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Mixed-mode fracture response of metallic fiber-reinforced epoxy adhesive

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Abstract

Adding metallic fibers to the adhesive layer in adhesively bonded joints can increase the load bearing capacity of the joints. This paper aims to determine the effect of metal fiber incorporation on the fracture toughness of aluminum/epoxy adhesive/aluminum joints under mixed mode loadings. The experimental tests on Double Cantilever Beam (DCB), End Notched Flexure (ENF) and Single Leg Bending (SLB) specimens were conducted to assess the fracture energy of both non-reinforced and reinforced adhesives in pure mode I (G_{IC}), pure mode II (G_{IIC}) and mixed mode (G_T) loading conditions. The distance between the metal fibers was considered as the key parameter in the experiments. The experimental results showed that the highest improvements in fracture energy were obtained for the specimens under mode I loading condition with a considerable improvement about 12 times higher than the non-reinforced adhesive. Additionally, the reinforced adhesive joints with lower fiber distances had higher values of fracture energy. The fracture surfaces were analyzed using microscopic photography. It was found that the presence of metallic macrofibers in the adhesive layer led to a mixture of failure mechanisms in reinforced adhesives including fiber pull out, fiber bridging, fiber slippage and shear banding resulting in rougher fracture surfaces.

Keywords: Adhesive reinforcement; Metal fibers; Ductile adhesive; Double Cantilever Beam (DCB); End Notched Flexure (ENF) ; Single Leg Bending (SLB)

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