

INTISARI

Komposit *Glass Fiber Reinforced Polymer* (GFRP) banyak digunakan pada aplikasi struktur ringan. Namun, kerusakan seperti delaminasi dan patahnya serat masih menjadi tantangan utama, khususnya dalam konteks perbaikan. Penelitian ini mengkaji efektivitas berbagai model perbaikan komposit serta peran penambahan *filler Multi-Walled Carbon Nanotube* (MWCNT) dalam memulihkan kinerja mekanik laminat GFRP yang mengalami kerusakan. Rumusan masalah penelitian difokuskan pada identifikasi konfigurasi perbaikan yang paling efektif berdasarkan sifat tarik, lentur, dan kekerasan, serta evaluasi pengaruh penambahan MWCNT (0,1-0,5 wt%) pada komposit hasil perbaikan. Spesimen perbaikan difabrikasi menggunakan metode *Vacuum Assisted Resin Infusion* (VARI) dengan variasi jenis serat penambal, meliputi *glass*, *carbon*, *hybrid Kevlar-carbon*, dan *hybrid polyester-carbon*, sementara MWCNT didispersikan ke dalam resin epoksi. Pengujian dan karakterisasi dilakukan melalui pengujian mekanik, pengukuran densitas, *Digital Image Correlation* (DIC), *Scanning Electron Microscopy* (SEM), dan *Differential Scanning Calorimetry* (DSC). Hasil penelitian menunjukkan bahwa perbaikan menggunakan serat *carbon* dan *hybrid Kevlar-carbon* memberikan pemulihan tertinggi terhadap kekuatan tarik dan lentur akibat peningkatan transfer beban dan kekakuan. Penambahan MWCNT dengan konsentrasi optimum sekitar 0,3 wt% terbukti meningkatkan kinerja mekanik dan kualitas ikatan antarmuka, sedangkan konsentrasi yang lebih tinggi menyebabkan aglomerasi dan penurunan performa. Secara keseluruhan, penelitian ini memberikan kontribusi eksperimental dalam pengembangan strategi perbaikan komposit yang dioptimalkan melalui pemilihan serat dan penguatan skala nano untuk aplikasi struktural.

Kata kunci: Perbaikan komposit, GFRP, VARI, sifat mekanik

ABSTRACT

Glass Fiber Reinforced Polymer (GFRP) composites are widely used in lightweight structural applications. However, damage such as delamination and fiber fracture remains a critical challenge, particularly in repair scenarios. This study investigates the effectiveness of different composite repair models and the role of Multi-Walled Carbon Nanotube (MWCNT) fillers in restoring the mechanical performance of damaged GFRP laminates. The research aims to identify the most effective repair configuration based on tensile, flexural, and hardness properties, while evaluating the influence of MWCNT addition (0.1-0.5 wt%) on the repaired specimens. Repair specimens were fabricated using the Vacuum Assisted Resin Infusion (VARI) method with various patch fibers, including glass, carbon, Kevlar-carbon hybrid, and polyester-carbon hybrid, while MWCNTs were dispersed into the epoxy resin. Mechanical testing, density measurement, Digital Image Correlation (DIC), Scanning Electron Microscopy (SEM), and Differential Scanning Calorimetry (DSC) were employed for characterization. The results show that carbon fiber and Kevlar-carbon hybrid repairs provide the highest recovery in tensile and flexural strength due to improved load transfer and stiffness. An optimal MWCNT content of approximately 0.3 wt% enhances mechanical performance and interfacial bonding, while higher contents lead to agglomeration and performance degradation. Overall, this work provides experimental insights into optimized composite repair strategies combining fiber selection and nanoscale reinforcement for structural applications.

Keywords: Composite repair, GFRP, VARI, mechanical properties