ABSTRACT

Zhu, Qiaqia. M.S.C.E., Purdue University, October 2014. Fire Behavior of Bolted Connections. Major Professors: Amit Varma, Mark Bowman.

Bolted connection failures have been observed in building fires and large-scale structural fire tests. Limited information is available on plate bearing behavior at elevated temperatures. The failure mode of a shear-tab connection could change from a plate bearing failure to a bolt shear failure between 400 (degree Celsius) °C to 600°C. Component-based models have been used to predict the behavior of bolted connections. Earlier researchers have developed simple mathematical models to represent the force-displacement relationships of bolt shear and plate bearing components of bolted connections. However, these models need to be verified experimentally for US building construction and materials. Therefore, eleven single-bolted lap joint specimens were tested in this research to achieve two objectives. Four specimens were used to evaluate bolt shear behavior at 400°C and 600°C. Seven specimens were tested to evaluate plate bearing behavior at 400°C and 600°C. Finite element analysis (FEA) models of single-bolted lap joints were developed and benchmarked using experimental data. Additionally, twenty eight FEA models were analyzed to evaluate the effect of parameters such as edge distance and plate thickness on the behavior of single-bolted lap joints at elevated temperatures. The experimental and analytical results were used to adjust the force-displacement relationship developed by earlier researchers. Overall, the study will help engineers to model and evaluate the fire performance of shear-tab connections.