Abstract

Light-frame shearwall assemblies have been successfully used to resist gravity and lateral loads, such as earthquake and wind, for many decades. However, there is a need for maintaining the structural integrity of such buildings even when large openings in walls are introduced. Wood portal frame systems have been identified as a potential alternative to meet some aspects of this construction demand.

The overarching goal of the research is to develop wood portal frame bracing systems, which can be used as an alternative or in combination with light-frame wood shearwalls. This is done through investigating the behavior of wood portal frames using the MIDPLY shearwall framing technique. A total of 21 MIDPLY corner joint tests were conducted with varying bracing details. Also, a finite element model was developed and compared with test results from the current study as well as studies by others.

It was concluded from the corner joint tests that the maximum moment resistance increased with the addition of metal straps or exterior sheathings. The test results also showed a significant increase in the moment capacity and rotational stiffness by replacing the Spruce-Pine Fir (SPF), header with the Laminated Veneer Lumber (LVL) header. The addition of the FRP to the standard wall configuration also resulted in a significant increase in the moment capacity. However, no significant effect was observed on the stiffness properties of the corner joint.

The FE model was capable of predicting the behavior of the corner joints and the full-scale portal frames with realistic end-conditions. The model closely predicted the ultimate lateral capacity for all the configurations but more uncertainty was found in predicting the initial stiffness.

The FE model used to estimate the behavior of the full-scale portal frames constructed using the MIDPLY framing techniques showed a significant increase in the lateral load carrying capacity when compared with the traditional portal frame. It was also predicted using the full-scale FE model that the lateral load carrying capacity of the MIDPLY portal frame would increase with the addition of the metal straps on exterior faces.

A parametric study showed that using a Laminated Strand Lumber (LSL) header increased the lateral load carrying capacity and the initial stiffness of the frames relative to the SPF header. The study also showed that there was an increase in the capacity if high strength metal straps were used. Doubling of the nail spacing at header and braced wall segment had a considerable effect on the lateral capacity of portal frame. Also, the initial stiffness was reduced for all the configurations with the doubling of the nail spacing at the header and braced wall segment in comparison with the reference frame.