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Abstract

The doctoral dissertation titled "Apparent Young's Modulus in Predicting the Strength of Adhesive Joints" focuses on analysing the properties of adhesive bonds, with particular emphasis on the non-uniformity of the Young's modulus across the thickness of the adhesive joint. Furthermore, the observed variations in the Young's modulus, as identified in experimental studies, were incorporated into the numerical modelling of adhesive joint. The dissertation comprises eight chapters, each delving into specific aspects related to the main subject.

The first and second chapters provide an introduction to the dissertation topic and a detailed analysis of the current state of knowledge regarding adhesives and adhesive joints. These chapters describe the characteristics of adhesives, including their properties and classification, as well as the theory behind the constitution of adhesive bonds. The discussions extend to the theories of adhesion and cohesion, as well as issues related to defects in adhesive joints. Additionally, these chapters review methods for the numerical modelling of adhesive joints and explore the phenomenon of apparent Young's modulus and changes in the properties of adhesive bonds. Chapter three outlines the justification for the dissertation's topic, its objectives, and scope, as well as the research hypotheses. The fourth chapter provides a detailed description of the research conducted. It details the research objects, materials used in the experiments, and the research methods employed, such as nanoindentation tests, stress analysis of adhesive joints, Young's modulus measurements of the adhesive material, and specifics of the numerical model development. Chapter five presents the results of the author's research and provides a thorough discussion of the findings. The sixth chapter focuses on the statistical analysis of the research results. Chapter seven offers a summary of the dissertation.

From the research findings, it follows that the Young's modulus of the adhesive layer varies significantly across its thickness, reaching its highest values in the interfacial region near the adhesive-metal boundary and decreasing towards the core of the adhesive layer. The adhesive layer can be segmented into zones with different Young's modulus values, with the elastic adhesives showing approximately a 24% difference and the rigid adhesives showing about a 15% difference. Incorporating these variations into the numerical modelling of adhesive joints enables more accurate predictions of joint strength, validating the research hypotheses. Notably, in the case of very thin adhesive layers, utilizing a model that accounts for the variability in

Young’s modulus can significantly enhance modelling accuracy. Based on the experimental results, a method for modelling adhesive joints was proposed that improves the precision of strength predictions and could have substantial implications in industrial applications such as aerospace and automotive industries, where precise modelling of adhesive joints is crucial.

Keywords: adhesives, adhesive joints, apparent Young modulus, heterogeneity of adhesive joints