



Still concerned for safety

A couple of months have passed since the attack on the World Trade Center (WTC) towers, and yet there remains a sense of danger. Email messages predicting doom and nightly reports of evacuations of buildings due to terrorist threats contribute to the trepidation. Many of these threats have and will prove to be hoaxes as time goes by, but we know now that we can't take our safety for granted.

The catastrophe has made some people skittish about entering high rise buildings, subways, shopping centres and other areas reportedly designated for attack. Though there is certainly some reason for concern, many say there need not be panic.

Engineers have already and will continue to give thought to designing and managing vulnerability: Civil Engineering Research Foundation, based in Washington, D.C., held a conference on that very subject at the end of October. Grant Milligan, P.Eng., a consulting engineer and a principal in the Toronto-based firm Quinn Dressel Associates notes that "if our culture demands a greater protection for our buildings, then [the engineer's] role is clear." Below he has answered a few questions about building design, evacuation, and the engineer's role in all of this, which, hopefully, will set some of our minds at ease.

Q. *Are there any Ontario buildings with superstructure similar to that of the WTC towers?*

A. The two 110-storey towers of the WTC were designed with a central service core with an exterior tube. All of the framing elements were structural steel. What made the WTC structure so unique at the time of construction was the exterior tube. Composed of 450mm-square steel box columns spaced at 1.02m with steel plate spandrel panels 1.32m deep, the exterior wall acted in concert with the interior steel-framed service core to resist both gravity and wind-induced forces on the building.

In Toronto, the Scotia Plaza Tower and the BCE Complex are similarly conceived as exterior-braced tubes with an interior service core. Each of the Toronto buildings, however, used reinforced concrete as the structural material for each of the perimeter tubes and the interior concrete shear walls. I believe that these structures would have fared better had a similar attack taken place in Toronto. First, the closely spaced concrete elements around the perimeter would have created a much stronger barrier to the initial airplane impact and would likely have resulted in less penetration of the building initially. Second, the service cores and in particular the stair exits within these buildings are structured completely in reinforced concrete and would have survived the initial impact intact and likely would have remained serviceable to allow for exiting of the floors above. And third, the inherent fire resistance of the reinforced concrete elements would have, I believe, at a minimum provided a greater amount of time for the building evacuation to take place, and could well have mitigated against a total building collapse as occurred in New York.

Q. *How vulnerable to collapse is a typical high rise building?*

A. In the case of the WTC, the perimeter tube system survived the impact very well, and if the fire could have been dealt with quickly, I believe that the structure and the building as a whole could well have survived. Had the airplanes struck a more conventional building, it would have likely led to an immediate collapse of a portion or a side of the building. But clearly some building systems are more vulnerable than others to certain types of attack. The use of structural steel as a structural material has led to some great achievements in terms of height and length of span; it does, however, require careful attention to fire protection.

Q. *Is fire the greatest safety threat in these buildings?*

A. Fire in a high rise building has always been a major concern, simply due to the difficulty in delivering resources to fight the fire. In this case the extent and speed at which the fire was spread over a number of floors was the main undoing of the buildings' structure.

Q. *Do procedures for evacuation need to be changed in these buildings?*

A. Generally, no. A good evacuation plan prior to September 11 is still a good plan today. Emergency evacuation needs to be practised. Communication within the building could be improved, though. The use of battery-powered speaker systems with radio links to emergency personnel outside of the building seems like a simple and inexpensive solution.

There have been reports that the fire and rescue personnel had difficulty in ascending the stairs as tenants were descending, and that wider stairs would have been useful. There are dedicated fire-fighter elevators; perhaps we should have dedicated stairways as well.

Q. *What will change about how high rise buildings are constructed in the future? What changes, if any, will result from these attacks?*

A. The fire protection of buildings, particularly those constructed with structural steel, should be reviewed. For instance, why were the stairwells impassable at the impact floors? The walls surrounding the stairs and other critical functions could have been designed to withstand a greater impact force without dramatically increasing the cost of the structure.

Could we have done better in protecting the structural elements? The answer is probably yes. How are smoke evacuation measures achieved when the power from either the main power source or the emergency diesels is physically severed? Could remote generators be hooked up to the building's system in a manner similar to the way sprinkler mains are fed from the street level and the power used to operate exhaust or pressurization fans for the stairwells? Again, issues like this can be introduced into the building's design without financially crippling the development.

High rise buildings have become a part of our collective culture. We can initiate smart and effective changes without losing part of our identity.

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