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**Original Article**

# A comprehensive statistical evaluation of shear and peel stresses in adhesively bonded joints

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**ABSTRACT**

This study presents a detailed analysis of shear and peel stresses in adhesively bonded single lap joints using the Goland and Reissner analytical model. The investigation evaluates the effects of key parameters, including adhesive thickness, adhesive material, adherend material, and overlap length on stress distribution. A General Linear Model (GLM) and Analysis of Variance (ANOVA) are used to assess the significance of each factor. Results show that adhesive thickness contributes 36.55% to shear stress variation, followed by adhesive material (31.08%) and adherend material (25.83%). For peel stress, adhesive thickness accounts for 38.01% of the variation. A second-order polynomial regression model is employed to capture non-linear relationships between the input parameters and stress outcomes. The predicted shear stress of 8.676 MPa closely matches the actual value of 8.64 MPa, with a relative error of 0.42%, while the predicted peel stress of 10.9901 MPa aligns with the actual value of 11.04 MPa, with a relative error of 0.45%. The analysis highlights that thinner adhesive layers lead to higher stress concentrations, while thicker layers distribute stress more effectively. The choice of adhesive material and adherend material also significantly impacts stress levels. The study concludes that optimizing adhesive thickness, material selection, and overlap length is essential for improving the performance and reliability of adhesively bonded joints. The polynomial regression model successfully captures the non-linear stress behavior, offering a robust tool for predicting joint performance.

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## INTRODUCTION

Adhesively bonded joints are widely used in various structural applications like aerospace, automotive, and civil engineering. These joints provide light weight and the possibility of joining dissimilar materials without damaging the structural integrity of the assembly [1]. Due to their increasing application, the complex interaction of various factors such as adhesive thickness, adherend material, and overlap length and environmental influences make the accurate prediction of their mechanical behavior under different loading conditions difficult to carry out [2].

Adhesive thickness is one of the major issues in the performance of ABJs. Several investigations demonstrated that optimum adhesive thickness is related to higher joint strength and reliability. Arenas et al. [3] considered 0.5 mm as the optimum value of adhesive thickness to obtain the maximum joint strength of structural joints. da Silva et al. [4] also identified adhesive thickness as one of the major factors contributing to a significant share of variance in shear strength, pointing out that smaller adhesive thicknesses minimize the concentration of stress, further adding to the general strength. Using the DOE approach, Lasprilla-Botero et al. [5] showed that adhesive formulations

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