

Examination of the graphs for the insulated steel pieces indicated the following:

- FSI captured the shape of the temperature rise at the steel surfaces and the significant decrease in the rate of temperature rise when the SFRM was present.
- The times to the peak temperature (or a near-plateau) were predicted to within about a minute in all cases.
- There was no consistent pattern of overprediction or underprediction of the surface temperatures.
- On the average, the numerical predictions of the steel surface temperature were within 7 percent of the experimental measurements for bare steel elements and within 17 percent for the insulated steel elements. The former was within the combined uncertainty in the temperature measurements and the heat release rate in the fire model. The increase in the latter was attributed to model sensitivity to the SFRM coating thickness and thermal conductivity.

In general, the FSI added little to the overall uncertainty in the simulation of the temperatures at the outer surfaces of bare steel elements and, more importantly, at the SFRM-steel interface.

An additional, important outcome of the experiments was the demonstration of the insulating effect of even 3/4 in. of SFRM. Trusses, made of relatively thin steel, were far more susceptible to heating than the perimeter and core columns. As shown in Figure 2–10, in 15 min, a bare truss reached a temperature at which significant loss of strength was imminent. An identical, but insulated truss had not reached that temperature in 50 min.

6.12.5 The Four Cases

FSI imposed the thermal environment from each of the four FDS fire scenarios (Cases A and B for WTC 1 and Cases C and D for WTC 2) on the four damaged structures from the aircraft simulations, which carried the same case letters. The FSI output files carried the same case letters as the input files.

The FSI calculations were performed at time steps ranging from 1 ms to 50 ms. Use of the resulting data set for structural analysis would have required a prohibitive amount of computation time. Thus, for each case, the instantaneous temperature and temperature gradient for each grid volume was provided at 10 min intervals after aircraft impact. For WTC 1, there were 10 such intervals, ending at 6,000 s; for WTC 2 there were 6 intervals, ending at 3,600 s. Comparison of these coarsely timed output files with files at 1 min resolution showed any differences to be within the combined uncertainty.

Each floor in the FSI simulation provided thermal information for the floor assembly above. Thus, there was not sufficient information for FSI to model the lowest floor in the FDS simulations. For WTC 1, the global thermal response generated by FSI included floors 93 through 99; for WTC 2, the included floors were 79 through 83.