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Explicit finite element analysis of failure behaviors of thermoplastic composites under transverse tension and shear

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Abstract This paper studies failure behaviors of glass fiber/PC resin thermoplastic composites under transverse tension and shear loads using explicit finite element method. Microscopic long fiber/matrix composite representative volume elements with randomly distributed fibers and periodic boundary conditions are established by ABAQUS-PYTHON script language. The finite-deformation viscoplastic Gurson model is used for predicting the plastic deformation and void growth of thermoplastic glassy polymer matrix, which is implemented using ABAQUS-VUMAT explicit subroutine. The bilinear cohesive model with finite-thickness interface element is used to simulate the fiber/matrix debonding. Three important issues are explored: First, effects of the cohesive interface strength on the plastic deformation and void growth of composites are studied using three mesh models and three fiber distributions. Second, failure surface under different tensile and shear displacement ratios is obtained, compared with the predictions using the Hashin and Puck failure criteria developed mainly for thermoset composites. Finally, the influence of the plastic softening effect of matrix on the strain concentration or localization behaviors is discussed. Results show the tension/shear load ratio and the cohesive interface strength produce large effects on the void growth and failure surface of composites, but fiber distribution shows a small effect on transverse load-bearing ability of composites.

Keywords**:** Thermoplastic composites, Void growth, Failure surface, Cohesive interface, Representative volume element (RVE), Explicit finite element analysis (FEA)