Naval composite structure monitoring by fibre optics strain measurements MARINE 2023

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ABSTRACT

Naval structures must combine robustness and efficiency. This concern for optimization can lead, depending on the case of use, to the use of composite materials, whether for their interesting weight/mechanical performance ratio, their non-corrosion property or the ability to functionalize them. The structural damage of these materials is not necessarily visible to the naked eye but can have an impact on its residual service life. A structural health monitoring (SHM) can be considered to improve the reliability of the structure and also the knowledge of the behaviour of the structures in service in order to optimize their uses and future constructions. This is possible by using reduced order models, which optimize the location of measurements for field reconstruction, and allow the interpretation of these measurements for comprehensive monitoring. In order to meet the need for an optimized number of sensors and for speed of calculation, the empirical interpolation method (EIM)[1] can be considered. This method associates an off-line phase, the construction of a reduced base associates to an optimal set of sensor locations determination, with an on-line phase, of real-time reconstruction of the variable of interest thanks to the contribution of measurement data. However, the assimilated measurement data can present noise and uncertainties, generalized GEIM [2] and regularized REIM [3] methods bring solutions to correct them and allow the management of this uncertain model. Beyond the detection of damage or abnormal behaviour, the development of structural health monitoring must allow a prediction of the remaining life of the instrumented structure. To this end it will be necessary to translate the deformation field reconstructed by the on-line phase into a stress field in order to determine the residual life of the structure by comparing the history of stresses seen by the structure with the Wohler curves of the materials used. At this date the works focus on this last point of the interpretation of the results. A proof of concept with a concrete application to a composite hydrofoil instrumented in groove by strain optical sensors is underway.

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