Dynamic Stress and Failure Characteristics around an Elliptical Cavity Subjected to Impact Loading

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Abstract

Based on complex conformal mapping and Duhamel's integral method the steady and transient dynamic stress distribution around an elliptical cavity subjected to plane P-wave was obtained. The influence of incident angle($\vartheta 0$), axial ratio(k) and normalized wave length (t0) on the dynamic stress concentration factor (DSCF) was evaluated. Further, the finite element method (FEM) software LS-DYNA was utilized to validate the analytical solution. The results indicated that the maximum compression DSCF increased with $\vartheta 0$, except $\vartheta 0$=0, and decreased with k. When $\vartheta 0$=0 the maximum tensile DSCF increase with the decrease of k. The position of maximum compression and tensile DSCF varied with incident $\vartheta 0$. Under the transient incident condition DSCF was affected by normalized wave length t0, with the increasing of t0 the DSCF gone up then down finally gone closed to the static stress concentration factor. Further, the stress state around the elliptical cavity under transient impact loading was compared with the experimental results of elastic stress distribution and plastic failure and got a good agreement, and possible dynamic failure modes of elliptical cavity were discussed.

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