OPTIMAL SENSOR PLACEMENT IN COMPOSITE CIRCULAR CYLINDRICAL SHELLS FOR STRUCTURAL HEALTH MONITORING

SANDRIS RUCEVSKIS[1], ANDREJS KOVALOVS[2], ANDRIS CHATE[3]

[1]Riga Technical University, Institute of Materials and Structures, Latvia, sandris.rucevskis@rtu.lv,

[2]Riga Technical University, Institute of Materials and Structures, Latvia, andrejs.kovalovs@rtu.lv,

[3]Riga Technical University, Institute of Materials and Structures, Latvia, andris.cate@rtu.lv

Laminated composite cylindrical shells are widely used as structural elements in many engineering fields such as aerospace, automotive, marine, civil and mechanical engineering due to their superior stiffness and strength properties. However, these advantages are balanced by a lower damage tolerance. External mechanical and cyclic loads as well as varying environmental conditions can induce damage in composite structures, which can heavily degrade their mechanical properties and load carrying capability. Structural damage can initiate failure and disintegration leading to undesirable consequences and losses. Thus, structural health monitoring (SHM) and damage detection is one of the most important tools for maintaining the integrity and safety of the composite structures. The aim of SHM is to detect, locate and assess various defects in composites at the earliest stage possible to ensure their safety and durable service life. One of the best solutions for this purpose is to integrate a sensor network in composites for periodic or continuous monitoring and evaluation of structural state. The quality of monitoring and damage identification greatly depends on the data received from sensors. Therefore, optimal sensor placement in composites is very important task for obtaining accurate and reliable information.

This work presents an approach for optimal placement of strain sensors in composite circular cylindrical shells. The approach uses numerical strain values in longitudinal and transverse directions extracted from the top surface of the thin-walled composite cylindrical shell. Numerical model of composite cylindrical shell was modelled using the FE commercial solver ANSYS. The modal analysis with the Lanczos eigensolver was performed to determine the first 11 eigenvalues and corresponding eigenvectors. Number of sensors and their location were obtained taking into account different loading conditions of the composite shell, physical constraints of strain sensors and optimisation strategies.