The value of blast resistant testing, standardization and certification

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TNO

- The largest Dutch research organisation
- TNO stands for applied scientific research
- Research on all kinds of topics, clustered as:
  - Health
  - Industrial innovation
  - Safety and security
  - Energy
  - Mobility
  - Build environment
  - ICT

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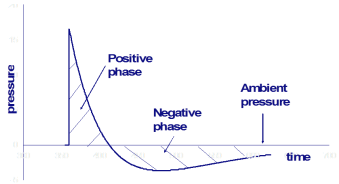
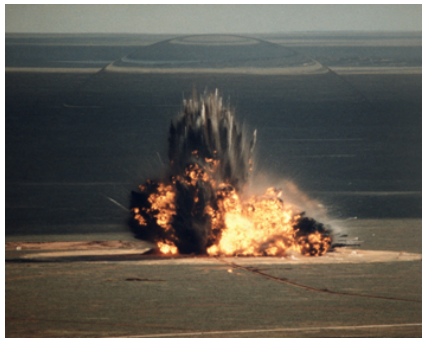
What is blast?

- The pressure wave that expands from an explosion into the air.
- The pressure is very high, but very short.
- The explosion can be an accident (dangerous goods), or it can be an intended one (e.g. terrorism)





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Blast causes damage and injuries

- Direct / primary consequences
  - Blast injuries and lethality, ear drum rupture, lung collapse, turnover
  - Window failure
  - Wall and column failure
  - Vibrations of a building
- Secondary effects / hazards:
  - Glass fragments
  - Building collapse
  - Debris from walls and roofs
  - Vibrations
  - Dust

➔ Blast resistant designs needed

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Blast resistant design - challenges

- Damage is allowed, as long as it does not cause unacceptable hazards and consequences and as long as the structure provides sufficient shielding.
- Strategy: use failure to prevent worse.

Need for hazard classification!

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Example of (acceptable) failure!

Blast resistant design – technical challenges

- Far beyond standard design principles; prediction of amount of damage and hazard is very challenging.
- Blast protection should not interfere with primary functions and normal use.

Testing is needed to validate a design!

Current testing standards

- The standards (particularly the EN) are hardly used.

- For glazing, windows and doors.
- European standards
  - EN 13123
  - EN 13124
  - EN 13541
- International
  - ISO/DIS 16934
  - ISO/DIS 16933
- The standards concern two testing methods.

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Field test with explosive charge

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Blast simulator test

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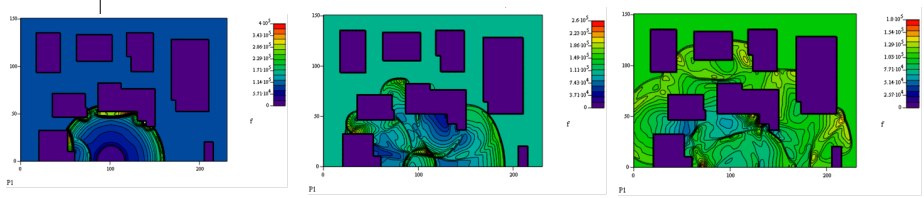
End user goal: Safe building in urban environment



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Possible reasons why standards are hardly used

- Discrepancies between test and real life situation.
- Mismatch between load categories and threats.
- Uncertainties around threats cause a difference view regarding standardization.
- Dual use is a concern for the end user. That is why they don't want to comply to standardized protection classes.
- Missing hazard categories.
- Costs are high. And: One test = no test?
- Explosion and blast resistance is very complex, with many parameters of influence. The response at the end depends on the complete system. ➔ A lot of testing needed before a system is properly tested for a flexible use.

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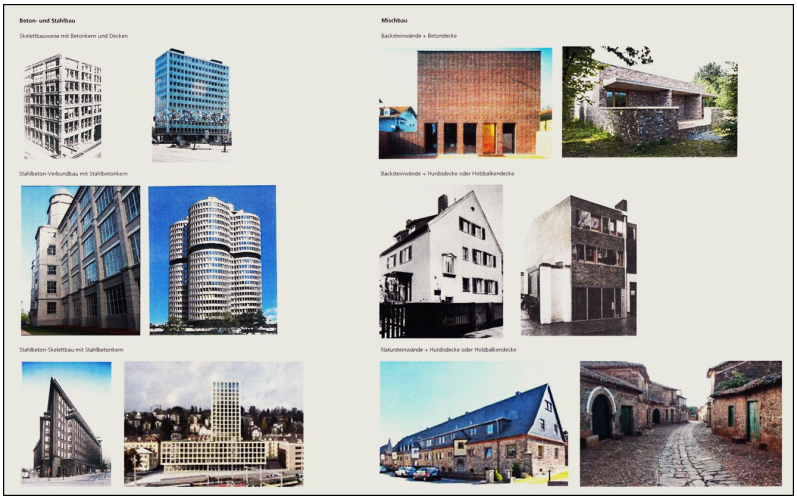
Large range of building types



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Computations

- Computations can play a role in this generalizing or extrapolation of test results
- But blast resistant computations are no well established exercises. So, how does one know that the computations are reliable?
  - Verification by testing can give greater confidence in computation, but is that sufficient?
  - Testing needs to provide input parameters for computation.
- The question is whether computations can be certified.
- Confidence in the person who carries the calculation and his/her knowledge in the field are more relevant than the tooling.

Idea for different test approach

- Normal test objective: show that a product meets the requirement.
- Test a product beyond its resistance level, and have it failing in the test
  - Such a test needs more data acquisition and costs more.
  - Such a test gives more info (failure mode and failure criterion), necessary for computations.
  - The validation range of the product is broader ➔ broader market.
- Feasibility needs research.

Summary

- Validation of the blast resistance of a product can only be done based on testing.
- Computations can help to extrapolate the product use.
- How can computations be certified? Is it the tooling? Is it the organization?
- A different testing approach, i.e. testing to find the failure mode and failure criterion, is suggested.