World Academy of Science, Engineering and Technology
International Journal of Materials and Textile Engineering
Vol:18, No:07, 2024

Comparative Assessment of Finite Element Methodologies for Predicting Post-Buckling Collapse in Stiffened Carbon Fiber-Reinforced Plastic (CFRP) Panels

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Abstract : The stability and collapse behavior of thin-walled composite structures, particularly carbon fiber-reinforced plastic (CFRP) panels, are paramount concerns for structural designers. Accurate prediction of collapse loads necessitates precise modeling of damage evolution in the post-buckling regime. This study conducts a comparative assessment of various finite element (FE) methodologies employed in predicting post-buckling collapse in stiffened CFRP panels. A systematic approach is adopted, wherein FE models with various damage capabilities are constructed and analyzed. The study investigates the influence of interacting intra- and interlaminar damage modes on the post-buckling response and failure behavior of the stiffened CFRP structure. Additionally, the capabilities of shell and brick FE-based models are evaluated and compared to determine their effectiveness in capturing the complex collapse behavior. Conclusions are drawn through quantitative comparison with experimental results, focusing on post-buckling response and collapse load. This comprehensive evaluation provides insights into the most effective FE methodologies for accurately predicting the collapse behavior of stiffened CFRP panels, thereby aiding structural designers in enhancing the stability and safety of composite structures.

Keywords : CFRP stiffened panels, delamination, Hashin’s failure, post-buckling, progressive damage model
Conference Title : ICCMAS 2024 : International Conference on Composites, Materials, and Structures
Conference Location : New York, United States
Conference Dates : July 11-12, 2024

Open Science Index, Materials and Textile Engineering Vol:18, No:07, 2024 publications.waset.org/abstracts/186782.pdf