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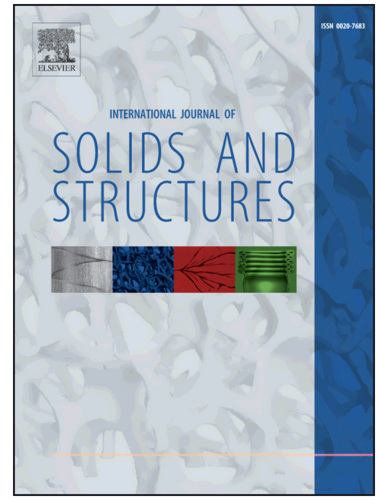

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On the application of the method of fundamental solutions for the study of the stress state of a plate subjected to elastic-plastic deformation

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Abstract

The plane elastoplastic problem for the stress state of a plate with a narrowing subjected to uniaxial extension is considered. The behaviour of the material that hardens with plastic deformation is characterized by the Ramberg-Osgood stress-strain relation. Since this relation provides a smooth continuous curve over the whole elastic and plastic deformation range, the same governing equation can be used for both deformation regions. The paper provides a method for solving the resulting nonlinear boundary-value problem. The algorithm is based on meshless methods, i.e. the method of fundamental solutions and the method of particular solutions, together with a Picard iteration process. The approximate solution, i.e. the stress function, obtained in each iteration step is a linear combination of fundamental and particular solutions. It can thus be further used to compute the values of stresses and some effective material parameters (i.e. the Young modulus and the Poisson ratio) at any point of the domain.

Keywords: meshless methods, method of fundamental solutions, method of particular solutions, Picard iteration process, Ramberg-Osgood model, elastic-plastic deformation, uniaxial extension

1. Introduction

Among other important topics of interest in the area of continuum mechanics, an analysis of deformation of elastoplastic materials seems to be one of the most significant. There are a number of numerical methods that can be used for solving elastoplastic problems. We can distinguish the finite element method (FEM) (see e.g. Cramer et al., 1999; Daoheng et al., 2000; Bilotta and Casciaro, 2007; Cui et al., 2009; Berezhnoi and Paimushin, 2011), the boundary element method (BEM) (see e.g. Dong and Antes, 1998; Gao and Davies, 2000; Deng et al., 2011; Ochiai, 2011) and a coupling of these two popular methods (see e.g. Dong and Bonnet, 1998). As an alternative to these methods, mesh-free methods have been developed in the last decades. The method of fundamental solutions (MFS) that is subsequently applied by the authors belongs to the family of meshless methods. Nevertheless, there is a number of meshfree methods, such as the element-free Galerkin method, the meshless local Petrov-Galerkin method, the point interpolation method, the finite point method, the finite difference method with arbitrary irregular grids, and so forth. Some of these methods were applied for solving elastoplastic problems (Yeon and Youn, 2005; Boudaia et al., 2009).

The MFS was first formulated by Kupradze and Aleksidze (see e.g. Kupradze, 1964; Kupradze and Aleksidze, 1964; Aleksidze, 1966) in the 60s. It is a relatively new meshless method for solving certain boundary-value problems. It gained increasing popularity because of some significant advantages over other methods. The most important advantage is that its implementation is simple, even for problems in complicated geometries. There are also other important features that distinguish the MFS from the boundary

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