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FINITE ELEMENT ANALYSIS FOR STRUCTURAL HEALTH MONITORING OF HELICOPTER AIRFRAMES

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Summary: ASTYANAX is a Research project promoted by the EDA (European Defence Agency), focused on the development of reliable methodologies for Structural Health Monitoring (SHM) of rotary and fixed-wing platforms. ASTYANAX focuses in 2 types of damages relatively common in helicopter airframes: local plastifications caused by hard landings, and cracks originated in rivet holes that grow in fatigue during the operational life of the vehicle.
Within the project a complete set of activities related to SHM methodologies are carried out: study of state of the art of SHM components (sensors for instance), development of damage detection algorithms, Finite Element Analysis (FEA) of the damaged and undamaged structure, sensor network technologies, SHM systems reliability, etc.
Demonstrations are made to a full scale helicopter: the Mi 8/17 Hip. Two kind of tests will be performed, the first one are drop tests from increasing height with the aim of identifying the onset of local plastifications. The other main tests carried out are fatigue tests of the helicopter tail boom (TB). Both test specimens are equipped with a sensor network composed among others of PZTs and optical sensors measuring mechanical strain.
The SHM systems developed in ASTYANAX have diagnostic and prognostic capabilities, and are designed by using Artificial Neural Networks (ANN) algorithms, while Finite element Models (FEM) generate the simulated experience required for ANN training.
In the paper the FEA approach used in relation with the fatigue crack SHM system; a global-local approach, is justified and explained. Two main sets of FEMs have been done. The first one simulates TB fatigue tests and it is used to determine relevant test features (optimum size of the initial notch, crack growth rate, etc. The second FEM set consists on parametric versions of the local TB FEM considering different crack configurations. With these FEMs the ANN training database is generated.
In the paper, the strategies followed for FEM parameterization and automation, and for derivation of strain and Stress Intensity Factor (SIF) results are explained. The final validation of the SHM system, and its diagnostic and prognostic capabilities, will be made with the real-time sensor readings during fatigue tests.