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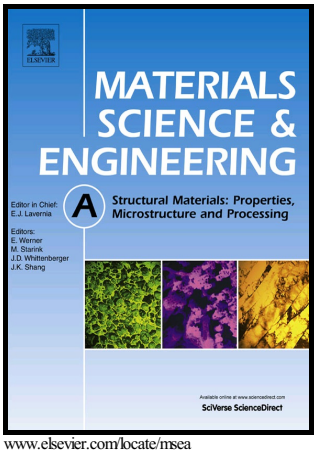

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Identification of the plastic properties of structural steel using spherical indentation

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Abstract

In this paper, a method for identification of the plastic properties of structural steels that exhibit a plastic plateau in their stress-strain curve from spherical indentation was proposed based on the results from extensive dimensional analyses and finite element (FE) simulations. Three explicit relationships, which related the properties of structural steel to the response from spherical indentation, were established. Considering that elastic modulus of structural steel was priori known since it can be extracted from the conventional methods, the plastic parameters of steel including yield strength (σ_y), the strain hardening exponent (n), and the ratio (α) between the strain at beginning-point of strain hardening (ε_{st}) and the yield strain (ε_y) can be determined from a spherical indentation load-depth (P-h) curve using three proposed dimensionless functions. The spherical indentation process was simulated by using a finite element program, and a large number of analyses with different combinations of steel properties were conducted. From the FE analyses results, the functions were established from regression analyses, and a reverse algorithm was suggested. Spherical indentation, tensile tests, reverse analyses were carried out on three different structural steels (SS400, SM490, and SM520) to validate the proposed algorithm.

Keywords: Dimensional analysis; FE analysis; Plastic properties; Structural steel; Spherical indentation.