Risk Based Approach to Cultural Heritage Buildings

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FiRE-TECH is a thematic Network

Fire Risk Evaluation
To European Cultural Heritage

⇨ AIM

- Evaluate fire risk to cultural heritage
- Suggest quantification methods
- Elaborate decision methods for optimisation of the use of fire protection methods

⇨ Consortium constituted in 2001

- 11 Partners
  - TNO (NL), WFR (UK), IST (P), CSTB (Fr), TUBS-iBMB (Ger), AUTH (Gr), UIBK (Au), IUAV (It), FSN (Sw), EMI (Hu)
  - Coordinator: UGent (B)
- Project started February 2002
- Project finalised Spring 2005

⇨Motives

- Fire presents most serious threat to cultural heritage
- Europe looses one Cultural Heritage building a day

Motives

- Lack of interest from fire community
- Lack of specific national regulations
- General prescriptive regulations
  - Can often not be met
  - Sometimes detrimental
  - Not (cost) effective
- BeneFeu project promoted risk based approach for fire protection

- Two Main Parts
  - Collection of useful information
  - Develop a risk based approach optimizing the use of available protection means

- ⇨ Collection of information on:
  - Existing practices and regulations
  - Fires affecting cultural heritage
  - Fire performance of ancient materials
  - Fire protection technologies and products

- ⇨ Develop a risk based approach
  - Select suitable fire risk assessment methods
  - Develop a quantitative decision model

⇨ Existing practices and Regulations

- Few specific regulations address Cultural Heritage
- Some countries have guidance documents.
  - Examples of these guidelines are documents from Historic Scotland, English Heritage.
- Most regulations are prescriptive.

⇨ Analysis of fires affecting cultural heritage

- No systematic statistical information
- Main causes of fires:
  - Arson
  - Renovation works
  - Old electrical/gas installations
  - Late detection,…

- Evaluation of the fire behaviour of ancient materials and assemblies
  - Evaluation of load-bearing elements
  - Evaluation of separating elements

⇨ Fire protection technologies and products

- Overview of
  - Available technologies;
  - Their efficiency;
  - Their reliability;
  - Their applicability and acceptability in cultural heritage buildings;
  - Their cost.

Fire risk assessment methods

- 9 Ranking Methods
  - Risk Value Method:
  - Fire Safety Evaluation System:
  - Specific Commercial Property Evaluation Schedule:
  - Dow Fire and Explosion Index:
  - XPS FIRE
  - Hierarchical Approach
  - SIA 81 - Gretener Method
  - Fire Risk Assessment Method for Engineering
  - The Fire Risk Index Method

Fire risk assessment methods

- 7 Quantitative Methods
  - Computation of Risk Indices by Simulation Procedures
  - Risk-Cost Assessment Model (FiRECAM-Fire Risk Evaluation and Cost Assessment Model)
  - The Building Fire Safety Engineering Method
  - Fire Evaluation and Risk Assessment System
  - Petri net to Fire Safety Measures
  - Event Tree Analysis as a Risk Analysis Method
  - Fire Risk Assessment with Reliability Index β

⇨ Much attention paid to

- Event Tree Analysis Method
  - Case Studies: De Nieuwe Kerk (Nl), Chiado (P), St Mary of Consolation (It) …
- Fire Risk Index Method
  - Case Study: Hoffburg Schönbrunn (Au)
- Fire Risk Assessment Method for Engineering
  - Case Study: Het Pand - Ugent (B)

→ ALL VERY SUITABLE

⇨ Quantitative Decision Methods

⇨ The Analytical Hierarchical Process

- Defines
  - General policy
  - Objectives
  - Strategies
  - Measures

⇨ The Analytical Hierarchical Process

- General Policy
  - **P1 - Fire Safety of Cultural Heritage Building**
- Objectives
  - OB1 - Protect the occupants
  - OB2 - Protect the firemen
  - OB3 - Protect the building
  - OB4 - Protect contents
  - OB5 - Safeguard continuity of activity
  - OB6 - Protect the environment
- Strategies
  - ST1 - Reduce the probability of fire start
  - ST2 - Facilitate fire fighting
  - ST3 - Facilitate egress
  - ST4 - Limit the fire development/propagation
  - ST5 - Limit the effects of fire

