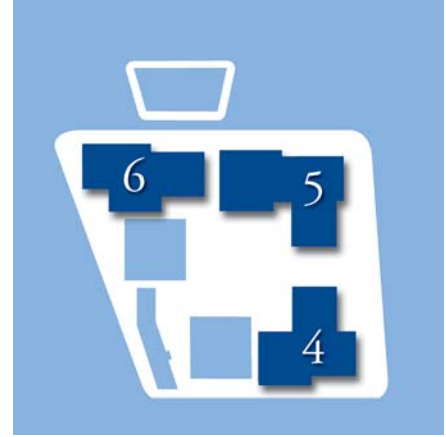


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4 *WTC 4, 5, and 6*

4.1 Design and Construction Features

WTC 4, 5, and 6 are eight- and nine-story steel-framed office buildings, located on the north and east sides of the WTC Plaza, that were built circa 1970. The buildings had a range of occupancies, including standard office and retail space. There were underground parking facilities and access to the WTC Concourse, as well as the Port Authority Trans-Hudson (PATH) and New York City subway system.

Because of their close proximity to WTC 1 and WTC 2, all three buildings were subjected to severe debris impact damage when the towers collapsed, as well as the fires that developed from the debris. Most of WTC 4 collapsed when impacted by the exterior column debris from WTC 2; the remaining section had a complete burnout. WTC 5 and WTC 6 were impacted by exterior column debris from WTC 1 that caused large sections of localized collapse and subsequent fires spread throughout most of the buildings. All three buildings also were able to resist progressive collapse, in spite of the extensive local collapses that occurred.

This chapter describes the design and construction features of these buildings and observed damages. Site observations of damage in WTC 5 and WTC 6 were conducted by team members, although access in WTC 6 was severely limited. WTC 4 was declared unsafe, and no access was allowed.

All three buildings were designed by Minoru Yamasaki & Associates, Architects; Emery Roth & Sons, Architects; and Skilling Helle Christiansen Robertson, Structural Engineers. The buildings had similar design features, but their configurations were somewhat different. Therefore, because most site observations were made in WTC 5, the following discussion focuses primarily on this building, and is assumed to be applicable to all three structures.

4.1.1 Structural Design Features

WTC 5 was located in the northeast corner of the WTC Plaza. The nine-story building was L-shaped in plan, with overall dimensions of 330 feet by 420 feet, providing approximately 120,000 square feet per floor (Figure 4-1). Floors were constructed of 4-inch-thick lightweight concrete fill on metal deck (with a combined thickness of 5-1/2 inches), supported by structural steel framing. The steel floor frame had shear studs welded to the top flange to create a composite floor system with the concrete deck. Wide-flange structural columns were placed on a regular 30-foot-square grid pattern. The floor plates cantilevered out 15 feet from the exterior column lines on all sides. To support this cantilever and provide the basic lateral resistance for the structure, a pair of W27 wide-flange beams were provided at each column line. These doubled wide-flange beams extended between the two outermost column lines, forming a moment-resisting frame, and cantilevered past the outer columns.

Floor beams were typically W16 wide-flange members. At interior column lines, a column-tree system was used, in which a 4-foot-long stub was shop-welded to the column on each side, and the floor girder was