ABSTRACT

Miamis, Konstantinos Ph.D., Purdue University, December 2007. A study of the effects of elevated temperature on structural steel framing. Major Professor: Mete A. Sozen.

The 9/11 terrorist attacks on the twin towers of the World Trade Center were one of the saddest events in history which resulted in a tragic loss of life. An understanding of the structural response of the North Tower (WTC 1) to the fire following the aircraft impact and the collapse sequence is necessary, so that similar attacks on high-rise buildings can be resisted with limited casualties and minimal structural damage. To this end, the effect of elevated temperature on the behavior of structural steel members was studied. The reduction of material properties, such as the yield stress and Young's Modulus with temperature was discussed. Experimental data from fire tests on structural steel members were presented and useful conclusions about the deflection characteristics, the critical temperature, the failure mode and the effect of important parameters, such as the loading level, the axial and rotational restraint, were drawn. Once the interaction between fire and steel members was studied, the thermal environment of North Tower was discussed. The structural system of the building was then analyzed in the discussed environment while taking into account the materials, the unique building structural characteristics, and the evidence (observed and inferred) of the initial damage of the impacted zone. Credible failure mechanisms for the North Tower structure were then identified and the dominant factors affecting them were established. The failure mechanism that most likely triggered the collapse initiation was identified.