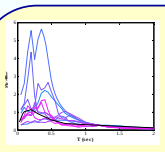
APPLICATION OF THE PEER PERFORMANCE-BASED METHODOLOGY FOR SEISMIC ASSESSMENT OF THE I-880 VIADUCT

Sashi Kunnath, Boris Jeremic, Erol Kalkan, Leah Larson, Keith Bauer and Anna von Felten

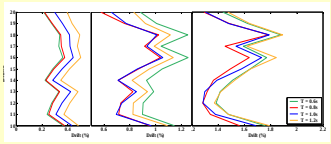
ABSTRACT

The implementation of the PEER performance-based evaluation methodology on a highway bridge structure is summarized. The methodology relies on the estimation of conditional probabilities of demand, damage and decision variables which are then integrated over the seismic hazard. The intensity measure used to characterize ground motions is the spectral acceleration of the record at the characteristic period of the bridge model. A series of nonlinear time-history simulations of a multi-frame model of the viaduct is carried out to estimate the seismic demands. In order to assess the seismic performance of the viaduct, a damage function derived from an experimental data base of bridge column tests is utilized. The simulation results are integrated with the damage function to yield a damage-based seismic fragility function of the I-880 viaduct. Finally, the conditional probability of bridge closure is evaluated for the potential seismic hazard at the bridge site.

SCALING OF GROUND MOTIONS



Fault normal record was scaled to match spectral acceleration of fault normal hazard spectrum at fundamental period of T=1.2s. Same scaling factor applied to fault parallel and vertical motions. Resulting records were transformed to longitudinal and transverse components.

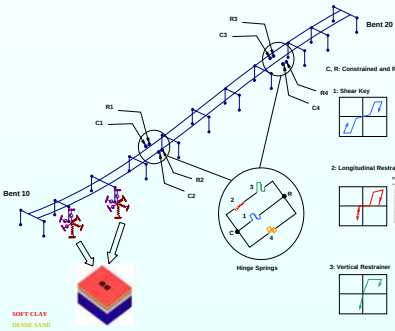


50% in 50 Years 10% in 50 Years 2% in 50 Years

Effect of Scaling on Peak Response for Varying Intensity Levels

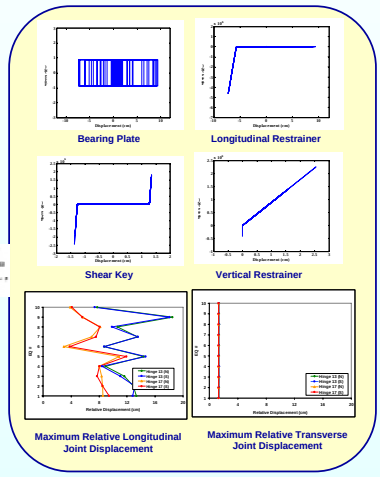
PROJECT OBJECTIVE:

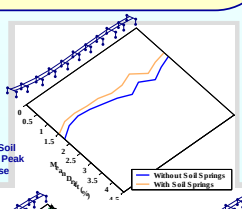
APPLICATION OF THE PEER PERFORMANCE-BASED METHODOLOGY IN THE EVALUATION OF A TYPICAL CALTRANS-DESIGNED ELEVATED HIGHWAY STRUCTURE



