Performance-Based Seismic Evaluation of Precast Concrete Frames with Hybrid Connections

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Abstract

The unique features of hybrid frames, which include minimum structural damage when subjected to earthquake loadings, are the result of using a combination of mild steel reinforcement and unbonded pre-stressing to establish connections between precast beams and precast columns. Considering the combination of two different conceptual systems, namely Non Linear Elastic (NLE) and the Tension Compression Yielding (TCY), the cyclic moment-rotation behavior of the hybrid connection can be analyzed by individually modeling the behavior of unbonded tendons and mild steel. For performance base evaluation, six hybrid frames were modeled and analyzed under earthquake input motions corresponding to three intensity levels. At each intensity level, the damage state in the buildings was quantified using the maximum transient interstory drift. The seismic performance of hybrid frames satisfied the performance limits under earthquake input motions with intensities similar to or below that of the design-level earthquake.

Keywords: Precast concrete, Performance base evaluation.

1. INTRODUCTION

The rate of contribution of post tensioning tendons in the nominal moments is an important and effective factor on the nonlinear response of precast hybrid frame system. One of the main points that should be noted in designing a hybrid moment frame is to determine the distribution of the post tensioning in the height of a structure. So for a hybrid system, this distribution can be used based on the control of drift ratio of the structure [1]. Comparing the response of hybrid frames with monolithic frames, it became clear that the drift ratio in the hybrid frames is larger than the concrete frames, especially in the lower floors. The main reason for this difference is that a hybrid connection is a semi-rigid connection. To evaluate the pattern of distribution of the post tensioning in the height of structure, performance assessment of hybrid system are used. So in this study the nonlinear responses of hybrid frames, designed based on this method, are evaluated and verified.

For performance based seismic evaluation of hybrid moment frames, scaled input ground motions with specific hazard levels were used and responses of hybrid systems with nonlinear dynamic response history analysis for the performance levels compatible with the hazard levels were investigated. Also In this study, a nonlinear dynamic analysis was performed for each case using SAP2000 software.

2. SEISMIC HAZARD LEVEL

Based on the performance based seismic regulations of Structural Engineers Association of California ([1] SEAOC) as well as hazard levels used in test of a five-story building in PRESSS project, three levels of EQ-I, EQ-II and EQ-III were used to assess the hybrid moment resisting frames in this study (Figure 1)[2].

[1]. Structural Engineers Association of California, Performance-Based Seismic Engineering