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Three-dimension J-integral for Large Deformation Elastic-plastic Problems Using Quadratic Tetrahedral Finite Elements

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In this presentation, we discuss about the three-dimensional J-integral evaluation for material and geometric nonlinear problems. The domain integral method with the quadratic tetrahedral finite element is adopted to compute the three-dimensional J-integral. We can make use of automatic meshing software to build fracture mechanics analysis models, since the model is consisting of the tetrahedral elements.

It should be pointed out that, for material and geometric nonlinear problem, we need to account for domain integral term that contains the derivatives of the strain energy density, the stresses, and the displacement gradients. This term is usually ignored with the assumption of proportional loading when elastic-plastic analysis is carried out under the assumption of infinitesimally small deformation. We developed a method to accurately compute the derivatives of the strain energy density, the stresses, and the displacement gradients for quadratic tetrahedral finite elements using local least squares approximation to compute the derivatives. The value of evaluated J-integral is independent of the size and the shape of domain of integration. Proposed method can be used in three-dimensional J-integral evaluation for large deformation elastic-plastic problems.

Keywords: J-integral, Domain integral method, Large deformation elastic-plastic analysis, Quadratic tetrahedral finite element, Local least squares approximation