Abstract for 2008 ASCE Structures Congress

FIRE LOAD BEHAVIOR OF STEEL BUILDING COLUMNS WITH DAMAGED SPRAYED FIRE RESISTIVE MATERIAL

Stephen Pessiki
Professor and Chairperson
Department of Civil and Environmental Engineering
Lehigh University, Bethlehem PA 18015, USA, pessiki@lehigh.edu

Kihyon Kwon
Graduate Research Assistant
Department of Civil and Environmental Engineering
Lehigh University

Byoung-Jun Lee
Staff Engineer
WDP and Associates, Inc.

Current U.S. practice in steel building construction is to use fire protection materials such as sprayed fire resistive material (SFRM) to thermally protect structural steel columns in fire. During construction or occupancy, the SFRM may become damaged - either complete removal or reduction in thickness of SFRM. Damaged SFRM may reduce the structural performance of steel columns at elevated temperature during fire events.

Analyses were performed to examine the fire load behavior of steel columns with damaged SFRM subjected to concentric axial compression. The columns treated in the research are W14x109 sections typical of multi-story steel building construction practices in the U.S. Nonlinear heat transfer analyses were performed to predict the temperature distribution in the steel columns under the action of the ASTM E-119 curve. Nonlinear structural analyses were then performed to evaluate the influence of temperature on column axial load behavior. Variables treated in the analyses include size and location of damaged SFRM, and fire duration.

Results show that complete removal of a relatively small patch of SFRM causes a dramatic temperature increase in the steel column at any fire duration, and a significant reduction in axial load resistance of the column. For a given patch size of removed SFRM, the axial capacity of the steel column under the action of fire was more sensitive in the flange patch removal cases as compared to the web patch removal cases. Even small remnants of SFRM in cases where the SFRM was reduced in thickness led to an effective reduction of temperature at any given fire duration, and significantly improved the axial load capacity of a column as compared to the complete removal cases of SFRM. For a given reduction in thickness of reduced SFRM, the axial capacity of the steel column under the action of a fire was more sensitive in the flange reduction in thickness cases as compared to the web reduction in thickness cases.