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Elastic field prediction for a welding repaired material using a semi-analytical method.

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Summary: Material mismatch between the welding bead and its surrounding matrix has been known to cause stress concentration due to incompatible deformation, and/or even crack regeneration, thus greatly affecting the performance of a welding repaired material. In this paper, a semi-analytical method (SAM) is developed to tackle problems for material mismatch in a welding repaired material with free surface under remote tensile loading. The heterogeneous welding bead is modeled by a homogeneous base material containing unknown eigenstrains through the equivalent inclusion method; after which a numerical discretization is adopted and the eigenstrains within each computational element are determined by iteratively solving a set of linear equations with the assistance of conjugate gradient method. Stress field arising from the eigenstrains can be obtained by employing previously derived influence coefficients. The SAM is then examined by a simple finite element model and utilized to analyze influences of material properties, aspect ratio, angle of differently shaped welding bead and interactions among multiple welding beads on the stress distribution. The SAM may have potential applications in dealing with problems related to residual stress in welded material due to eigenstrains.

MSC:

74G10 Analytic approximation of solutions (perturbation methods, asymptotic methods, series, etc.) of equilibrium problems in solid mechanics

Keywords:

semi-analytical method; elastic field; welding repair; equivalent inclusion method; remote tensile loading

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