Pentagon Building Performance Study 2001

On September 11, 2001, a hijacked commercial airliner was intentionally crashed into the building in an act of terrorism. One hundred eighty-nine persons were killed and a portion of the building was damaged by the associated impact, deflagration, and fire.

That same day the American Society of Civil Engineers established a building performance study (BPS) team (that included one NIST researcher) to examine the damaged structure and make recommendations for the future. Team members possess expertise in structural, fire, and forensic engineering. The BPS team's analysis of the Pentagon and the damage resulting from the attack was conducted between September 2001 and April 2002.

The members of the BPS team inspected the site as soon as was possible without interfering with the rescue and recovery operations. They reviewed the original plans, the renovation plans, and available information on the material properties of the structure. They scrutinized aircraft data, eyewitness information, and fatality records; consulted with the urban search and rescue engineers, the chief renovation engineer, and the engineer in charge of the crash site reconstruction; and examined the quick, focused assessments of the disaster conducted by the United States Army Corps of Engineers and Pentagon Renovation Program staff.

The BPS team concluded that the impact of the aircraft destroyed or significantly impaired approximately 50 structural columns. The ensuing fire weakened a number of other structural elements. However, only a very small segment of the affected structure collapsed, approximately 20 minutes after impact. The collapse, fatalities, and damage were mitigated by the Pentagon's resilient structural system. Very few upgraded windows installed during the renovation broke during the impact and deflagration of aircraft fuel. The BPS team recommends that the features of the Pentagon's design that contributed to its resiliency in the crash—that is, continuity, redundancy, and energy-absorbing capacity—be incorporated in the future into the designs of buildings and other structures in which resistance to progressive collapse is deemed important. The team further advocates that additional research and development be conducted in the practical implementation of measures to mitigate progressive collapse and in the deformation capacity of spirally reinforced columns subjected to lateral loads applied over the height of the column.

The report, "*Pentagon Building Performance Report (January 2003)*," is available from the ASCE website (http://www.asce.org/Product.aspx?ID=2147485891).

Arlington, VA, September 21, 2001 -- The exterior of the Pentagon crash site is shown after the area has been stabilized by shoring structures. (Photo by Jocelyn Augustino/ FEMA News Photo)

Publications

Pentagon Building Performance Report (January 2003)

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