



## Vulnerability of Infrastructures to Explosions and subsequent Progressive Collapse

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## Summary

Nowadays, terroristic attacks with explosive devices are no longer restricted to regions with open conflicts. One consequence is that security issues have become more and more important especially in cities. Therefore, urban planners have to think about security and consider this issue during their work. This was the starting point for the research project VITRUV. Within this project one important task is to analyse the structural safety of typical urban infrastructures during and directly after an explosion. The progress from the structural engineer's point of view is that not only the direct effects due to an explosion will be calculated but also the consequences of a possible progressive collapse initiated by the explosion. The findings of the research work are twofold. Firstly, urban planners will be qualified to design safer urban areas. Secondly, structural engineers will improve their knowledge regarding actions due to explosions and subsequent progressive collapse.

**Keywords:** Building, urban infrastructure, explosion, progressive collapse, safety.

## 1. Introduction

Nowadays, terroristic attacks with explosive devices are no longer restricted to regions with open conflicts. This is clearly shown by the recent incidences in Oslo (2011), London (2005) or Madrid (2004). One consequence of these incidences is that security issues have become more and more important especially in cities, which seem to be major targets for terroristic attacks. In a first reaction, the police and the city authorities started to improve our level of security immediately. But in order to achieve a higher level of security in the long term, even urban planners have to think about security and consider this issue as a further boundary condition during their work.

This was the starting point where the research project Vulnerability Identification Tools for Resilience Enhancement of Urban Environments (VITRUV) [1] started three years ago. The objective of this research project, which is co-funded by the European Union, is to develop tools that enable urban planners to consider security issues professionally during their design work. Within the VITRUV-project one important task is to analyse the structural safety of typical urban infrastructures during and directly after an explosion. This is done by investigating 10 different building types which reflect well our European urban infrastructure. The progress from the structural engineer's point of view is that for these buildings not only the direct effects due to an explosion will be calculated but also the consequences of a possible progressive collapse which might be started off by local damage due to the explosion.