1) Sistemi di misura degli spostamenti nelle prove su strutture edilizie e civili

2) Quando si applica il codice dei contratti pubblici?

3) Procedure di movimentazioni di carichi sospesi in sicurezza

Prova informatica

Il candidato riporti su Excel la funzione y=3+4*x+2*x^2 nell'intervallo -10<=x<=10 con passo 0.5. Effettui una rappresentazione grafica delle coppie (x;y) aggiungendo una regressione polinomiale ed incolli il grafico nei formati word ed Excel equipment, and most of all complexities arising from simulating fire conditions (i.e. survivability of sensors as well as ensuring proper measurements under elevated temperatures) [4]. As a result, fewer studies managed to successfully conduct material property tests under high temperatures as compared to that at ambient conditions [5].

The outcome of these studies presented the adverse effects of fire on material properties through temperature-dependent material models which were either prepared into simplified expressions, or informative charts [6,7]. Despite the fact that most of these research studies were carried out in 1960-90's, the outcome of such studies continues to form the basis for currently adopted temperature-dependent material models [6,7]. A close examination of these models exposes discrepancies arising from different testing methods and equipment, specimen configuration etc. used in high temperature tests [5,8]. Another factor that adds further complexities is the existence of distinct variations in the make-up (composition) of construction materials tested in the 1960–90s and those available today as a result of the natural progression in materials science, differences in origin/amount/type of additives, as well as from modern production/milling procedures.

A review of literature also shows that this community has accepted two material models to be used in fire resistance assessment. For the most part, these models are adopted in North America (i.e. American Society of Civil Engineers (ASCE) design guide [6]), and Europe (Eurocodes [7,9–11]). Despite the fact that these two models have been widely used, recent works have shown that variation in fire resistance predictions can be in the range of 25% when using temperature-dependent models adopted by ASCE or Eurocodes [5,12]. This often complicates structural evaluation at elevated temperatures; particularly in the analysis/design for compound load effects (viz. torsion, or buckling etc.), selecting appropriate fire protection material/type/thickness, or even in carrying out design/engineering (consulting) services.

Such variation arises due to a number of reasons. For a start, these codal-adopted models imply that the micro-structure of construction materials is independent of its fabrication process, or composition/origin. Further, these models were developed using vintage devices, which are inferior to the modern and state-of-the-art equipment, and thus provided scientists with restricted testing set-ups, and possibly mediocre measurements [5,12]. Furthermore, these material models continue to be not updated since their development; dating back to 20–30 years. Finally, while Eurocode 3 suggests the use of certain models to represent behavior of contemporary construction materials (i.e. stainless steel and cold-formed steel), ASCE design guide does not provide direction nor insights into how to account for temperature-dependent effects in materials; leaving designers with limited guidance, hence complicating the process of fire resistance evaluation.

From this work's perspective, it is infeasible to regularly conduct temperature-dependent tests on materials – given the variety in compositions, origins and mixes. Thus, a dilemma arises highlighting the need for a uniform and modern model for construction materials at elevated temperatures. With the hope of overcoming this challenge, and in support of current inertia aimed at promoting standardization for fire resistance assessment, this study aims at utilizing Artificial Intelligence (AI) to develop modern and updated temperature-dependent models for commonly used construction materials – and this could be the first step towards realizing uniform (universal/standardized) constitutive material models. As such, this work presents a novel approach to develop temperature-dependent thermal and mechanical material models for some of the commonly used building materials, namely: normal strength concrete, masonry, structural steel, stainless steel, cold-formed steel and wood. This study starts by presenting high temperature properties of common construction materials and then showcases a proper procedure to developing an AI model capable of deriving temperature-dependent material models. To ensure precision and wide acceptance, the developed AI model integrates material models adopted by notable fire codes, standards and design guides, together with models collected from past and recent published studies/reports.

2. Temperature-dependent properties of common construction materials – an overview

Response of structures once exposed to elevated temperatures is largely a function of properties of building materials. Under such effects, thermal and mechanical[1] properties fluctuate with temperature mirroring the series of phase changes that occur. As such, this section delivers a brief overview on the various temperature-dependent properties for normal strength concrete, masonry, structural steel, stainless steel, cold-formed steel and wood. For brevity, this paper only covers those properties of interest to fire engineers including thermal conductivity, specific heat, density, strength and modulus. It is worth noting that the variation in other properties such as permeability, charring etc. can be found elsewhere and the readers are encouraged to visit such resources [3,13,14].

2.1. Thermal properties

Thermal properties govern both the rise and distribution of temperature within a component or a structural member. These properties comprise of thermal conductivity (k), specific heat (C_ρ), and density (ρ), and for the most part, their behavior is governed by material composition and characteristics of rising temperatures (rate/intensity etc.) [15]. To start with, the thermal conductivity (k) is the property that indicates the rate at which a given material transmits heat. This property is sensitive to the crystalline structure [3].

