SIMULATION OF ENHANCED PERFORMANCE POST-TENSIONED BRIDGE PIERS

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A precast segmental concrete bridge pier system is being investigated for use in seismic regions. The proposed system uses unbonded post-tensioning (UBPT) to join the precast segments and has the option of using a high performance fiber-reinforced cement-based composite (HPRFCC) in the precast segments at potential plastic hinging regions. The UBPT is expected to facilitate self-centering of the columns (i.e. cause minimal residual displacements) after cyclic loading and allow only a low amount of hysteretic energy dissipation. The HPFRCC material displays high tensile ductility and tensile (strain) hardening behavior, and is therefore expected to add hysteretic energy dissipation and damage tolerance to the system. The focus of this research is to evaluate the enhanced performance bridge pier system using the Performance Based Earthquake Engineering (PBEE) assessment methodology currently being developed by the Pacific Earthquake Engineering Research (PEER) Center.

The PEER PBEE assessment methodology encompasses four main steps: (1) hazard analysis, (2) structural analysis, (3) damage analysis, and (4) loss analysis. Each step is handled on an individual basis and in a probabilistic fashion, and is finally brought together to provide an assessment of overall system performance in terms of monetary losses, downtime, and casualties. The current focus is on studying the UBPT bridge pier system in the areas of structural analysis and damage analysis. To evaluate the benefits of the proposed system, a comparison is being made with a traditional reinforced concrete (RC) bridge pier system using the PEER PBEE assessment methodology.

To perform the damage analysis in the framework of the PEER PBEE methodology, damage states unique to the UBPT system must be identified, and they must be related to the structural response through the development of fragility curves. However, due to the lack of a large amount of existing experimental data on UBPT column systems, the fragility curves must be developed using numerical models. To aid in identifying appropriate damage states and to calibrate the models, detailed continuum finite element analyses of a series of large-scale cyclic tests of UBPT bridge columns are being performed. Accurate simulation of damage response and overall behavior of UBPT concrete structural systems will allow for the analysis of a series of prototype UBPT bridge piers that have been designed for comparison with traditional RC systems.