How the Loss of One Column May Have Led to the Collapse of WTC 7
By Ramon Gilanz, P.E., S.E., and Willa Ng

The collapses of World Trade Center 1 (WTC 1) and World Trade Center 2 (WTC 2) on September 11, 2001 were attributed to the impact of two airplanes and the ensuing fires. The subsequent collapse of World Trade Center 7 (WTC 7), which was not directly struck by airplanes, is more of an enigma. Additionally, the nature of its collapse, which occurred nearly seven hours after WTC 1 and WTC 2 failed, has led to rampant speculation.

The following analysis shows that, although there were several phases leading to the global collapse of WTC 7, the building likely would have remained standing if not for the failure of one critical column. The location of this column, and its role as a key structural component, meant that its local failure caused the global failure of WTC 7.

The Federal Emergency Management Agency (FEMA) Building Performance Assessment Team and the National Institute of Standards and Technology (NIST) formed a team to analyze the collapse of WTC 7. The effort began with the collection of structural pieces, existing plans, eyewitness accounts, and photos and videos taken that day. This information led to the formation of several probable collapse theories. The team then created a computerized model of the building, using existing plans and information, to test these theories.

WTC 7, one of the seven buildings that formed the World Trade Center complex in New York City, was bounded by Washington Street, West Broadway, Barclay Street and Vesey Street. This 47-story commercial office building was approximately 330 feet long, 140 feet wide and 610 feet tall, and was constructed over a pre-existing electrical substation owned by Con Edison. The original plans for the substation included the construction of a high-rise tower above it. However,
During the collapse, a kink develops in the east penthouse before it falls into the building. The west penthouse then fails, followed by a kink in the entire façade of the building. Total collapse follows. This sequence of events, with roof elements sinking into a building with an intact façade, suggests an interior failure. An interior failure would explain the appearance of a “controlled” collapse with a relatively small debris field, as seen with WTC 7.

The sequence of final collapse can be interpreted using knowledge of the building’s framing from existing plans. For instance, the observed collapse of the east penthouse may signify a failure in a line of columns (columns 76-81). In particular, interior columns were numbered for ease of identification and will be referred to by their number herein.

The failure of WTC 1 and WTC 2 sent flaming debris into the southern face of WTC 7. This impact and fire damage initiated a sequence that would lead to global collapse. Eyewitness observations by building occupants, NYPD, FDNY and bystanders indicated that the damage was located on the south face between floors 8 and 18, and that there was a fully involved fire on the south side of floor 7, which included the transfer elements. From 3:00 to 5:00 PM, fires were still burning in the building, which may explain why it took several hours for it to collapse. The continued heat of the fire weakened steel structural components until they failed at 5:21 PM, nearly seven hours after the collapse of WTC 1 and WTC 2.

**WTC 7 Collapse Sequence and Observations**

The final collapse of WTC 7 occurred over 8.2 seconds and was recorded on several videos from locations northeast and northwest of the building. Study of these videos led to the development of the timeline of the visible external sequence of events. The images accompanying this article are taken from a CBS News Archives video to show key points observed during the collapse. As seen in the photos, a kink develops in the east penthouse before it falls into the building. The west penthouse then fails, followed by a kink in the entire façade of the building. Total collapse follows.

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Start of the final collapse sequence (7.7 seconds elapsed). Note that the kink in the east penthouse in the first photo “shifts” towards the middle of the building in the fourth photo, indicating horizontal progression of the collapse.
significant, should have caused no more than local failure of structural components. That is, buildings should be designed to survive a local failure, due to blast, fire, impact, etc. but prevent the progression of a collapse throughout the structure.

Further Reading

National Institute of Standards and Technology (June 2004), Interim Report on World Trade Center 7, Appendix L


Acknowledgements

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