Innovative Design Procedures for Bridges Allowing Rocking Foundations

PEER Transportation Systems Research Program

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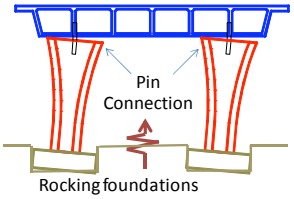
Introduction

Current bridge design protocols of California suggest use of stiff foundations and ductile columns. The problem with this approach is that it imposes large ductility demands on bridge columns. Innovative design procedures with rocking foundations are proposed to apply to Caltrans ordinary standard bridges.

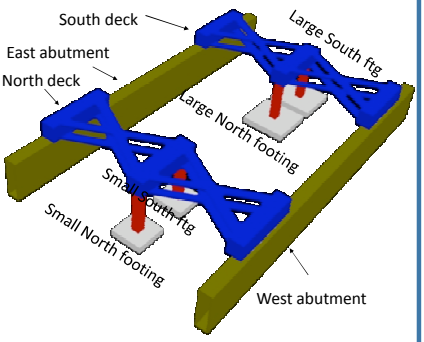
Failed bridges due to column failure from previous earthquakes

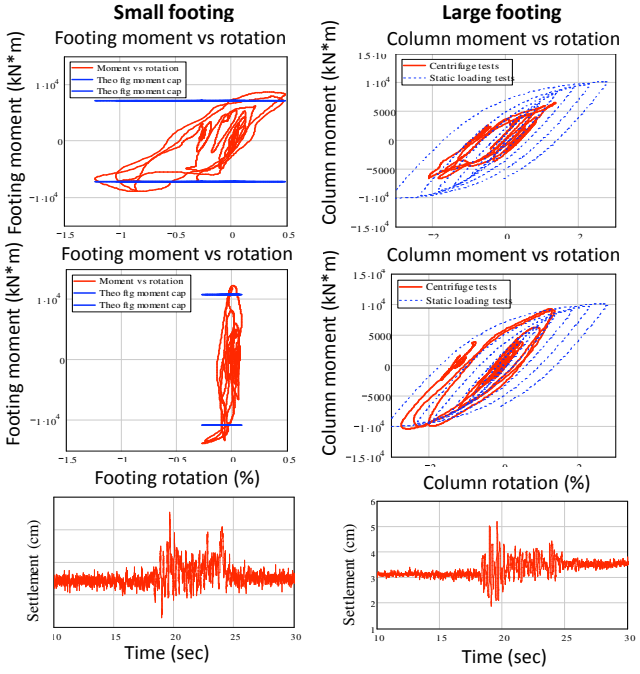


Conceptual drawing of innovative bridge design

Physical modeling and results

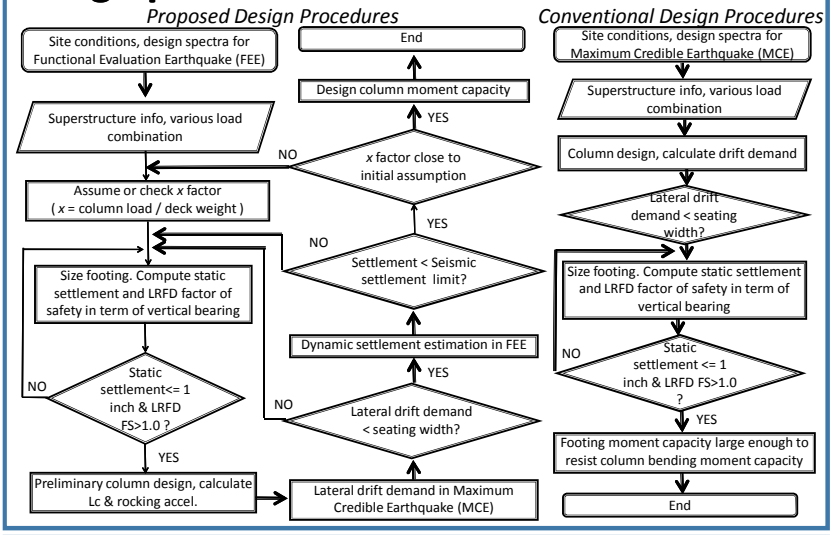
Model tests on two bridge systems were performed using the centrifuge facility of UC Davis. One bridge was designed with small footings whose moment capacity was less than the bending moment capacity of the columns to allow for rocking. Another bridge complied with conventional design which had essentially elastic footings.





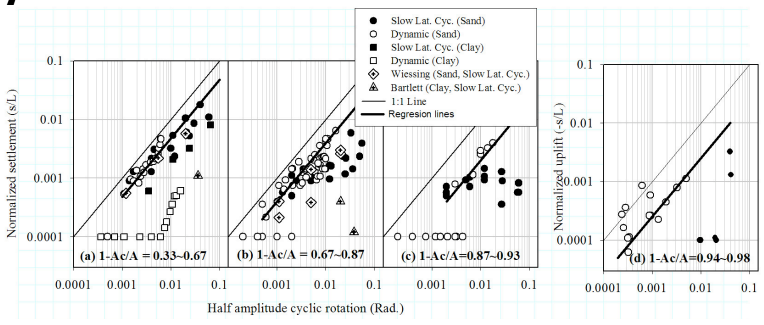
Experimental plots from a seismic event

Design procedures



Dynamic settlement estimation

A/Ac ≃ FSv



Conclusions

For most of the input motions, it was observed that if small settlements are acceptable, performance can be improved by reducing the size of foundations and allowing them to rock:

1. *ductility demand on columns with small footings were smaller than that for large footings.*
2. *the permanent drift of the bridge deck was also superior for columns with small footings due to the recentering effect.*

Last Hurdles

A new project funded by PEER will attempt to overcome some of the last hurdles for implementation of rocking foundations. The hurdles include:

1. *Identifying cases where rocking foundations are definitely not applicable (e.g. very poor soil conditions and below the water table, and very tall bridges).*
2. *Finalizing procedures to estimate magnitude of settlement of rocking foundations.*
3. *Work with Caltrans to produce a procedure that will work for them; the ultimate goal would be the alteration of the Seismic Design Criteria (SDC).*

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