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VITRUV

VULNERABILITY IDENTIFICATION TOOLS FOR RESILIENCE ENHANCEMENTS OF URBAN ENVIRONMENTS

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VITRUV

The VITRUV tool offers to urban planners and architects unique risk analysis capabilities combined with a user friendly intuitive graphical user interface.
It is the result of the EU FP7 project VITRUV (www.vitruv-project.eu), which was accomplished together with end users from Bologna, Copenhagen, Dublin, London and West Yorkshire.

Features

- Easy generation of urban models from digitized 2D maps or 3D AutoCAD .dxf files
- Choice of numerous predefined urban building and traffic objects
- Empirical Risk Analysis (ERA) for weak spot identification using historical data
- Vulnerability assessment with Quantitative Risk Analysis (QRA)
- Resilience enhancement
- Cost-benefit analysis for enhancement measures
- Spreadsheet export of result data.

Hot spot identification with Empirical Risk Analysis (ERA)

The VITRUV software helps city planners with empirical risk analysis based on the comprehensive terrorist event database (TED) in detecting potentially threatened points in their urban area models.

For each building, empirical frequency of hazardous events are shown (Figure 3) as well as empirical consequences per event. The in-built algorithms allow easy but quantitative identification of potential hot spots at risk.

A hands-on access to security relevant knowledge is supported by links to the conceptual planning tools SecuRbAn and Securipedia (www.securipedia.eu).

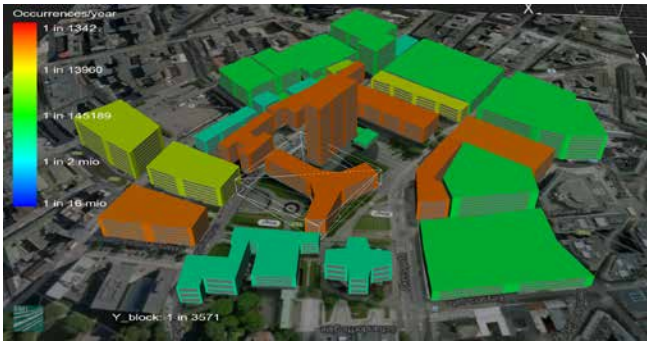

Fig. 3: Empirical frequency of hazardous events in dependency of the building usage in an urban area.

Vulnerability assessment with Quantitative Risk Analysis (QRA)

Beside the empirical risk analysis, the VITRUV tool is also able to evaluate the quantitative risk using validated physical and engineering models. A fast assessment provides results for consequence evaluation of:

- Damage to persons
  (in buildings or open space)
- Structural damage
  (glazing failure or progressive collapse of buildings; traffic infrastructure)
- Economic damage
  (buildings; direct or indirect costs for traffic infrastructure).

1 *3D CAD model of an urban area.*

2 *The imported urban area model in the VITRUV software.*

For evaluation of the structural damage, numerous pre-defined building types and uses are implemented.
They provide construction details from a single family house up to a public transport terminal or a high-rise building and cover the majority of existing cities. A detailed collapse analysis was carried out and implemented as basis for consequence assessment.
Figure 6 shows an example of the pre-defined buildings and the definition of possible scenarios.

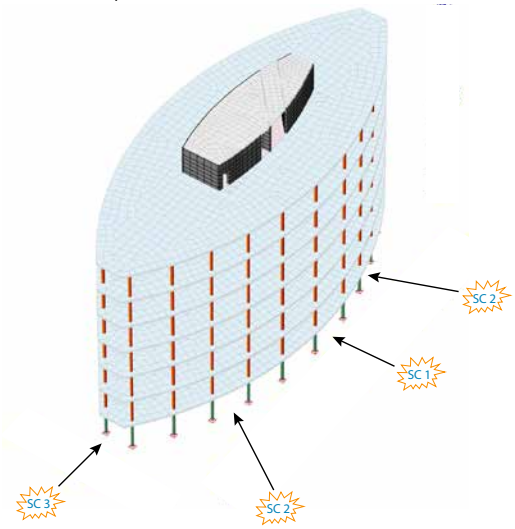

Fig. 6: Pre-defined office building and scenario definition as basis for consequence assessment concerning structural and economic damage.

Validation of the software in comparison to a real attack (Oslo 2011)

For validation of the VITRUV software, a back calculation of the Oslo attack on July 22, 2011 has been conducted. In comparison, the results show a good agreement concerning the human injury and structural damage estimation.

Figure 4 shows the results for the calculated damage for glazing facades, comparing to improvements using security glazing in Figure 5.

The licensed software allows a vulnerability analysis by automated calculation of multiple events to identify the best location for improvements.

Security and resilience enhancement measures

With VITRUVs countermeasures, it is possible for architects and city planners to increase the resilience of their urban areas significantly during the planning phase already. Therefore, VITRUV offers various kinds of building reinforcement with cost calculation:

- Security glazing
- Ductile concrete
- Highly reinforced concrete
- Enhanced masonry and strongly enhanced masonry.

Some types of enhancement such as enhanced masonry can also be applied to existing buildings.

Experimental validation

The high-speed dynamic engineering models behind the quantitative risk analysis are based on physical experiments such as shocktube and full-scale blast experiments for various materials. An example for experimental investigation of a masonry retrofit application is shown in Figure 9. This product prevents a penetration of fragments into the building and provides an excellent security measure.

4 *Visualization of damage for glazing facades in an urban area.*

5 *Visualization of damage for enhanced security glazing facades in an urban area.*

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A further example is shown in Figure 7 and 8. These pictures show the comparison of normal to security glazing due to an experimental investigation at the Fraunhofer EMI shock tube facility BlastSTAR.

Fig. 9: Experimental full-scale investigation of the TecDur® BlastWall protection system.
Left: Internal view during the test. Right: External view after the test.

Required Resources

VITRUV can be run on standard PCs or notebooks. Memory, CPU and graphics cards requirements depend on the urban area model sizes the user wishes to simulate. For typical applications, a memory of 2 GB is recommended as well as a CPU with at least 2 GHz and a graphics card with 128 MB.

7 *Experimental shock tube investigations for normal glazing.*

8 *Experimental shock tube investigations for security glazing.*

Contact

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