Seismic Reliability Analysis of a Timber Steel Hybrid System

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Summary:

Abstract Seismic reliability analyses account for the inherent uncertainties in both the actions (earthquakes) and the reactions (properties of the structural systems) of a structure. To predict the failure probability of a structure, the system response due to external loads is usually estimated by a numerical method. In this paper, seismic reliability analyses were performed on a novel timber-steel hybrid system labelled FFTT (Finding the Forest Through the Trees) system. The FFTT system utilizes mass-timber panels to resist gravity and lateral loads and interconnecting steel members to provide the necessary ductility for seismic demands. To reduce the computational effort for reliability analyses, Genetic Algorithms (GA) and Analysis of Variance in combination with response surface methods were applied and compared. Uncertainties involving ground motions, seismic weight, connection properties of the lateral load resisting system, and ductility factor were considered in formulating the performance functions. Mean and standard deviation of peak inter-storey drift were selected as performance criteria. Nonlinear dynamic analyses were run to generate the response database for the FFTT system and the reliability index was calculated using second-order reliability methods. The results showed that the GA method was superior and that the ground motion was the most significant factor for structural reliability, while the ductility factor, the structural weight, the hold-down and connection stiffness also played significant roles.

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