Seismic Performance Assessment of Steel Frame Infilled with Prefabricated Wood Shear Walls

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Summary:

Steel-timber hybrid structural systems offer a modern solution for building multi-story structures with more environmentally-friendly features. This paper presents a comprehensive seismic performance assessment for a kind of multi-story steel-timber hybrid structure. In such a hybrid structure, steel moment resisting frames are infilled with prefabricated light wood frame shear walls to serve as the lateral load resisting system (LLRS). In this paper, drift-based performance objectives under various seismic hazard levels were proposed based on experimental observations. Then, a numerical model of the hybrid structure considering damage accumulation and stiffness degradation was developed and verified by experimental results, and nonlinear time-history analyses were conducted to establish a database of seismic responses. The numerical results further serve as a technical basis for estimating the structure's fundamental period and evaluating post-yielding behavior and failure probabilities of the hybrid structure under various seismic hazard levels. A load sharing parameter was defined to describe the wall-frame lateral force distribution, and a formula was proposed and calibrated by the time-history analytical results to estimate the load sharing parameter. Moreover, earthquake-induced non-structural damage and residual deformation were also evaluated, showing that if designed properly, desirable seismic performance with acceptable repair effort can be obtained for the proposed steel-timber hybrid structural system.

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