

Fire-induced thermal expansion of the floor system surrounding Column 79 led to the collapse of Floor 13, which triggered a cascade of floor failures. In this case, the floor beams on the east side of the building expanded enough that they pushed the girder spanning between Columns 79 and 44 to the west on the 13th floor. (See Figure 1–5 for column numbering and the locations of girders and beams.) This movement was enough for the girder to walk off of its support at Column 79.

The unsupported girder and other local fire-induced damage caused Floor 13 to collapse, beginning a cascade of floor failures down to the 5th floor (which, as noted in Section 1.2.3, was much thicker and stronger). Many of these floors had already been at least partially weakened by the fires in the vicinity of Column 79. This left Column 79 with insufficient lateral support, and as a consequence, the column buckled eastward, becoming the initial local failure for collapse initiation.

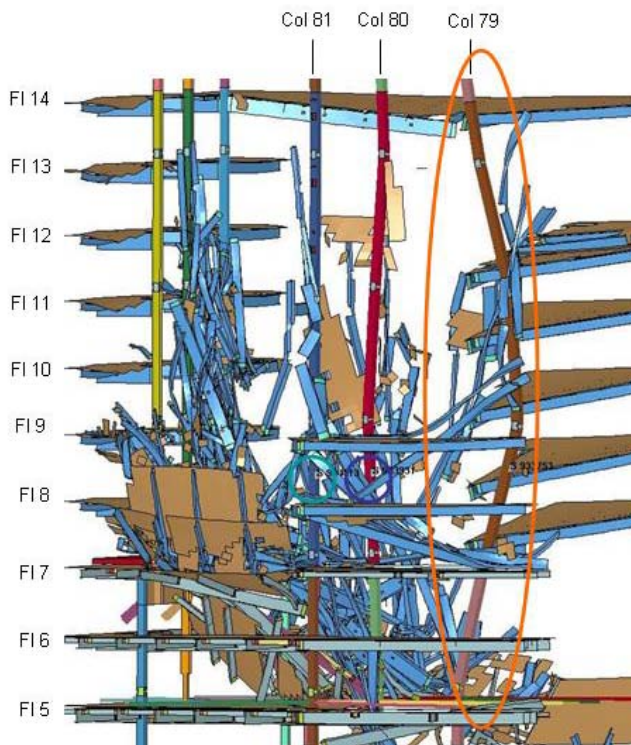


Figure 2–2. Eastward buckling of Column 79, viewed from the southeast.

Due to the buckling of Column 79 between Floors 5 and 14, the upper section of Column 79 began to descend. The downward movement of Column 79 led to the observed kink in the east penthouse, and its subsequent descent. The cascading failures of the lower floors surrounding Column 79 led to increased unsupported length in, falling debris impact on, and loads being re-distributed to adjacent columns; and Column 80 and then Column 81 buckled as well. All the floor connections to these three columns, as well as to the exterior columns, failed, and the floors fell on the east side of the building. The exterior façade on the east quarter of the building was just a hollow shell.

The failure of the interior columns then proceeded toward the west. Truss 2 (Figure 1–6) failed, hit by the debris from the falling floors. This caused Column 77 and Column 78 to fail, followed shortly by Column 76. Each north-south line of three core columns then buckled in succession from east to west, due to loss of lateral support from floor system failures, to the forces exerted by falling debris, which