Synopsis Seminar

Seminar Title	: Numerical and Experimental Investigation on the Structural Response of Adhesively Bonded Joint with Multiple Damage Under Thermo-Mechanical Loading
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Abstract

: Now-a-days, multi-material structures are being increasingly used in many applications because they combine the benefits of different materials within a single component and can able to tailor the specific properties and functionalities. One of the most essential techniques for joining multi-material structures is adhesive bonding. It offers many advantages over traditional joining methods like uniform stress distribution, increased design flexibility and the ability to join dissimilar materials. Adhesively bonded joints are commonly used in many structural applications, where they are subjected to dynamic loading under different environmental conditions. The present research work focuses the numerical and experimental study on the structural behaviour (natural frequency, static deflection, and dynamic response) of adhesively bonded single lap joints (SLJs) under thermo-mechanical loading conditions. Two distinct adherent materials such as aluminium alloy (AA2014) and glass fiber reinforced polymer (GFRP) composite and an epoxy-based adhesive is taken in this study. The finite element analysis (FEA) tool (ABAQUS CAE, 2021) is used to develop a 3D explicit model of the bonded joint, enabling the simulation of its behaviour under different loading scenarios. To accurately measure the behaviour of the joint structure, 8-node quadrilateral in-plane general-purpose continuum shell elements (SC8R) are used to model the polymer adherend. In contrast, 8-node linear brick elements (C3D8R) are used to model the homogeneous isotropic materials of the adhesive and metal adherend. The Lanczos iteration method is employed to evaluate the natural frequency response. An implicit solver with a general static step is applied to analyze the static response, while an explicit dynamic procedure with an explicit time integration scheme is used to compute the dynamic response. Initially, a sufficient number of convergence tests are conducted to verify the consistency of the developed numerical model. Then, the accuracy of the numerical model is validated against published results (numerical and experimental). Subsequently, the second stage verification is carried out through experimentation to validate the numerical results. Further, design parameters influencing the structural response such as fiber orientation, boundary conditions, loading position, delamination shape, presence of cracks and crack position and orientation are analyzed. The decrease in eigenvalue response of 6.47%, 4.11% and 8.82% is observed with the presence of crack, delamination and combined damage, respectively in the jointed structure compared to the intact one. The combined damages (longitudinal crack with delamination) increase the deflection response with an increase in temperature. The dissimilar joint exhibits a 4.70% higher deflection than the similar joint at &DeltaT = 10°C. The dynamic response of longitudinal crack-embedded similar and dissimilar joints decreases with the increase in temperature. Besides, the strength of the bonded joint is analyzed both numerically and experimentally. The maximum bond strength is found at adhesive thickness of 0.15 mm and an overlap length of 12.5 mm through experimental study. Finally, a predictive model is developed to determine the bond strength of the adhesively bonded joint using machine learning (ML) techniques.