Abstract

In recent years, hybrid systems have grown in popularity as potential solution for mid-rise construction. There is also an increased interest in using timber for such systems. The lack of established design guidance, however, has tabled the practical implementation of timber-based hybrid structures. The aim of this thesis is to address the existing knowledge gap regarding the detailed connection design of hybrid systems through combined experimental and numerical investigations on a novel timber-steel system called “FFTT”. The FFTT system relies on wall panels of mass timber such as Cross-Laminated-Timber (CLT) for gravity and lateral load resistance and embedded steel beam sections to provide ductility under seismic loading. A vital step towards practical implementation of the FFTT system is to obtain the proof that the connections facilitate the desired ‘strong column – weak beam’ failure mechanism.

The numerical work applied the software ANSYS; a parametric study based on the results of previous tests was conducted to obtain a suitable connection configuration for improved structural performance. The experimental work, carried out at FPInnovations, consisted of quasi-static monotonic and reversed cyclic tests on two different connection configurations: fully and partially embedded ASTM wide flange sections in combination with 7 ply CLT panels. The combination of partial embedment length and full embedment depth, even when using the smallest wide flange section, did not facilitate the desired behavior. The connection performance was significantly improved when reducing the embedment depth (to avoid creating stress peaks on a weak cross layer) and increasing the embedment length (larger center to center distance between bearing plates). The used small size steel beam, however, is not practical for a real structure; therefore, further studies with larger beams and a modified geometry are recommended before the FFTT system can be applied in practice.