Risk Based Approach to Cultural Heritage Buildings

www.firetech.be

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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, …
Fire Behaviour of Ancient Materials and Assemblies

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 $\beta$
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 (1)

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 (2)

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
Case Study: De Nieuwe Kerk

➡️ 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
Case Study: De Nieuwe Kerk

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