International and Russian experience in implementation of the vulnerability analysis and risk assessment for enhanced safety of building structures

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Outline:

• Why Eurocodes “encourage innovation and good design”?

• How risk analysis can contribute to building safety enhancement?

• What else can be done for the Eurocodes refinement?
The Eurocodes system is an important milestone on a long way from “prescriptive” to “performance-based” and “risk-informed” approach for building design and technical regulation.
Instead of

- unnecessary *overdesign*
- *too conservative* requirements
- high cost

of the “prescriptive” approach,

the “*performance-based*” approach encourage and foster

- use of *novel* materials
- treat the *realistic, relevant* design situations
- *competitive* cost

on the base of preliminary risk analysis and assessment
The Eurocodes can be called as the “risk-informed” codes.

Technical decisions are making, taking into account an information on the risks, associated both with

- the hazards/threats to building through its life-cycle and
- the construction projects implementation
Two factor model of risk analysis (consequence-oriented)

\[ \text{Risk} = \text{Probability} \times \text{Consequences} \]

International experience (fire safety, seismic design):
- Eurocodes
- ISO/IEC
- NFPA, NIST
- Japan, Canada

Russian experience:
- Technical regulation “on fire safety” (July 2008)

How to find “weak points” in specific design of building?
Three factor model of risk analysis (safety-oriented)

\[ \text{Risk} = \text{Threat} \times \text{Vulnerability} \times \text{Criticality} \]

International experience (fire safety, seismic design):
- BSI – software safety / security
- HAAPC – food safety
- FEMA 452

Russian experience:
- Guidelines on risk-based vulnerability analysis of the high-rise and unique buildings (December 2007)

Why it is important for the innovative building codes?
Russian experience: Guidelines on risk-based vulnerability analysis of the high-rise and unique buildings (December 2007)

• List of critically important points
• List of the design basis scenarios
• List of the protective measures (prevention/delay/mitigation) for the multi-hazard conditions
Emerging topical issues:

- Building Protection under Multi-hazard Conditions
- Building Resilience

What about completeness of ontology of the Eurocodes?

How safe is a robust building?
Multi-hazard situations - Case 1: 9/11

Combined Hazardous Effects: Impact – Explosion - Fire

CHEIEF

$10^0$ sec

$10^1$ sec

$10^3$ sec
Multi-hazard situations - Case 1: 9/11

Combined Hazardous Effects: Impact – Explosion - Fire

CHEIEF

Tower was robust enough to withstand mechanical impact. Does it enough for safety?
Multi-hazard situations - Case 1: 9/11

Combined Hazardous Effects: Impact – Explosion - Fire

CHEIEF Tower was robust enough to withstand explosion. Does it enough for safety?
Multi-hazard situations - Case 1: 9/11

Combined Hazardous Effects: Impact – Explosion - Fire

Collapse is a result of unsufficient resilience of building.
Multi-hazard situations –
Case 2: San Francisco-Oakland Bay Bridge collapse 05/07
Combined Hazardous Effects: Impact – Fire

How to measure and enhance a building/structure resilience against multi-hazard?
What else?

What can we do jointly:

Knowledge generation
1. extend *ontology* of the Eurocodes – safety, durability, serviceability, robustness, resilience
2. propose *metrics* for characterization of the robustness and resilience

Pre-normative studies and support actions
1. *Guidelines* on risk-based robustness and resilience differentiation
   (TC250 & TC164 ?)
2. EU-Russia *Glossary* on multi-hazard risk management of the building/structures
Link:

“Resilience of Cities to Terrorist and other Threats: Learning from 9/11 and further Research Issues”

http://www.springer.com/978-1-4020-8487-4
Thanks for attention and resilience 😊.

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