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Fatigue and fracture mechanics analysis of dissimilar joints in ship structures via Thermoelasticity

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The use of hybrid joints composed of dissimilar materials presents a promising technological solution for combining the distinct advantages of different materials, enabling the design of components that meet diverse and often conflicting performance requirements. This challenge is particularly relevant in shipbuilding, where structures must be simultaneously strong, corrosion-resistant, and lightweight, while also aligning with sustainability goals across production, usage, and end-of-life phases.
Steel–aluminum joints produced via explosion welding offer an effective compromise, combining the mechanical strength of steel with the corrosion resistance and low density of aluminum. Despite their potential, these joints remain underutilized, largely due to limited understanding of their structural performance and damage mechanisms. Process-induced imperfections, such as interfacial defects and residual stresses, pose significant concerns especially in marine applications where high mechanical reliability is essential. Consequently, a thorough investigation into the fatigue behavior and fracture mechanics of these joints is critical.
Fatigue crack growth in general materials is governed by the driving force at the crack tip, which can be analyzed through various analytical and numerical models that describe the plastic work and energy dissipation mechanisms. From an experimental standpoint, advanced techniques such as infrared thermography and digital image correlation have proven effective in recent years for assessing fracture mechanics parameters.
This research focuses on the fatigue crack propagation behavior of Triclad joints, which are three-layer composite materials fabricated via explosion welding. These joints consist of an ASTM A516 Gr55 steel base plate and an AA5086 aluminum flyer plate, separated by an AA1050 aluminum interlayer. Through the application of multiple experimental techniques, this study aims to address key challenges such as early detection of crack initiation and growth, identification

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