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Proposed Cyclic Loading Protocol of Moment-Resisting Connections for Soft Soil Sites

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Extended Abstract

In earthquake engineering, experimentation may have a variety of objectives and may utilize different testing techniques, ranging from field to laboratory experimentation, dynamic to quasi-static experimentation, and two to three-dimensional experimentation [1]. The study presented in this paper is concerned with development of quasi-static loading protocol for experimentation of moment-resisting connections for structures located on soft soil sites. The knowledge of strength and deformation capacities of structural elements is necessary to seismic design of structures based on performance based design method. In many cases, experimental testing is required because the capacities cannot be predicted exactly by analytical modelling, thus quasi-static cyclic tests are typically conducted, which apply pre-defined displacement (or drift) histories, named loading protocols, at low velocity rates to structural members such as beam- column connections in steel structures. So, strength and deformation capacities of structures not only depend on structural configuration, but also on the imposed cumulative damage demand [2]. Hence, in order to provide accurate strength and deformation capacity estimates, appropriate loading protocols should reflect the estimated cumulative seismic demands in the regions of interest. Several loading protocols like SPD protocol [3], The New Zealand protocol [4], CUREE protocols [2], FEMA-461 protocols [5] and ISO protocol (ISO 2010) [6] have been developed in the literature for different types of structural and non-structural elements. All of these protocols have been developed without considering of site soil conditions for regions with high seismicity. However, large magnitude earthquakes typically impose higher cumulative damage demands especially in soft soils sites. In this research soft soil includes soil class E and defined as sites along rivers or other waterways underlain by deep soft clay deposits with shear wave velocity less than 600 ft/s. For this purpose, the seismic responses of seven, twelve and twenty-stories steel moment frames to a set of ground motions recorded in soft soil (NEHRP class E) were evaluated. Each record was scaled differently for each frame. The time histories responses in critical floors of studied frames were used as rainflow cycle counting algorithm inputs. By means of developed program, cycle counting starts at the beginning of time history. Once a cycle is counted and recorded, the peak and valley associated with the cycle are not considered for further cycle counting purposes. A cycle is counted when the second range in a peak-valley-peak or valley-peak-valley combination is greater than the first range. The cycle counted is defined by the first peak-valley or valley-peak combination. Finally, a loading protocol is proposed for moment resisting joints using statistical approaches. Statistical measures are necessary in order to achieve data reduction in a rational way. Developed quasi-static loading protocol can help to predict the probable behaviour of moment-resisting connections during an earthquake for structures located in site soil class E more accurately. Finally the comparison of the proposed protocol and former protocols was presented.

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