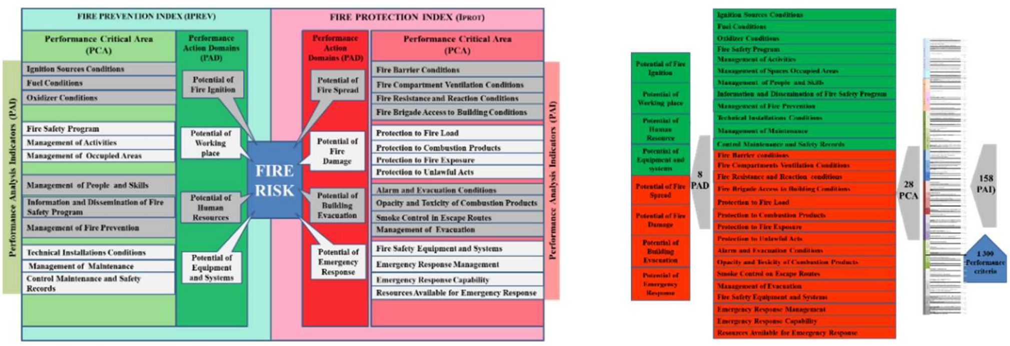
Proposal of a performance-based fire risk assessment methodology for buildings

Summary

This PhD thesis proposes the development of a hypothetical multidimensional risk assessment model, based primarily on an analysis of the fire safety performance of buildings. The aim was to develop a fire risk assessment model whose applicability would be equally reliable in as many buildings as possible, regardless of their nature and type of occupancy. It was also considered important that the model can be a tool to support fire risk management. To this end, the components of fire safety that were considered to contribute most to the fire risk were identified and studied. They are integrated in a mathematical model that was deemed appropriate. The methodology is being tested for different buildings for testing its reliability for as many types of buildings as possible. The main arguments for the relevance of the proposed model are the redundancy of the assessment process and the multidimensional analysis of the fire risk. One of the paths chosen for the development of the model was the integration of multi-criteria fire risk analysis methodologies that would also help to consistently validate alternative fire safety engineering solutions. Applying the model in the field made it possible to test the multidimensional fire risk assessment process, based on a multi-criteria analysis. The first stage (first analysis dimension), of a more prescriptive nature, is carried out on the basis of pre-defined criteria in Performance Analysis Indicators (PAIs) which are used in checklists comprising 26 Critical Performance Areas (CPAs), made up of 8 Performance Action Domains (PADs) which analyze the performance of the so-called prevention indexes and fire protection indexes. In the second stage (second dimension of analysis), a performance-based analysis is carried out using 7 project fire scenarios, from which the probability of their occurrence is assessed, depending on the performance of critical components of the prevention index, and the severity of the consequences of their actual materialization, depending on critical components of the prevention index. In the third stage (the third dimension of analysis), an analysis of the safety of building evacuation is carried out using interactive performance diagrams that contrasts counter-point growth modeling with modeling of the building's evacuation conditions. Fire growth modeling is carried out according to the physical and chemical characteristics of the fire loads in the building and makes it possible to determine the building's Time Available for Safe Evacuation (TDES). The building evacuation conditions are modeled according to the characteristics of the occupants, the nature of the route to a safe point, as well as the density of the evacuation flows, and determine the Time Needed for Safe Evacuation of the Building (TNES). By comparing these two times, the safety of the occupants in the evacuation process can be evaluated. The field studies consisted of 48 cases involving 12 building types. The application of the model in the field demonstrated its suitability and effectiveness as a tool to support integrated fire safety management and that the multidimensional analysis process allows for a level of redundancy that reduces the uncertainty of the building fire risk assessment process. It can be considered that by considering a new philosophy of multi-criteria analysis with multiple redundancies, the aim was to break with the paradigm of a single dimension of analysis and a single value for fire risk, in order to move towards a paradigm of holistic analysis that generates a multidimensional picture of fire risk.

Keywords

Model, analysis, safety, evaluation, risk, fire.



Structure diagram of the performance-based fire risk methodology.

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Period
2018-2024

Funding
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