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Original Article

Experimental investigation of mechanical properties of cold-drawn AISI 1018 steel at high-temperature steady-state conditions

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ABSTRACT

Fire is one of the most serious problems that affect the integrity of building structures. It can cause significant degradation of the structural strength of steel over a short period prior to building collapse. This study conducted an extensive experimental program on the mechanical properties of AISI 1018 cold-drawn steel (CDS) at elevated temperatures using the steady-state method. The elastic modulus of CDS AISI 1018 underwent a reasonably rapid reduction at temperatures of 100–200 °C. At higher temperatures up to 500 °C, the steel exhibited slow reduction in its elastic modulus, whereas sharp reduction was observed at temperatures of 550–750 °C. In contrast, slow reduction in mechanical strength was observed at temperatures of 100–200 °C. At 300 °C, the mechanical strength increased gradually until it achieved a peak at 500 °C. This phenomenon was attributed to a dynamic strain ageing (DSA) effect that provided benefits in terms of increased mechanical strength and ductility, which were relatively higher than the mechanical strength at room temperature. Dimple fracture characteristics were observed in all samples tested at elevated temperatures. After raising the test temperature to 750 °C, subsequent reduction in the area of the lamellar pearlite phase boundary led to a spheroidization process followed by increased ductility. Prescriptive model predictions based on the experimental data series were proposed and important features regarding the DSA phenomenon were highlighted regarding fire-safety design when using CDS AISI 1018 in building construction.

1. Introduction

Current demand for steel is high because it is used in various forms in the construction of modern buildings, e.g., steel plates, round bars, steel wire rope, hot- and cold-rolled steel, and cold-drawn steel (CDS). The strength of the steel used in modern building structures should meet fire-safety design standards to ensure that in the event of a fire, structural collapse does not occur before all occupants have evacuated the building. Therefore, the performance of steel under fire conditions requires serious scientific research. Zong et al. [1] and Shakya and Kodur [2] both investigated the mechanical properties of cold-drawn wire strands with high carbon content of 0.810–0.840 wt% under high-temperature steady-state conditions. Under these conditions, the blue brittleness

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