FIRE RISK MANAGEMENT IN BUILDINGS

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Abstract

Fire risk management is coming of age. Some risk managers view fire risk management in terms of the type of insurance to carry. Others are vigilant in applying good practices that attempt to avoid common errors that have been made in the past. However, modern fire safety knowledge, combined with the power of information technology enable fire safety engineers to provide risk management that is based on performance knowledge of site specific buildings. Although this process is not yet mature, experience indicates that the results give a value added above other methods.

This paper will describe some successes and failures in applying probability and statistics to performance based assessment and the resulting risk characterizations. Over thirty years of research in applications of fire safety performance has provided examples of each. The objective is to give some insight from these experiences that will enable other researchers to avoid, or at least be aware of, the potential for making similar mistakes. Lessons learned are described as a conclusion.

In order to establish a base of understanding, a brief historical perspective on structural engineering and fire safety engineering is given. Structural engineering and fire safety engineering are distinctly different disciplines. Structural engineering is a mature discipline while fire safety is an emerging discipline. Structural performance is static while fire safety performance is dynamic. The role of probability theory and techniques in applications of risk management between the two disciplines is different today, although during its formative years the structural engineering reasoning was not very different from that of fire safety performance analysis today. These disciplines share a similar thought process in the way performance is handled and risk is managed to allow a correspondence to be made and analogies to be recognized.

Two essential ingredients to an engineering analysis include a framework for thinking and methods for quantification. Structural engineers throughout the world use the same framework for thinking to understand the anatomy of a structure, its geometry, and the relationship between its parts and the whole. Similarly, quantitative methods such as statics, mechanics of materials, dynamics, elastic stability, and structural analysis are the same throughout the world. Although codes and standards reflect local conditions, the structural engineering frame of thinking and analysis knows no geographical boundaries.

Fire safety engineering does not yet have the luxury of a universally accepted framework for thinking, although the world is rapidly moving toward a consensus process. Quantitative methods for calculating performance have not yet matured, and there are gaps in completeness and validation. Nevertheless, knowledge has grown during the past generation that enables a credible performance analysis to be made for the fire safety of a building. Understanding site specific performance provides a basis for characterizing risks that can be caused by a hostile fire.

The anatomy of the building-fire system is an important ingredient to understanding quantification methods. A brief description of an organized way of to view the building-fire system serves to orient thinking away from traditional regulations and toward a performance way of thinking. A framework for thinking is presented to create an awareness of the major components and the dynamics of fire behavior. A framework is inseparable from performance quantification. Time does not permit development of the

logic for this framework. It is presented here to create an awareness that a systematic, organized way of thinking about fire and buildings exists.

Fire performance quantification has not yet reached maturity. Nevertheless, many tools are available to provide performance understanding. A gap exists between quantification methods and performance predictions. A technique is described that uses probability theory and engineering logic to bridge this gap. This intermediate technique enables systems analysis and failure analysis procedures to be employed to create a better use and understanding of deterministic information. It also enables logical documentation to be provided.

The framework that is described in this paper evolved over three decades. It depicts an engineering thought process in a rigorous and technically valid systems organization. During this time period, quantification methods were examined to establish numerical measures of performance. Both deterministic and probabilistic methods were used. Over the years, a gradual transformation took place. An initial bias against subjective probability existed, even though it was used as a temporary expedient to test the logic of the framework. This led to examination of the history and philosophy of probability theory because discrepancies existed between observations during building evaluations and statistical expectations.

Over the years, it became apparent that in an emerging discipline such as fire safety, applications of both definitions of probability in combination can provide rigorous solutions. The weaknesses of each can be complemented by the strengths of the other. The history of probability in the Western world has shown a duality of meaning from its inception in the mid 17th Century. Although during the 18th and 19th Centuries the frequentist and the subjectivist became philosophical rivals, this conflict has been subsiding in recent years. Today, it is becoming more common to use these definitions in a way that enables the strengths of each to be combined to give better understanding of performance. Fortunately, the mathematics of probability does not distinguish about how the numbers are obtained.

The years of applications using this systems approach to building fire safety has involved many experiments with numerical methods of performance. Some were successful. Others were failures. Yet, an awareness of why some succeeded while others failed provided useful insights into helping others to avoid potential pitfalls. A few of these experiences, as well as some of the more important lessons learned, are described in this paper.