COMPORTAREA ÎMBINĂRILOR METALICE CU ȘURUBURI SUB ACȚIUNI EXTREME / BEHAVIOUR OF STEEL BOLTED CONNECTIONS UNDER EXTREME ACTIONS

Teză de doctorat – Abstract

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The assessment of the durability of structural components at elevated temperatures is of utmost importance when designing structures under fire hazards. The capacity of multi-storey steel frame structures to withstand unforeseen events is significantly influenced by the strength of their beam-to-column joints. In instances where a column is lost due to a fire, the dynamic process can result in high strain rates, which must be taken into consideration when analysing the resistance and ductility of these connections.

The aim of this research is to enhance the fire safety of steel structures by revealing more information and understanding the behaviour of high strength bolts for steel structures, specifically grade 10.9 bolts, in fire conditions. The research work consisted of two main parts: an experimental study, concluded with a series of proposed reduction factors for bolt strength under elevated temperatures and different strain rates, and a numerical validation of the proposed factors. The research work was carried out in the laboratory of Steel Structures and Structural Mechanics Department of Politehnica University Timișoara.

In order to gain a deeper understanding of the behaviour of grade 10.9 bolts under high temperatures, an extensive study was conducted. This study examined various factors that may affect the bolts' performance, including their manufacturing process, heat treatments, surface treatments, and chemical composition. An experimental program consisting of 116 tests on grade 10.9 bolts was conducted according to EN guidelines. Tensile tests were performed at nine different temperatures (ranging from 20°C to 800°C) and nine strain rates (ranging from 0.000033 s-1 to 0.06 s-1) to obtain stress-strain curves that describe the material behaviour. Reduction factors based on the tests were proposed to calculate the strength of grade 10.9 bolts under high temperatures. These factors depend on the strain rate that may occur in a bolt during a fire.

Additionally, numerical simulations were conducted using Abaqus software to validate the new proposed reduction factors. The simulations were based on four experimental tests from literature, which involved tension tests on T-stub specimens at normal and high temperatures. The numerical models were validated against these experiments, demonstrating a good replication of the T-stub behaviour. A comparison of the new proposed method with the EN1993-1-2 method, revealed significant differences in the estimation of the maximum force value for the T-stubs considered. These results provide important insights for the design and optimization of bolted T-stub connections when accounting for elevated temperatures.