METHODICAL DEVELOPMENT OF A STRUCTURAL HEALTH MONITORING SYSTEM FOR COPV SUPPORTED BY A DIGITAL SHADOW

Rebecca Richstein[1*], Thorsten Reichartz[1], Andreas Janetzko-Preisler[1], Kai-Uwe Schröder[1]

[1]RWTH Aachen University, Institute of Structural Mechanics and Lightweight Design, Wüllnerstraße 7, 52062 Aachen, Germany
* rebecca.richstein@sla.rwth-aachen.de

Hydrogen promises to become an important green option for future mobility [1]. Safety and reliability are essential for the widespread use of H_2 pressure vessel and are a special concern for composite overwrapped pressure vessels (COPV). The associated inspection effort can be significantly reduced using Structural Health Monitoring (SHM) systems [2]. Digital Shadows (DS) can play an important role in the design and operation of the SHM system by collecting, analysing and visualizing data, even during operation.

To achieve online monitoring and evaluation, the use of classical FEM models involves excessive computational effort and is unable to reach a real time capability. Therefore, the FEM model of the vessel is reduced to a few measurement points, so information is only available at potential sensor locations. For these locations, pre-calculated potential damages and their strain effects into the structure are stored as sets of strain values in a databank. New data sets, e.g. measurements, are compared pairwise with these pre-calculated set taking into account a potential fuzziness. Comparing each measurement value with all possible database values at the same point the most probable damage scenario is reconstructed, as indicated by the red markings in Figure 1.

The higher the reduction of the model, the more inaccurate the statements of the SHM evaluation system become. Therefore, further structural-mechanical constraints of the vessel, such as the rotational symmetry, are introduced into the DS. The constraints additionally put the measured values into relation. Within this workaround, it is possible to assign simulated delamination damage with a probability up to 98%.

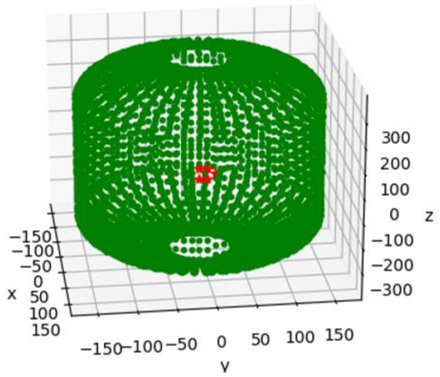

Figure 1. The H_2 vessel, reconstructed by data points (green) which are pairwise compared to datasets of damaged structures to evaluate size and position of the damage (red).

References

[1] R. Moradi and K. Groth (2019) Hydrogen storage and delivery: Review of the state of the art technologies and risk and reliability analysis. *International Journal of Hydrogen Energy*, **44**, 12254 – 12269.

[2] A. Preisler (2020) Efficient damage detection and assessment based on structural damage indicators. *PhD thesis,* RWTH Aachen University, DOI: 10.2370/9783844072037