⇨ The Analytical Hierarchical Process

Measures

- **M1 - Reaction to fire**
- **M2 - Fire resistance of structure**
- **M3 - Fire resistance of partitions**
- **M4 - Size of fire compartments**
- **M5 - Characteristics and location of openings on the facades**
- **M6 - Distance between buildings**
- **M7 - Geometry of egress paths**
- **M8 - Access for the firemen**
- **M9 - Means for fire detection**
- **M10 - Means for fire suppression**
- **M11 - Smoke control**
- **M12 - Emergency and alarm signs**
- **M13 - On site firemen**
- **M14 - Fire brigade**
- **M15 - Maintenance of fire safety systems**
- **M16 - Education for fire safety**
- **M17- Emergency planning + training**
- **M18 -Salvage operation management**
- **M19 - Periodic inspection of the building**

⇨ Two Numerical Tools

- ALADIN (CSTB)
  - Fortran computer programme
  - Limited to comparison of six measures
- Cost/Effectiveness Sheet (IST)
  - Excel sheet
  - No limitation in the number measures that can be compared

➢➢ both include COST - EFFECTIVENESS COMPARISON

⇨ Building

- 2000m² church - 25m² shop
- 100m high tower

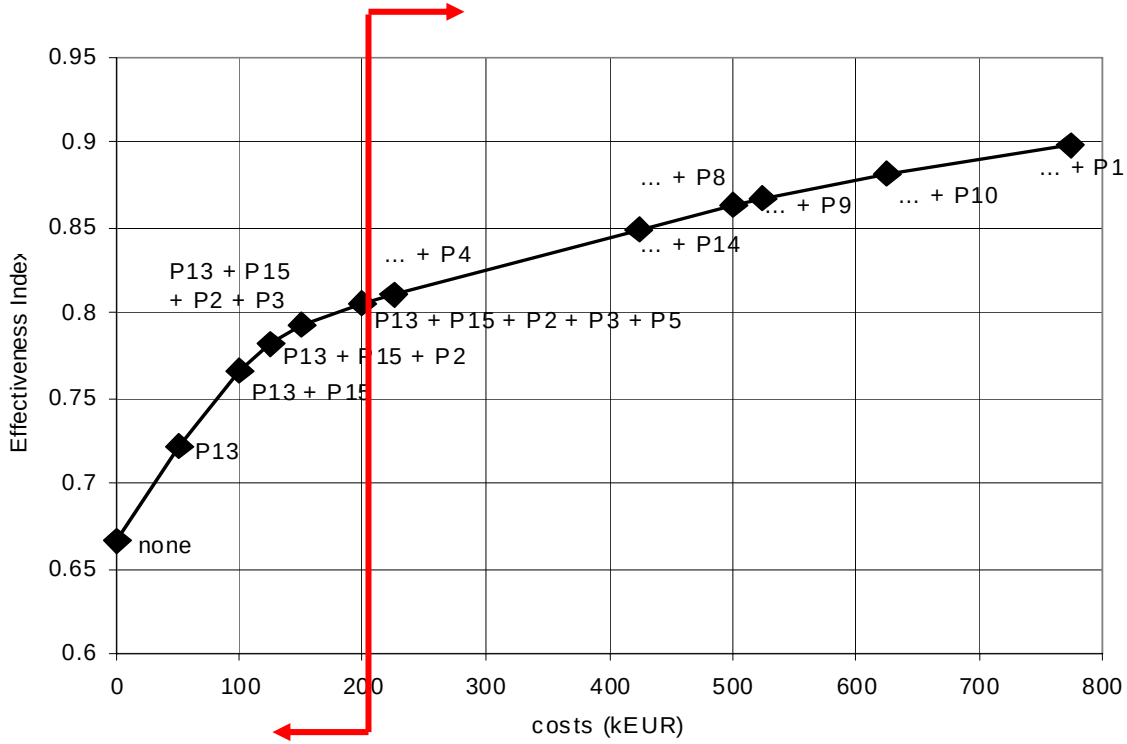
⇨ Present situation – Risk Analysis

⇨ Conclusions

- tower: 35 % probability people in tower to be evacuated only by special means;
- church: 22% probability that more than 4% of the building would be destroyed

⟹ Extra measures are needed for both tower and church

⇨ Cost-effectiveness



Note: With a budget of 200 k€ an improvement from an effectiveness index (EI) of 66.6% to 80.5%
To reach the max. EI (± 90%) another 600 k€ is needed.

Thank you for your attention