DEVELOPMENT OF A LOADING PROTOCOL FOR PBEE EXPERIMENTATION

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Objective

A loading protocol will be developed whose implementation in the Pacific Earthquake Engineering Research (PEER) experimental studies will provide the information needed for performance assessment and analytical modeling of RC components.

In order to predict component performance under seismic conditions, experiments should simulate the deformation history that a component is likely to experience in a realistic seismic environment, and the results from the experiments should serve the purpose of developing damage models and load-deformation models that account for damaging features due to strength deterioration and stiffness degradation. For these and other reasons, representative test loading histories need to be developed whose objectives include, but are not limited to, the following:

- represent "reality", in a statistical sense, for conforming and non-conforming components;
- permit performance evaluation at various performance levels;
- account for the great differences in damaging cycles between ordinary and near-fault ground motions;
- permit the development of realistic analytical models, and;
- avoid undue complications in the testing process and in test interpretation.

Research and Achievements

The process is to perform extensive nonlinear analysis on SDOF and MDOF systems, using sets of ordinary and near-fault ground motions. The deformation excursions of the response histories are first evaluated by means of the rain flow cycle counting method in order to account for cumulative damage effects. The resulting excursions (which are different from the excursions as they appear in the time history response) are then ordered in decreasing magnitude, and statistics are performed on the ordered excursions (i.e., on the largest excursion, the second largest excursion, etc.). This results in statistically representative values of the magnitudes of individual excursions. These values are then used to construct representative loading histories, which account for the number and relative magnitudes of the excursions the components are expected to experience under ground motions representative of selected hazard levels. For conforming (new) components, it is found that most of the cumulative damage is caused by a small number of excursions, which are called primary excursions. Most of the excursions are smaller excursions that follow the primary excursions. These excursions, called trailing excursions, contribute little to cumulative damage. The loading history accounts for this phenomenon by a sequence in which larger primary excursions are followed by smaller trailing excursions.

A more complex approach has to be employed for the development of representative loading histories for non-conforming (less ductile) components of RC structures. In this case the response modeling has to include the effects of deterioration in strength and stiffness. For this purpose a general deterioration model has been developed that simulates the deterioration observed in experimental studies. This deterioration model is being calibrated against available experimental results. Extensive simulation is now being performed of the response of SDOF and MDOF systems with deteriorating models in order to capture the effects of deterioration on the number and magnitudes of the expected excursions. The added complexity is that now the loading history has to account not only for the effects of different strength and the uncertainty in ground motions, but also for the effects of different deterioration parameters. This added complexity is the major challenge of this project.