Columbia News
the Public Affairs and Record Home Page

Damage to Buildings Near WTC Caused by Falling Debris and Air Pressure Wave, Columbia Seismologists Report

By Abigail Beshkin

On September 11, seismographs operated by Columbia University's Lamont-Doherty Earth Observatory in Palisades, New York, recorded seismic signals produced by the impacts of the two aircraft hitting the Twin Towers of the World Trade Center and the Towers' subsequent collapse. While the ground shaking was consistent with the energy released by small earthquakes, it was not sufficient to cause the collapse of or damage to the surrounding buildings, as some have thought. Rather, the buildings around the Twin Towers were impacted both by the kinetic energy of falling debris and by the pressure exerted on the buildings by a dust- and particle-laden blast produced by the collapse.

Writing in the November 20 issue of Eos, published by the American Geophysical Union, seismologists from Columbia's Lamont-Doherty Earth Observatory outline the sequence of seismographic recordings on that tragic day, and argue that vibrations recorded on September 11 were of a magnitude thought to be too low to cause structural damage to buildings, especially in the northeast region of the United States.

However, the authors add that because there were no seismographic stations in or even near the World Trade Center, it is impossible to know for sure that the ground-shaking did not have any impact on the neighboring buildings. Ultimately, they say, urban officials should consider the importance of placing seismographic stations in high-density urban areas.

"Our recordings were made at considerable distance," said Won-Young Kim, who is in charge of seismological network operations for Lamont-Doherty. "However, plans are pending for an Advanced National Seismic System (ANSS) that calls for placing seismic instruments in such urban areas as New York City. The tragic events of September 11 show that such instrumentation can serve a purpose that sometimes transcends strict earthquake applications."

The paper was authored by 12 researchers at Lamont, including Kim; Lynn Sykes; Klaus Jacob, Paul Richards, and Arthur Lerner-Lam. Lerner-Lam is the director of Columbia's new Center for Hazards and Risk Research.

Lerner-Lam explained what happened once the planes hit the World Trade Center, and how they resulted in relatively small seismographic readings.

"The energy contained in the amount of fuel combusted was the equivalent to the energy released by 240 tons of TNT," said Lerner-Lam. "This energy was absorbed by the buildings and produced the observed fireballs, but did not immediately cause the collapse. During the collapse, most of the energy of the falling debris was absorbed by the towers and the neighboring structures, converting them into rubble and dust or causing other damage— but not causing significant ground shaking."

Seismographic recordings of the tower collapses were recorded in five states, as far away as 428 kilometers [266 miles] in Lisbon, New Hampshire. Lamont's home station, in Palisades, New York, is located above the Hudson River, 34 kilometers [21 miles] from downtown Manhattan, where the towers stood. The aircraft impacts registered local magnitude (ML) 0.9 and 0.7, indicating minimal earth shaking as a result. The subsequent collapse of the towers, on the

contrary, registered magnitudes of 2.1 and 2.3, comparable to the small earthquake that occurred beneath the east side of Manhattan on January 17, 2001.

The Lamont seismographs established the following timeline: 8:46:26 a.m. EDT [1240 UTC] Aircraft impact - north tower, Magnitude 0.9; 9:02:54 a.m. EDT [1302 UTC] Aircraft impact - south tower, Magnitude 0.7; 9:59:04 a.m. EDT [1359 UTC] Collapse - south tower, Magnitude 2.1; 10:28:31 a.m. EDT [1428 UTC] Collapse - north tower, Magnitude 2.3.

In addition, the seismic waves were short-period surface waves, meaning they traveled within the upper few kilometers of the Earth's crust. They were caused by the interaction between the ground and the building foundation, which transmits the energy from the impacts and the collapses.

The authors also noted that as seen in television images, the fall of the towers was similar to that of a pyroclastic flow down a volcano, where hot dust and chunks of material move in a dust/mud matrix down the volcano's slope. The collapse of the WTC generated such a flow, though without the high temperatures common in volcanic flows.

The Lamont-Doherty Earth Observatory operates 34 seismographic stations in the northeast in collaboration with several institutions. Network operations are supported by the United States Geological Survey. The network is part of the Advanced National Seismic System, a national seismological monitoring initiative being implemented through a USGS-university partnership.

Published: Nov 20, 2001
Last modified: Sep 18, 2002
