

4.3.3 Fire-induced Thermal Effects

- Calculated fire-elevated temperatures in the interior columns, including Columns 79, 80, and 81, stayed below 200 °C on all of the floors. The exterior column temperatures were below 150 °C (300 °F), except on Floors 12 and 13, where the east and south exterior columns reached 300 °C (570 °F). At these temperatures, structural steel experiences relatively little loss of strength or stiffness. Thus, WTC 7 did not collapse due to fire-induced weakening of critical columns.
- The simulated fires on Floors 7, 12, and 13 heated portions of the tops of the floor slabs to over 900 °C (1650 °F). In all cases, significant temperature gradients were observed through the thickness of the slab. The temperatures of some sections of the beams supporting Floors 8, 12, 13, and 14 exceeded 600 °C (1100 °F). The temperatures of some sections of the floor beams at Floors 9 and 10 reached 400 °C (750 °F).
- Raising the fire-generated air temperatures by 10 percent, which was within the range of reasonable and realistic fires, raised the peak temperatures in the floor beams and slabs by about 70 °C (170 °F). Additionally, the areas over which the temperatures of the floor beams exceeded 600 °C (1100 °F) increased. A 10 percent increase in temperature resulted in a roughly 30 percent increase in the heat flux to structural members. Comparable changes in the opposite direction resulted from lowering the fire-generated air temperatures (Case A).

4.3.4 Structural Response and Collapse

Initiating Event

- The buckling failure of Column 79 between Floor 5 and Floor 14 was the initiating event that led to the global collapse of WTC 7. This resulted from thermal expansion and failures of connections, beams, and girders in the adjacent floor systems.
- The connection, beam, and girder failures in the floor systems, and the resulting structural responses, occurred primarily at temperatures below approximately 400 °C (750 °F), well below the temperatures at which structural steel loses significant strength and stiffness.
- Thermal expansion was particularly significant in causing the connection, beam, and girder failures, since the floor beams had long spans on the north and east sides (approximately 15 m, 50 ft).
 - Heating of the long beams resulted in proportionately large thermal elongation relative to the other components of the floor system, in effect, compressing the beams along their length. This led to distortion of the beams and breaking of the connections of the beams to the floor slabs. Furthermore, the simple shear connections used in the typical floor framing were not able to resist these axial compressive forces that developed as the floor framing was heated.
 - At Column 79, heating and expansion of the floor beams in the northeast corner caused the loss of connection between the column and the key girder. Additional factors that