EXPERIMENTAL TECHNOLOGY FOR CONDITION MONITORING OF HELICOPTER ROTOR UNITS IN FLIGHT

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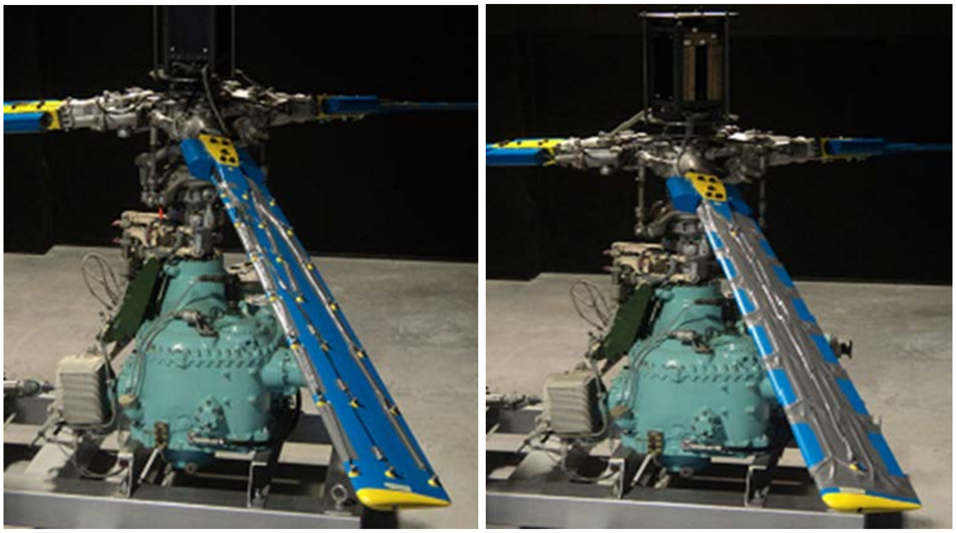
Actual HUMS or alternative helicopter onboard systems allow condition monitoring of a drive train and gearboxes in flight at reasonable level. However, both main and tail rotors with blades and main gearbox are not observable in flight. There are technical problems of moving rotor parts sensing, measuring, data transferring and power supplying. Another problem is the absence of acknowledged techniques applicable for rotating structural parts diagnostics. As above problems solution the paper describes experimental technology application for structural health and condition monitoring of helicopter main rotor components in operation mode on-line. This work presents a brief summary of the study of Experimental and Operational Modal Analysis (EMA and OMA) application for structural health monitoring of rotating blades and other rotor units. Special focus is on the topicality of OMA as the tool for modal properties identification (frequency and mode shape) of blade models under near-natural conditions that could be principal diagnostic indicators of structural health monitoring. The research was conducted using helicopter blade models operating within the experimental system, including electric driven test bench, the main gearbox with the rotor, the measurement and harvesting systems. Discussion of finite-element modelling of the blade model, identification of natural its modes and the influence of global and local faults on the dynamic properties modification is presented. Rotating blade models have embedded sensors network distributed longwise and widthwise model surface. Application of advanced dynamic deformation sensors is presented for rotating blades dynamic behavior characterization. Newly developed harvesting system provides powering of the rotating measurement system. Dynamic signals from sensors come to Data Acquisition System (DAQ) mounted on the rotating hub. Wi-Fi module transfers collected data from DAQ to stationary PC located out of operating rotor test bench. The paper describes the specialties of the rotating blade models, its testing and the approach to experimental verification of OMA application for rotating blades damage identification through their technical state modification. Results of the experimental study of modal parameters of the blade models are discussed, including EMA and OMA techniques application and comparing experimental data with the modelling one. For validation of the experimental technology, blade models stiffness was modified without mass variation simulating loss of composite blades mechanic properties under sun radiation. There is also the consideration of ballistic damage identification applying OMA technique. There are presented also some capabilities of diagnostic techniques application to main rotor deflections, its gears and bearings using deformations measured by the experimental system. Conclusions are made about successful check of OMA techniques applicability for structural health monitoring of rotating blades and its effectiveness for damage identification in-flight. It is outlined also opportunity to use rotating measurement system

for condition monitoring for rotating units related to main rotor, like the shaft, gears and bearings. Planning of further research works are presented.

The test bench providing application of experimental technology includes operating helicopter main rotor and three blade models (fig.1).



a) b)

Figure 1. Photo of helicopter experimental test bench with blade models equipped by:
a) – 3-axial accelerometers; b) - deformation sensors.