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Characterizing and Modelling Delamination of Carbon-Fiber Epoxy Laminates during Abrasive Waterjet Cutting

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Abstract

Delamination is a common defect when abrasive waterjet (AWJ) cutting composite laminates. This paper presents experimental and numerical results used to characterize delamination when AWJ cutting a carbon-fiber/epoxy laminate. A fluid-structure interaction model was used to simulate the AWJ cutting. The structural domain used cohesive zone modeling to predict delamination along the ply interfaces. The numerical results showed that cutting delamination of the carbon-fiber/epoxy was primarily dependent on the normal interlaminar stress, with relatively large damage zones occurring ahead of the cutting front. This trend was also observed in x-ray micro-tomographs of an AWJ cut. To distinguish between side-wall and cutting-front forces, the loading generated by the jet was measured using a strain gage. This showed that the loads applied to the cutting front were larger than those generated on the side walls, and thus the likelihood of delamination was greater on the cutting front. The amount of delamination during AWJ cutting was measured using a moisture uptake methodology that was implemented with a six-factor (pressure, stand-off distance, abrasive flow rate, traverse speed, mixing-tube size, and fiber orientation) Taguchi experimental design. The trends evident in these data were consistent with the extent of delamination predicted by the numerical models,