

Vibration based Structural Health Monitoring of Composite Structures

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IMPACT

Introduction

One of the key issues in composite structures for aircraft applications is the early identification of (invisible) damage, like delaminations. Their identification often imposes costly and time consuming maintenance techniques (figure 1). Vibration based Structural Health Monitoring proposes a promising alternative. The measured change of the dynamic properties is employed to detect and localise damage.



Figure 1: Left, visible damage, a matter of pattern recognition. Right, time consuming and costly inspection.

Objective

Damage identification in advanced composite structures based on dynamic behaviour by using an integrated sensor system.

Approach

The feasibility of the Modal Strain Energy Damage Index algorithm is investigated [1]. Two steps are distinguished:

- **Dynamic measurement:** A forced-vibration set-up, including a laser vibrometer system, is employed to measure the dynamic behaviour (see figure 2) of a stiffened plate structure up to 2 kHz.

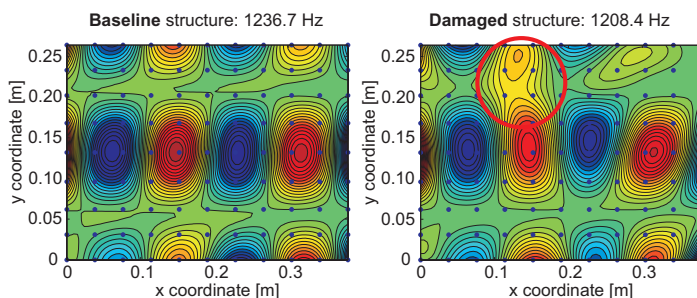


Figure 2: Experimental mode shapes of a stiffened composite plate structure.

- **Damage identification:** The mode shape curvatures, including a cubic spline interpolation, are used in the Modal Strain Energy Damage Index algorithm [2].

Modal Strain Energy Damage Index

Impact induced damage is detected and localised [1] in the composite structure, even for a reduced number of measured points, as shown in figure 3. The 1D formulation tends to be more sensitive compared to the 2D formulation. This is caused by the fact that mainly the bending stiffness in one direction (x) is affected.

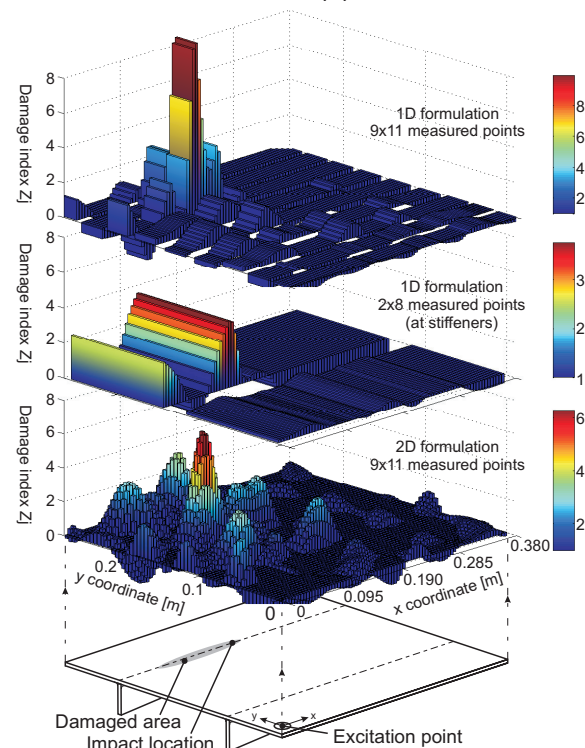


Figure 3: Experimental results, showing the damage index Z_j distributions across the composite plate structure.

Outlook

Future work will focuss on the application of integrated sensors, like optical fibre Bragg gratings, for dynamic measurements. Moreover, the extension to more complex structures.

References

1. T.H. Ooijevaar, L.L. Warnet, R. Loendersloot, R. Akkerman, A. de Boer. In Proceedings of the Fifth European Workshop on Structural Health Monitoring: 2010.
2. N. Stubbs, J.T. Kim, and C.R. Farrar. In Proceedings of the 13th International Modal Analysis Conference, pages 210–218, 1995.

