

tank supplying these floors, the sprinkler system could not function when the only source of water, which was from the street mains, was not available.

- The passive fire resistance design of the WTC 7 structural system was based on catalogued ASTM E 119 test data. Practice today (and in the 1980s) for the fire resistance design of structures, based on the use of ASTM E 119 standard test method, is deficient since the method was not designed to include key fire effects that are critical to structural safety. Specifically, such practice does not capture: (a) important thermally-induced interactions between structural subsystems, elements, and connections—especially restraint conditions; (b) system-level interactions—especially those due to thermal expansion—since columns, girders, and floor subassemblies are tested separately; (c) the performance of connections under both gravity and thermal effects; and (d) scale effects in buildings with long span floor systems.
- Determination of the actual fire performance of the WTC 7 structural system was not the responsibility of any of the design professionals associated with the design, construction, or maintenance of WTC 7. This was typical of practice in the 1980s, and continues to be the practice today. Current practice also does not require design professionals to possess the qualifications necessary to ensure adequate passive fire resistance of the structural system. In current practice, architects typically rely on catalogued ASTM E 119 test data to specify the required passive fire protection that is needed for the structure to comply with the building code. They are not required to explicitly evaluate the fire performance of the structure as a system (such as analyzing the effect of the thermal expansion or sagging of floor beams on girders, connections, and/or columns). Structural engineers are not required to consider fire as a load condition in structural design. Fire protection engineers may or may not be called upon to assist the architect in specifying the required passive fire protection. Thus, none of these professionals has been assigned the responsibility to ensure the adequate fire performance of the structural system.
- The design of WTC 7 did not include any specific analysis of how the structural system might perform in a real fire. There is a critical gap in knowledge about how structures perform in real fires, particularly considering: the effects of the fire on the entire structural system; the interactions between the subsystems, elements, and connections; and scaling of fire test results to full-scale structures (especially for structures with long span floor systems).

## **14.3 THE MECHANISMS OF BUILDING COLLAPSE**

### **14.3.1 Debris Impact Damage from the Collapse of WTC 1**

- WTC 7 was damaged by debris from the collapse of WTC 1, which occurred at 10:28:22 a.m. However, WTC 7 collapsed at 5:20:52 p.m., nearly seven hours later.
- The structural damage to WTC 7 was primarily located at the southwest corner and adjacent areas of the west and south faces, on Floors 5 through 17. Severed columns were located between Floors 7 and 17 on the south face (six columns) and the west face (one column) near