Effectiveness of damage identification in composite plates using damage indices based on smoothing polynomials and curvelet transform: A comparative study

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Damage identification *Damage indices* *Curvelet transform*

Abstract With continuously growing demands to the structural safety and reliability, effective damage identification methods in structures are crucial to react on the identified damage timely and perform necessary repairing or replacement actions. From the variety of available non-destructive testing techniques applied nowadays for this purpose, vibration-based damage identification is considered as effective and inexpensive approach widely used in mechanical and civil engineering applications. However, the research results in the last decades clearly indicate that detection and identification of small damage in structures requires additional processing of raw results acquired from a modal analysis. Usually, mode shapes or modal curvatures are taken into account during such a procedure due to their high sensitivity to structural damage. This is due to the ability of detection and localization of local decrease of stiffness indicating damage.

To-date, numerous approaches and algorithms have been developed for damage identification. These approaches can be grouped into two main categories: the approaches based on the damage index concept involving various processing techniques and the approaches based on direct application of various transforms. Within this study, we compare a performance of the approaches from both of these groups, namely, the damage indices based on smoothing polynomials and the curvelet transform. Both approaches are reference-free, which means that only a damaged structure is considered in the damage identification procedure and no reference data is necessary for a comparison purpose, which has significant practical meaning. The approach based on damage indices is selected due to its proven sensitivity to damage in previous studies, while the selection of the curvelet transform for processing of mode shapes was chosen due to its exceptional filtering capabilities and some other useful properties.

The studies were performed on experimental vibration data acquired for artificially damaged laminated composite structures. The advantages of the application of both approaches as well as their performance in terms of proper detection, localization, and identification of single and multiple damage sites were deeply analyzed and discussed. The results of this study show the superior filtering ability of both approaches, which makes it possible to identify small damage in composite structures using vibration data.

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