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Mechanical properties of cold-formed steel tubular sections exposed to fire: A reliability-based assessment

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ABSTRACT

Elevated temperature material properties are vital for predicting the behaviour of cold-formed structural steel members in fire conditions. The strength and stiffness of cold-formed steel (CFS) degrade progressively with rising temperature, and this deterioration must be reliably anticipated in the fire-resistant design of steel structures. In this study, 140 tensile coupons were extracted from CFS tubular sections with (a) non-uniform cross-sectional shapes, including Rectangular Tubular Section (RTS) and Square Tubular Section (STS), (b) varying cross-section dimensions and thicknesses, (c) two different steel grades, and (d) distinct chemical compositions. Mechanical properties were experimentally investigated over a temperature range of 24 °C–800 °C. Results revealed that the combined effect of chemical composition, different geometrical configurations and cold-forming led to significant variation and non-uniformity in the strength and stiffness reduction factors at elevated temperatures. Temperature-dependent reduction factors were developed for the modulus of elasticity, tensile strength, yield strength, ultimate strain, and fracture strain. The experimentally derived reduction factors were compared with predictions from existing fire design standards and values reported in the literature. This comparison indicated that current design approaches—largely calibrated for Hot-Rolled Steel (HRS)—may not fully capture the behavior of CFS tubular sections at both ambient and elevated temperatures. To address this limitation, reliability analyses were performed using the present experimental data in conjunction with codal provisions and previous studies, leading to the formulation of new design equations for temperature-dependent reduction factors. These proposed equations provide improved accuracy and reliability in predicting the fire resistance of CFS structural systems.