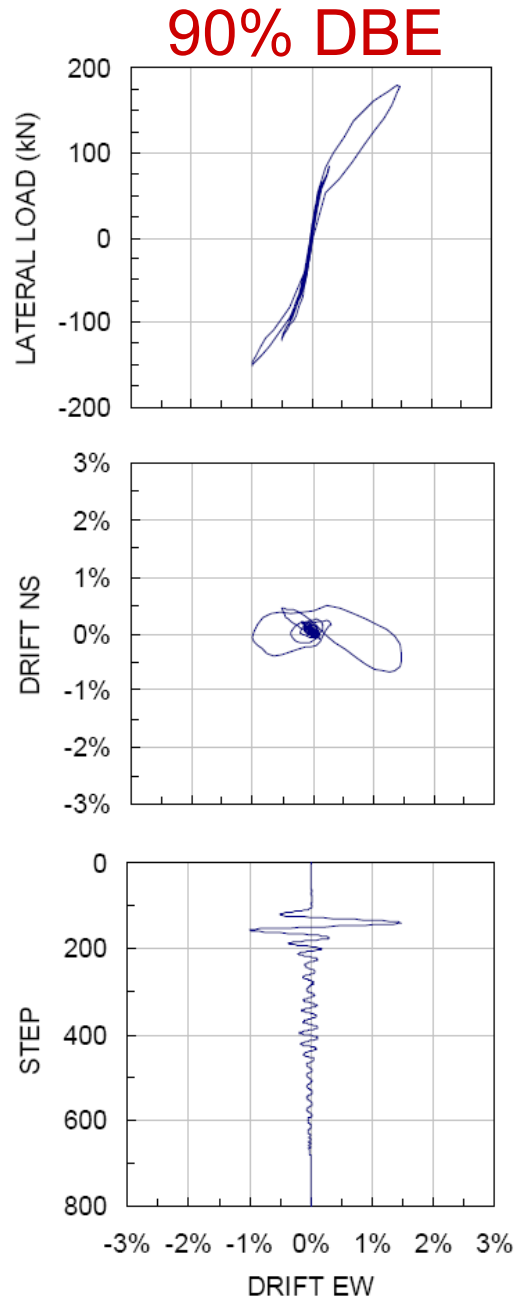
Elastic  
beam/frame  
elements



# IDA results



# QED: results



# Key Findings:

- The specimen performed well through the most arduous earthquake event with NO damage. Moreover, re-centering was maintained at all times
- For successful DAD implementation small compact dampers should be installed within the connection region. Such devices should require no post-earthquake maintenance.
- The LED devices performed well in this regard.

# Conclusion

- DAD precast systems are an attractive constructional alternative to monolithic conventional systems designed for ductility.
- DAD systems can eliminate damage to the structural elements over a broad range of extreme seismic performance. Thus post-earthquake serviceability (I.O.) can be maintained even for very rare (MCE++) events.



# Future Work

- The next step is to investigate the potential for eliminating damage beyond the frame and wall systems. Particular emphasis should be directed to the articulations of precast floor systems within DAD precast concrete frames