The thermal conductivity of concrete derivatives is noted to be highly influenced by moisture content and type of aggregate. On average, the room temperature thermal conductivity of concrete and masonry is comparatively low and ranges between 1.4 and 3.6 W/m.K and 0.9–1.1 W/m.K, respectively. It is commonly accepted that the thermal conductivity of these materials decreases with temperature rise due a number of factors including loss of moisture, increased permeability and porosity [14]. At high temperatures, those exceeding 800 °C, the thermal conductivity stabilizes at about one half its value at ambient conditions. It is worth noting that there is a general tendency for concretes made of siliceous aggregates to have higher conductivity than those made of carbonate aggregates (see Fig. 1a) [16].

Fig. 1b and c show that all types of steels have high thermal conductivity as compared to concrete, masonry or wood. This conductivity varies between 46 and 65 W/m.K for carbon steel to 12–16 W/m.K for stainless steel [16,17]. While this property decreases at elevated temperature in carbon steel due to a drop in free path of molecules, the conductivity of stainless steel slightly increases over rising temperatures but remains lower than that in carbon steel up to 1000 °C [18]. The conductivity of wood is even lower than above construction materials and is in the range of 0.08–0.2 W/m.K at room temperature [19]. A unique feature in wood is that its thermal conductivity slightly drops between 200 and 320 °C and then increases due to the higher conductivity of dry layers (see Fig. 1d).

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[1] There also exist two additional types of properties, i.e. deformation properties and special properties. For brevity, deformational and material specific properties are not be discussed herein.

1) Sistemi di misura delle forze: tipologie e principi di funzionamento

2) Quali fasi delle procedure regola il codice dei contratti pubblici

3) La valutazione dei rischi nei luoghi di lavoro: oggetto e modalità

Prova informatica

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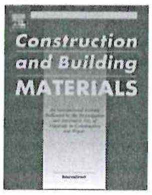

Properties and material models for common construction materials at elevated temperatures

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HIGHLIGHTS

- A novel framework for deriving temperature-dependent material models is presented.
- The framework leverages AI to understand material behavior under extreme conditions.
- ANN and GP are used to develop unified constitutive material models.
- The AI-derived models can modernize and standardize fire design of structures.

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ABSTRACT

Construction building materials experience physio-chemical and phase changes when subjected to elevated temperatures. These changes are often defined through temperature-dependent material models. A cross examination of adopted models reveals that such models markedly varies across open literature and fire guides (i.e. ASCE, Eurocodes etc.). This, not only complicates the process of fire analysis and design, but can also hinders ongoing standardization initiatives. In support of these initiatives, this paper leverages symbolic regression through artificial neural networks (ANN) and genetic programming (GP) to arrive at representative temperature-dependent thermal and mechanical material models for common building materials, namely: normal strength concrete, masonry, structural steel, stainless steel, cold-formed steel and wood. The proposed material models have the potential to regulate and modernize structural design under extreme loading conditions, i.e. fire. The result of this investigation demonstrates the value of utilizing artificial intelligence (AI) into comprehending the complex nature of temperature-induced effects on building materials; together with deriving associated temperature-dependent models.

1. Introduction

Civil constructions are to be designed to satisfy codal requirements. One such requirement is to withstand extreme events (i.e. fire/thermal loading). The ability of a structure to withstand fire and associated fire-induced forces is highly reliant on, 1) the type of material the main structural members/components are composed of, and 2) how properties of such materials are influenced by elevated temperatures [1]. This ability is often measured through experimental fire testing or, for the most part, through fire resistance evaluation. In such evaluation, thermal and mechanical characteristics of construction materials are of interest as fire resistance assessment requires carrying out a two-step analysis; thermal and structural. In the first step, rise in temperature and associated temperature propagation in a load bearing member are obtained by examining how density, thermal conductivity, and specific heat properties fluctuate with increasing temperatures. Once sectional temperatures are obtained, these are then loaded into the second step of analysis. In this step, the adverse effect of increasing temperature upon mechanical properties of construction materials; primarily comprising of strength, and modulus, is considered in evaluating the assessing behavior of a fire-exposed member [1,2].

Thus, carrying out a proper fire resistance analysis requires thorough knowledge of thermal and mechanical properties at ambient and fire conditions. While evaluating aforementioned material properties at ambient conditions can be achieved with ease mainly due to the availability of testing standards and instrumentations, assessing properties of building materials at high temperatures is shown to be a tedious task [3]. This can be primarily ascribed to the current lack of expertise and/or standardized (i.e. agreed upon) guidance, shortage and limited access of testing

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1)Sistemi di misura delle vibrazioni nelle prove su strutture edilizie e civili

2) Cosa disciplina il codice dei contratti pubblici?

3) La gestione della prevenzione nei luoghi di lavoro: obblighi e figure coinvolte

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