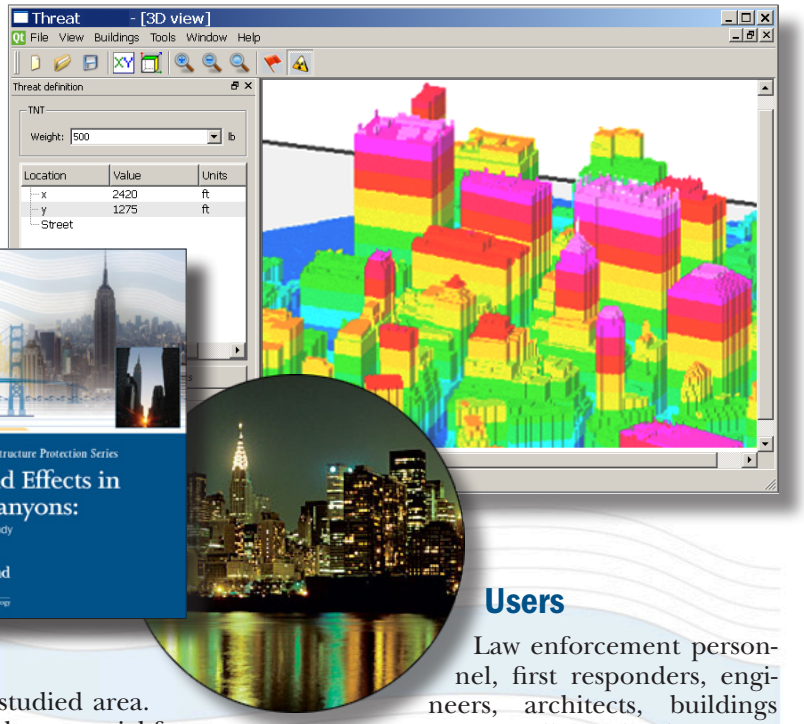
Blast Load Effects in Urban Canyons– The Urban Blast Tool (UBT)

Overview

Since 2008, the U.S. Department of Homeland Security (DHS) Science and Technology (S&T) Directorate's Infrastructure Protection and Disaster Management Division (IDD) has been working to develop different methods for the rapid evaluation of significant damage to buildings resulting from explosive attacks in large urban centers. For this study, the streetscapes of the New York City Financial District were modeled to represent the surfaces of all the buildings and the geometry of all the streets and alleys. Extensive Computational Fluid Dynamics analyses were performed for different size explosive threats and the results were stored in the UBT. Nonlinear explicit dynamic finite element analyses were performed for representative structures to determine the effectiveness of the simplified methods to evaluate the potential for progressive collapse.



Project Outputs

- The UBT allows the user to select a detonation size and location and accurately calculate the blast loading, within seconds, of any building within the studied area. The UBT identifies the likelihood for column failure and the potential for progressive collapse on various structural systems in response to blast loads in dense urban areas.
- A report on the analysis and calculation of different types of buildings (steel moment frame, concrete moment frame, flat plate construction, and concrete shear wall buildings with associated floor framing systems) to determine their sensitivity to progressive collapse following the removal of key first floor structural elements.
- A study of structural response, emergency evacuation, rescue and recovery systems. These systems include egress stairway enclosures, stair pressurization systems, fire doors, fire/smoke detection systems, sprinkler pipe systems, emergency communication/fire alarm systems, emergency lighting, emergency generators, emergency elevators, air ducts, and conduit chases.

Challenges

The research undertaken by this project is very unique. Only sophisticated analytical methods are able to account for the shadowing and focusing that occurs as blast waves propagate through dense urban environments, reflecting off of buildings and diffusing around corners. In addition, the UBT allows the user to select different blast charges at specific locations to understand the response of buildings to blast loads and progressive collapse, as well as the threshold failure of emergency and response equipment. The wide deployment of the UBT is being carefully evaluated and considered by DHS S&T IDD.

Users

Law enforcement personnel, first responders, engineers, architects, buildings owners, as well as federal agencies and state and local governments.

Future Expansions

The current UBT tool was designed for the NYC Financial District and has already been deployed to a 24/7 organization in NYC. Future UBTs are being designed for NYC Mid-Manhattan, downtown Chicago, and Washington, DC. Expanded versions will incorporate more detailed collapse prediction algorithms and data fields that can be entered for each building within the studied area to accommodate building specific performance characteristics. These fields will identify the location of the different emergency and response systems and structural details that influence the potential for progressive collapse. In addition a UBT generic version, useful to all U.S. cities, is under development.

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