

## Article

# Behavior and Performance Analysis of Fire Protection Materials Applied to Steel Structures According to Exposed Temperatures

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**Abstract:** Spray-on fireproofing materials (SFRMs) and intumescent paints are commonly used to enhance the fire resistance of steel structures. Despite extensive studies on the performance of SFRMs and intumescent paints, there remains a significant lack of research on the material properties of certified products used in real-world applications, especially according to exposed temperatures. In this study, heating experiments were conducted to investigate the material properties of two widely used certified materials in Korea, focusing on their application thickness and exposure temperature. The experiments set target temperatures ranging from room temperature to 900 °C in increments of 100 °C. Additionally, various material properties, such as changes in shape and the insulation performance of the SFRM and intumescent paint, were observed at each temperature. Notably, the moisture content and discoloration depth of the SFRM displayed a consistent trend under different exposure temperatures, a material property that has not been previously reported. Furthermore, the insulation performance of the two materials differed by approximately 17% to 25% compared to an uncoated specimen exposed to the same temperature. The findings on the properties of SFRMs and intumescent paint relative to the exposure temperature presented in this study can serve as valuable data for selecting materials to improve fire resistance performance across various construction sites in the future. Additionally, they can act as key reference data in the diagnostic evaluation process for assessing the impact of fire on steel structures.

**Keywords:** steel frame structure; protection of steel; spray-on fireproofing material; intumescent paint; fire damage assessment



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## 1. Introduction

Fires in buildings cause numerous casualties, as demonstrated by past tragedies. These include the Grenfell Tower fire in 2017 and the 2022 Bronx apartment fire, which helped raise global awareness about building fires. After the Great Fire of London in 1666, the earliest regulations on building fires were promoted mainly by insurance companies who were more interested in protecting property. Later, related regulations were established with a focus on preserving life. Numerous researchers have conducted experimental and theoretical studies, and now, each country has fire resistance regulations for buildings. Each regulation requires different fire resistance performance standards for structural members depending on the use and scale of the building. If the required performance standards are not met, various strengthening methods are applied to secure fire resistance performance.

# Protection Of Materials And Structures From The Lo

**CO Houle**



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Opportunities in Protection Materials Science and Technology for Future Army Applications National Research Council, Division on Engineering and Physical Sciences, Board on Army Science and Technology, National Materials Advisory Board, Committee on Opportunities in Protection Materials Science and Technology for Future Army Applications, 2011-08-27 Armor plays a significant role in the protection of warriors During the course of history the introduction of new materials and improvements in the materials already used to construct armor has led to better protection and a reduction in the weight of the armor But even with such advances in materials the weight of the armor required to manage threats of ever increasing destructive capability presents a huge challenge Opportunities in Protection Materials Science and Technology for Future Army Applications explores the current theoretical and experimental understanding of the key issues surrounding protection materials identifies the major challenges and technical gaps for developing the future generation of lightweight protection materials and recommends a path forward for their development It examines multiscale shockwave energy transfer mechanisms and experimental approaches for their characterization over short timescales as well as multiscale modeling techniques to predict mechanisms for dissipating energy The report also considers exemplary threats and design philosophy for the three key applications of armor systems 1 personnel protection including body armor and helmets 2 vehicle armor and 3 transparent armor Opportunities in Protection Materials Science and Technology for Future Army Applications recommends that the Department of Defense DoD establish a defense initiative for protection materials by design PMD with associated funding lines for basic and applied research The PMD initiative should include a combination of computational experimental and materials testing characterization and processing research conducted by government industry and academia **Government-Sponsored Programs on Structures Technology**, 1997 **Mechanics of**

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