Fracture mechanics evaluation of V-bending die with a hole

using parametric analysis system

with coupling-matrix-free iterative s-version FEM

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ABSTRACT

Operators of V-bending process have sometimes been injured because of broken piece of a die. To prevent this accident, a structure of the die that is tough to break is required. According to the previous study [1], introducing a hole in the V-bending die reduced stresses at the bottom of V-groove. Therefore, parametric study of a hole in a structure is necessary to find an appropriate design of the structure. However, parametric study of a structure with a hole using conventional FEM has difficulty in remeshing. Using coupling-matrix-free iterative s-version FEM [2], a mesh of the whole analysis domain and a mesh in the vicinity of the hole can be created separately as a global mesh and a local mesh, respectively. In this study, we proposed a parametric analysis system to analyze the die with a hole for V-bending process, and we evaluated the results in terms of fracture mechanics. Fracture modes we considered were fatigue fracture and brittle fracture. We evaluated fatigue fracture by stresses and brittle fracture by stress intensity factors. The stress intensity factors were calculated by a three-dimensional virtual crack closure-integral method (VCCM) [3]. In the present parametric analysis system with the coupling-matrix-free iterative s-version FEM, we can analyze the V-bending die with a hole only by moving the coordinates of the local mesh. Thus, this system makes a parametric analysis possible to be executed automatically by a single command. As a result of the parametric analysis of the die for V-bending die with a hole, both stresses at the bottom of V-groove and stress intensity factors at the deepest point of the crack were reduced.

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