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Experimental and Computational Investigation of Blast Response of Carbon-Epoxy Weathered Composite Materials ☆

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ABSTRACT

An experimental study, with corresponding numerical simulations, was conducted to investigate the blast response of weathered Carbon-Epoxy composite plates. The dynamic behavior of the composite plates with and without prior exposure to an aggressive marine environment was explored using a shock tube apparatus coupled with a high speed photography system. In order to simulate prolonged exposure in an aggressive marine environment, specimens were submerged in an elevated temperature, 3.5% salt solution for 0, 30 and 60 days. The saline solution temperature was maintained at 65°C to accelerate the aging process. Finite element modeling (FEM) for the blast loading experiments was performed using the Ls-Dyna code. Models have been developed for both the simply supported and fixed boundary condition cases.

Tensile and four point bend tests were performed to characterize the quasi-static mechanical behavior of the composite material before and after prolonged exposure to aggressive marine environments. After 30 and 60 days of submergence, the tensile modulus decreased by 11% and 13%, the ultimate tensile strength decreased by 12% and 13%, and the ultimate flexural strength decreased by 22% and 22%, respectively.

Dynamic blast loading experiments were performed on simply supported and fully clamped specimens, to determine the effects of the boundary conditions on the Carbon-Epoxy specimen response. The Weathered (30 and 60 days) and Non-Weathered (0 day) specimens displayed dramatically different behavior after being subjected to a blast load. For the simply supported case, Non-Weathered specimens displayed an average maximum out of plane displacement of 20 mm and recovered elastically. Weathered specimens, both 30 and 60 days exhibited similar initial transient behavior but failed catastrophically due to through thickness cracking at the point of maximum deflection. For the fixed boundary condition, the Non-Weathered specimens displayed an average maximum out of plane displacement of 5.57 mm, whereas the 30 day and 60 day weathered specimens displayed a maximum out of