ABSTRACT

Fire is an extreme event that can lead to failure of structural components and potentially collapse of the structural system or sub-systems. Currently, there are no comprehensive, research-based methodologies for performance-based fire structural design (PBFSD) of composite wall-to-floor connections subjected to gravity loads and realistic fire scenarios. The existing studies primarily focus on the performance of simple shear connections to steel columns, and lack approaches for structural design of floor systems and their connections to walls (wall-to-floor connections) at elevated temperatures. This study addresses the need for evaluating the performance of composite floor systems and composite wall-to-floor connections under fire loading and developing research-based approaches to conduct performance-based structural design of these systems at elevated temperatures.

This study aims to give a simpler design method for shear tab and single angle shear connections at elevated temperatures by specifying retention factors for steel yield strength, ultimate strength, bolt material strength, and weld metal strength at elevated temperatures. The connection limit state equations specified in AISC Specifications are modified to incorporate these factors for higher temperatures. Additionally, an archetype building is designed and one floor system is evaluated using Finite Element Analysis (FEA) to assess the robustness of the structure and its resistance to collapse using PBFSD.

It also discusses the application of fire protection materials for steel members to resist fire scenarios for specified durations. Various fire scenarios, including ventilation-controlled and fuel-controlled fires were evaluated to assess localized behavior at the connection points and the overall behavior of the structural compartment. The FE analyses included various fire scenarios, compartment locations (interior, edge, or middle), and fire protection scenarios (2-hour rating fire protection, or no fire protection on interior beams). The composite floor system is evaluated for a combination of these scenarios under fire and gravity loading.

Through this study, a comprehensive analysis of the behavior of composite floors systems and associated connections in SpeedCore Wall Systems (C-PSW/CF) under fire loading is achieved.