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Fire Behavior and Fire Protection in Timber Buildings

Springer

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Preface

Fire safety for timber buildings and structures is the issue of the day in view of the new momentum this construction industry sector is gaining and the boom in novel technologies and timber materials.

The engineering idea behind this book is based on the concept we have embraced: Timber is a natural composite, and its behavior in fire conditions and fire resistance depend both on its physical structure (morphology) and features of its chemical structure as well as material chemical composition.

This has determined the principle of the book's arrangement and its division in three parts.

The first part (Chaps. 2, 3, 4, 5, 6, and 7) contains data on the structure and properties of various timber species and examines their behavior under high-temperature heating and response to fire. We show the effect of temperature and moisture on the thermal, physical, and mechanical properties of timber. We present the results of experimental and theoretical studies of pyrolysis, ignition, heat release, flame spread, and generation of smoke and toxic combustion products of various timber species. We offer the original form of presenting lower complete combustion heat of timber as a function of its chemical composition. This allows us to determine the lower complete combustion heat values for extractives and hemicelluloses into individual timber species.

The second part of the book (Chaps. 8 and 9) addresses the issues of fire safety, fire resistance, and fire protection of construction members of timber buildings and structures. We present an approach to the fire safety system in buildings and assessing the temperature regime during a fire. We show an engineering way to predict the time of the achievement of critical values of fire hazards factors (temperature, smoke, toxic gases, oxygen deficit) at the initial stage of fire development in a compartment with timber linings. We present data on the charring rate in timber structural members and properties of the char surface layer. We also describe modern trends in enhancing fire safety and fire resistance of timber structures. This part presents a detailed analysis of the fire-protection efficiency of two types of systems: impregnation compositions and intumescent coatings, where the latter is produced from plant raw material and is free of additional fire retardants.

We show the effect of fire-retardant impregnation on the charring parameters of timber structural elements in standard fire regime.

The third part of the book (Chaps. 10 and 11) presents our original data concerning the effect of long-term natural (up to 700 years) and artificial aging of deciduous and coniferous timber species on fire safety characteristics. We address to transformations in physical structure, chemical composition, and properties of timber during natural aging of timber buildings and structures. We provide analysis of the effect of aging on timber charring parameters and properties of the charred layers formed during a fire. The process of biodegradation of timber constructions and the efficiency of a new bio-moisture fire-protective composition is also examined.

This part describes an artificial aging method producing the equivalent to timber buildings that have been in service for up to 500 years. It is accompanied by experimental results of thermal and chemical analysis of timber specimens artificially aged to 150 years showing the change in the fire safety indices.

We would like to express our gratitude to Professor, Dr. Fyodor Shutov for his interest in our work, assistance, fruitful discussions, and valuable remarks.

Moscow, Russia

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