Collapse of the World Trade Center's Twin Towers a warning for the future

Better engineering of the World Trade Center would not have prevented the 9/11 attacks, but it might have reduced the number of casualties.

By Dean Poeth

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This Thursday marks the anniversary of the terrorist attacks on New York's World Trade Center. Seven years ago more than 2600 people lost their lives when two hijacked passenger jets were flown into these buildings. The collapse of the Twin Towers, like the attack on Pearl Harbor, was a short-term tactical victory for our enemies, but it was also an engineering failure.

Each tower survived the initial impact of the aircraft with only a relatively small loss of life, but why did the ensuing fires cause the collapse of the buildings only a few hours later? And why did fire and debris block all three of the supposedly fireproofed escape stairwells in each tower, preventing both the evacuation of the building's occupants and the firefighter's attempts to reach the fire? To answer these questions it is insightful to look at a similar disaster that occurred over half a century before.

JULY 28, 1945

On July 28, 1945 a B-25 twin engine bomber disoriented in the fog over New York City crashed into the Empire State Building at the 78th and 79th floors. The force of the impact sent one of the aircraft's engines clear through the building and out the other side. The other engine and landing gear entered an elevator shaft and fell 1,000 feet into the building's sub-cellar. As the airplane's gasoline exploded, flames rose up to the 86th floor, and burning gasoline ran down stairwells and into hallways as low as the 75th floor. The sound of the explosion was heard over a mile away.

The airplane's crew and 10 occupants of the building were killed, but the building's other occupants were able to evacuate using the heavily fireproofed stairwells. These same stairwells allowed firefighters to get to the fire and put it out in only 40 minutes, before it could weaken the steel structure (although even this was heavily fireproofed as required by New York City building codes). Portions of the building were reopened for business only a few days later.

Why such a difference in outcomes? Engineers are not in total agreement for several technical reasons, but the one difference that most agree on is the far more conservative design of the Empire State Building when compared to that of the World Trade Center. With its heavy steel girder construction, heavily fireproofed structural members, and heavily fireproofed masonry stairwells, the Empire State Building survived while the World Trade Center did not.

Investigators determined that the collapse of the Twin Towers on 9/11 was due to the heat from the fire distorting the thin steel used in the Twin Tower's structure (selected to save cost and weight) and also due to inadequate fireproofing. This distortion led to buckling, resulting in the collapse of the towers. Furthermore, the escape stairwells in each tower were inadequately fireproofed, preventing the escape of the occupants and blocking the firefighter's attempts to reach the fire.

The susceptibility of the World Trade Center to fire was known prior to September 11th. On February 13, 1975 an arsonist set fire to the north tower's 11th floor, and in only three hours it had spread to six other floors. This incident exposed the tower's vulnerability to fire, including, according to one source, the structure's dangerous susceptibility to heat-induced distortion.

EXEMPT FROM BUILDING CODES

The difference in fire resistance between the Empire State Building and the World Trade Center was primarily due to the Twin Towers' being granted exemptions from New York City building codes. This reduced their cost and weight, increased their height, and increased their profitability (since fireproofing consumes a significant amount of rentable floor space in a skyscraper). Conversely, the Empire State Building was required to adhere to New York City building codes, and its more conservative design and heavy fireproofing saved lives. According to Charles Harris in his book *Engineering Ethics: Concepts and Cases* (4th Ed., Wadsworth, 2008) many of the casualties of 9/11 can be directly attributed to this relaxing of the New York City building codes.

Most engineering failures share a common thread, the most noteworthy being that these disasters rarely occur without warning. For example, both the Columbia and Challenger space shuttles exhibited prior occurrences of the same failures that later caused their destruction; problems that were dismissed at the time as being unimportant. It's the same with the World Trade Center. If the lessons from the 1945 accident and the 1975 fire had not been disregarded, the casualty list from 9/11 might have been much shorter.

Every disaster presents an opportunity to learn. Tragedies like the collapse of the World Trade Center, along with many other failures, are used to teach engineers about ethical decision making. In this deadline driven world, tradeoffs between cost, ambition, and safety are not always obvious. The case of the World Trade Center is a lesson in incorrect choices and their ethical consequences; consequences that may have contributed to the deaths of over 2,600 people.

Better engineering of the World Trade Center would not have prevented the 9/11 attacks, but it may have reduced the number of casualties. If we learn from this and similar tragedies, perhaps in some small way we are honoring those who died. If not, history may someday rise up and repeat itself, unmercifully bringing with it the predictable consequences.

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