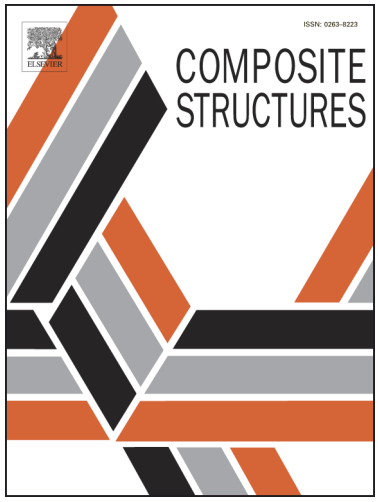

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Fatigue crack growth behavior of aerospace and ship-grade aluminum repaired with composite patches in a corrosive environment

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Abstract

Investigation of the performance for a composite repair patch to prolong the service life of pre-cracked 7050, 7075, 5083 and 6061 aluminum plates under fatigue conditions in a corrosive environment was conducted. Both insulated graphite-epoxy and boron-epoxy composite patches were evaluated for the effects of corrosion fatigue. The repair patches consisted of unidirectional plies (laminae) oriented in the loading direction. The improvement of service life and the effect that a corrosive environment had on crack propagation rates for the repaired aluminum plates were examined. The bond durability between the aluminum plates and the boron patch were also assessed. As expected, the introduction of salt water during testing greatly increased crack growth rates and can be quantified for comparison. The graphite patch consistently showed positive results compared to the boron patch for 6061 aluminum samples. The same system on 5083 aluminum had mixed results. Examination of potential 5083 sensitization due to elevated cure cycles is discussed. The boron-epoxy repairs showed a positive life improvement in both lab air and salt water exposed environments for 7050 and 7085 aluminums while the graphite-epoxy repair accelerated crack growth rates in the salt water environment.

1. Introduction

Corrosion is ever-present in operating areas for the United States Navy, which presents the Department of Defense with a very costly maintenance program. Maritime structures are constantly exposed to harsh environments such as sea spray, which results in increased crack propagation or premature fatigue, particularly enhanced due to corrosion. Corrosion is one of the primary problems for aging fleets around the globe, and major initiatives and studies have been done to study the issues affecting these fleets as in [1-3]. Adhesively bonded composite patch repair has been successfully applied to military aircraft repair, but the corrosion effects of harsh sea-based environments on patch repairs has yet to be characterized. More specifically, corrosion fatigue, or environmental effects on fatigue, is a common form of material degradation causing increased costs, reduced availability, or failure. Vehicles or vessels undergo cyclical stresses, which, when combined with the caustic environment at sea, greatly reduce the operational life of