

Performance-based fire design and the U.S. prescriptive guidelines: A comparative study

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Abstract

Current codes and standards for fire design of structures in the United States are mainly based on design at the component level using prescriptive approaches, while performance-based design for fire can be used to address the needs for designing modern buildings with cost-effective solutions. Previous research shows that, when system-level performance is considered, fire protection on secondary beam elements in composite steel-concrete floor systems is not necessary due to the development of a membrane action in the concrete slab during fire. This study compares the fire design of a 9-story office building using prescriptive and performance-based designs. The safety levels of the two designs are investigated and compared. It is shown that performance-based design can be used to achieve the required level of safety currently enforced in the U.S. prescriptive guidelines, while providing an opportunity for cost reduction in fire protection material.

Keywords: fire; building; prescriptive design; performance-based design; membrane action; SAFIR.

1 Introduction

Current codes and standards for fire design of structures in the United States are mainly based on design at the component level using prescriptive approaches, while performance-based design for fire can be used to address the needs for designing modern buildings with cost-effective solutions. The primary objectives and concerns of the engineer when designing for fire are life-safety of occupants, followed by economic losses. This study compares the fire design of a typical office building using prescriptive and performance-based designs. The U.S. prescriptive

approach provides the required fire resistance rating as a specified amount of time the building structural elements are required to withstand exposure to the standard fire. In this study, the prescriptive guidelines are assumed to provide the benchmark for fire safety; therefore, the acceptable level of fire safety when the design is based on performance-based approach is assumed to be guaranteed only when it exceeds the fire safety of the same structure designed based on the U.S. prescriptive guidelines.

A 9-story office building with steel frames and regular plan configurations with a composite floor system is used as the prototype structure. In the