

# **Reliability analysis of non-destructive evaluation techniques investigating adhesive joint quality**

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Non-destructive testing (NDT) and evaluation (NDE) are important for quality, safety, and reliability in different industries. Due to the insufficient reliability of non-destructive testing techniques for the evaluation of adhesive joints, it is an underused and undervalued joining technology. Adhesive bonding is superior to other joining methods with homogeneous load distribution, high strength-to-weight ratio, ability to join dissimilar materials and complex structures; however, its application is limited to secondary load structures, mainly because there is a lack of reliable NDT techniques for detecting weak bonds. In this study single-lap adhesive joints, containing different bonding qualities – perfect bond, debonding, and few types of weak bond - have been investigated with conventional pulse-echo ultrasonic technique and X-rays. To evaluate the impact of the various influential parameters in the case of adhesive bond inspection, a parametric and sensitivity study was performed using CIVA software. Then, the probability of detection curves for each type of bond have been calculated. Several parameters such as the thickness of adherend, thickness of adhesive, acoustic velocities of adhesive have been varied during metamodel calculations. The non-destructive evaluation of bonding quality (for perfect and weak bond cases) has been reported quantitatively by using probability of detection curves. The work highlights the need for a quantitative non-destructive evaluation of the quality of the adhesive bonding along with the importance of model-assisted probability of detection estimations.