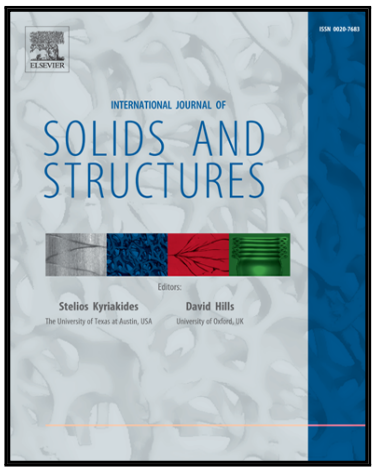

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Dynamic spherical indentation of elastic-plastic solids

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Abstract

A parametric study based on the finite element method was performed to analyze the dynamic indentation response of elastic-plastic solids indented by a rigid sphere moving at a constant velocity. The effects of elastic-plastic material properties and indentation velocity on the deformation behavior are examined in terms of global field parameters (contact force, mean contact pressure, contact area, and indentation depth) and characteristic local field variables (equivalent plastic strain and plastic zone evolution). Several trends of aforementioned parameters, which are unique to dynamic indentation, are discussed in the context of simulation results for a wide range of combinations of material properties and indentation velocity. A new dimensionless indentation parameter is introduced, which together with a normalized indentation strain, yield generalized solutions of dimensionless global field parameters and correlate with a specific deformation path. The physical meaning of the indentation parameter is interpreted in terms of the development of different deformation states and the kinetic energy density transmitted by the indenting rigid sphere versus the strain energy density accumulating in the elastic-plastic solid. The formulation and simulation results of this study provide a framework for deriving contact load (pressure) and contact area relations for dynamic indentation of elastic-plastic solids, analogous to those derived for quasistatic indentation.

***Keywords*:** dimensionless indentation parameter, deformation state, dynamic indentation, elastic-plastic material properties, indentation velocity, finite element analysis

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