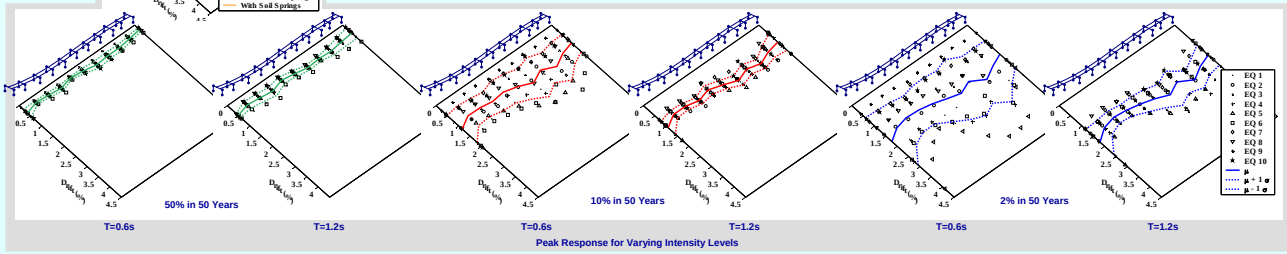
I-880 OPENSEES SIMULATION MODEL

TYPICAL RESPONSE OF CONNECTION ELEMENTS AT EXPANSION JOINTS





Effect of Soil Springs on Peak Response



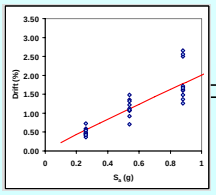
50% in 50 Years T=0.6s T=1.2s

10% in 50 Years T=0.6s T=1.2s

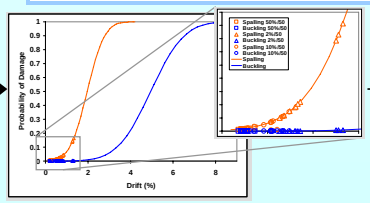
2% in 50 Years T=0.6s T=1.2s

Peak Response for Varying Intensity Levels

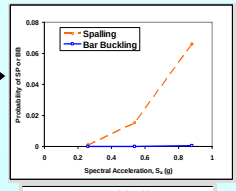
$$\lambda(DV) = \iiint G(DV \mid DM)\, dG(DM \mid EDP)\, dG(EDP \mid IM)\, d\lambda(IM)$$

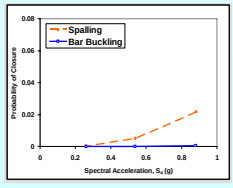


EDP|IM



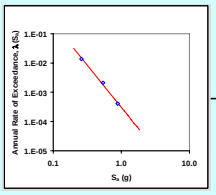
DM|EDP



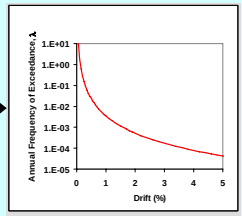


EDP-DM Relationships		
Probability of Damage		
2% in 50 Years	10% in 50 Years	50% in 50 Years
Concrete beam or column spalling		
0.0678	0.0134	0.0033
Beam or column rebar buckling		
0.0005	0.00001	0

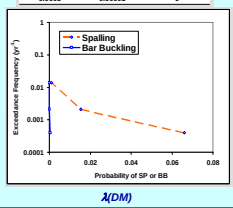
DM-DV Relationships	
Probability of Closure	
Concrete beam or column spalling	
P[dv | DM = true]	0.33
Beam or column rebar buckling	
P[dv | DM = true]	1.00



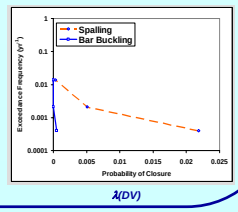
dλ(IM)



dG(EDP|IM)dλ(IM)



λ(DM)



λ(DV)

CONCLUDING REMARKS

The estimated closure probability for the I-880 is insignificant which suggests that the rebuilt section of the I-880 viaduct will perform satisfactorily for the hazard scenarios investigated. More importantly, the procedure described herein can be used to study the sensitivity of material and modeling parameters and then eventually to examine the impact of modeling considerations on the performance of the bridge. In this study, only a single demand variable was used. Additional measures such as plastic rotation or strain amplitude in the longitudinal reinforcing bar could have been selected. Likewise, different damage measures and decision variables may have been considered. Gaining an insight into the response of structures through probabilistic evaluations that incorporates a large parameter space offers advantages over other deterministic methods in performance-based seismic evaluation.