Quantification of the technical fire equivalence of buildings by applying a probabilistic risk analysis

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Abstract **This thesis aims to provide insight into the specific area of quantitative fire risk analysis in buildings and to underpin the necessary mathematical formulas and data, which each express a likelihood or probability.**

Keywords **probabilistic, risk assessment, statistical analysis, uncertainty, reliability, utility, fire safety engineering**

I. Introduction

It is true that in Belgium today this is an unknown domain, with the exception of some really special designs such as our nuclear power plants. It looks beyond the rather subjective qualitative approach, as typically used, and the semi-quantitative method of solution, which by means of guide figures give a quick idea of the positioning of the building to a proposed risk scale.

II. Chronological overview of the thesis content

The first chapter PRA is located in the present and future Belgian context and the differences with a prescriptive approach and the more simple analysis methods are interpreted. It will also be linked with the deterministic analysis and calculation of architectural and technical concepts. A deterministic calculation is also performed in the case study, but is here again limited to the design parameters and results.

Then is described what the problems are of the prescriptive design and how PRA fits in the overall set of "Performance Based Design". Here are four applications specified: selecting the relevant fire scenarios, using the appropriate parameters in a deterministic analysis, the relative risk analysis and the total or absolute PRA. A key element in these approaches is the understanding of the value of using probabilities in the architectural design and establish the criteria necessary to verify the result.

The first of three technical chapters deals with the PRA under the network analysis: the event tree and fault tree are explained and the integration of both in complex networks. The problems that are associated with them as well as its limitations are also addressed.

Much of the thesis is devoted to the statistical analysis. Several possible probabilities, based on historical obtained data, are listed: the probability of the onset of fire, the expansion, causing a flashover or not, and the likelihood that the compartment is broken. Furthermore, it would consider whether the damage - physical and personal – is in relation to the function of a building and their area.

For the more mathematicians there is a smaller section devoted to more sophisticated probability models. The emphasis is not on the complexity of the calculations but gives a basic insight into the dynamics of coincidences. Stochastic modelling and Monte Carlo simulation provide appropriate methods for this research.

An important element in the application of data is the reliability and sensitivity (need it be said that this will always remain a difficult exercise for Belgium). It is discussed how reliability and sensitivity is 'measured'. Fire origin and development percentages provided and also for various parts of technical installations : fire detection, automatic extinguishing, smoke and heat control systems. Moreover, the passive safety is discussed and the data on human consequences.

After a PRA is elaborated, the results needs translation into decisions regarding the project. In a first item is seen how a particular decision structure can be followed. This analysis is then applied to the costs and benefits of possible solutions to evaluate. Also the risks of potentially fatalities are considered. Finally, a conclusion is written down that first gives a summary of the PRA - methodology and also indicates its importance in the evolution of the application of Fire Safety Engineering in Belgium.

A separate descriptive section provides a summary of six currently known software models that can execute a risk analysis in a fire. The possibilities, limitations and pitfalls are listed.

At the end of the thesis a case study which is added in which a relative PRA is applied to the atrium in the existing building and the adjacent areas. The onset of the analysis is performed using an event tree and fault tree and the most remarkable results are examined with a statistical analysis and a sensitivity analysis. Some similar alternatives are proposed.

III. Conclusion

It is the aim of this thesis to put Probabilistic Risk Analysis and Assessment on the map in the Belgian fire safety “domain”: authorities having jurisdiction, investors, designers, scientific institutions, producers,...

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