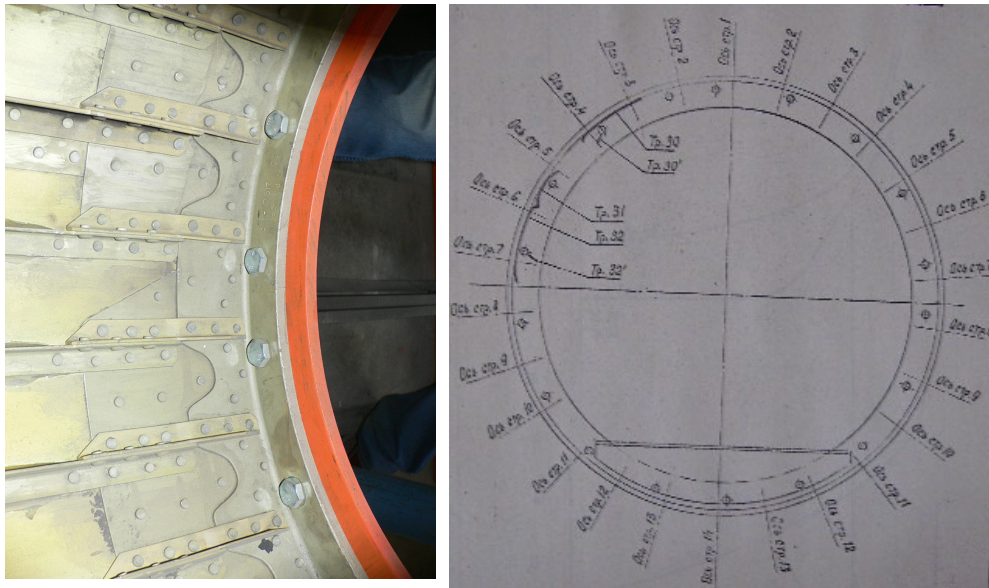


ELECTROMECHANICAL IMPEDANCE FOR STRUCTURAL HEALTH MONITORING OF A BOLT-JOINT

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a)

b)

Figure 1. A view of the frame 17 in zone of cracking (a) and the fatigue cracks in frame at fatigue test (b, view in a direction against flight)

The goal of the presented research is the piezoceramics transducer (PZT) electromechanical impedance as a function of the tightness loosing in a bolt-joint of some aircraft component. Object of investigation: the bolt-joint of the helicopter Mi-8 tail beam. One example of this kind of a bolt-joint and the scheme of possible fatigue damage is shown on Figure 1. Three sensors 27301 (Pz 27) 6.35x6.35x1 mm (In Sensor) were glued on each frame by Electrically Conductive Adhesive EPO-TEK EE129-4.

The initial tensile load of bolt-joint was accomplished by tightening a bolt to a pre-determined torque, or pre-load, with a torque wrench, that is precise tool for measuring the amount force applied to a fastener.

The testing includes measuring of the electromechanical impedance of all piezoceramics transducers (PZT) in the state of 100% of initial tensile load, and in the state with reduced tightness to 80 and 60% of maximal.

Several different criteria of tightness effect to the electromechanical impedance of transducers were used. One of them is real is a relative increment of the real part of impedance $\Delta\bar{R}$.

$$\Delta\bar{R} = Re\left(\frac{Z}{Z_0} - 1\right)$$

where Z un Z_0 is electromechanical impedance of transducer with reduced and 100% tightness.

Effect of tightness to bolt-joint to the electromechanical impedance of transducer is illustrated by Figure 2. The relative increment of the real part of impedance in resonance frequencies band increases with loosing of tightness. It is about 3.5 and 6.5 % for tightness to 80 and 60% respectively. It is no much. But statistical stability of this result was defined by special test. The real part of electromechanical impedance in resonance frequencies band for three state of the bolt-joint and 95% confidence intervals are shown an Figure 3.

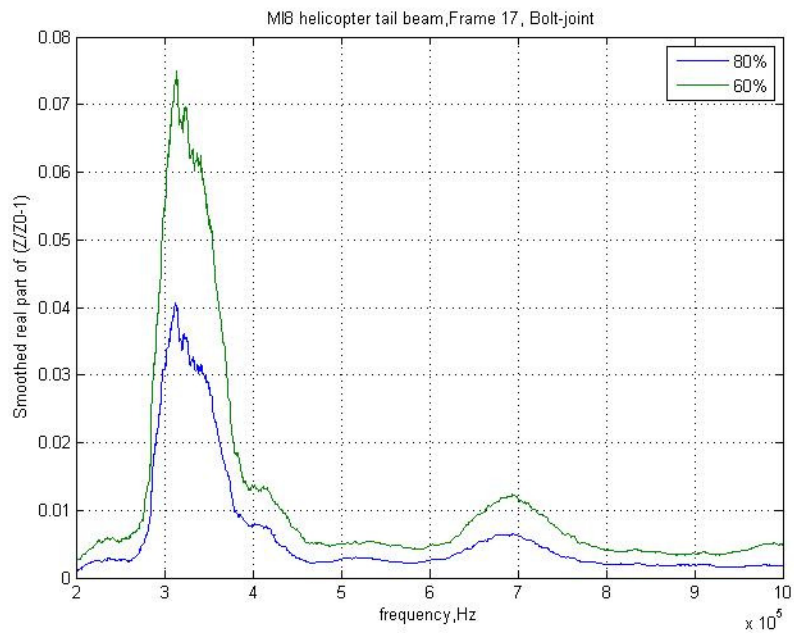


Figure 2. Effect of tightness to bolt-joint to the electromechanical impedance

**Bolt preload effect to impedance at rezonance frequency
The MI8 helicopter tail beam, frame 17, pz27 (InSensor)**

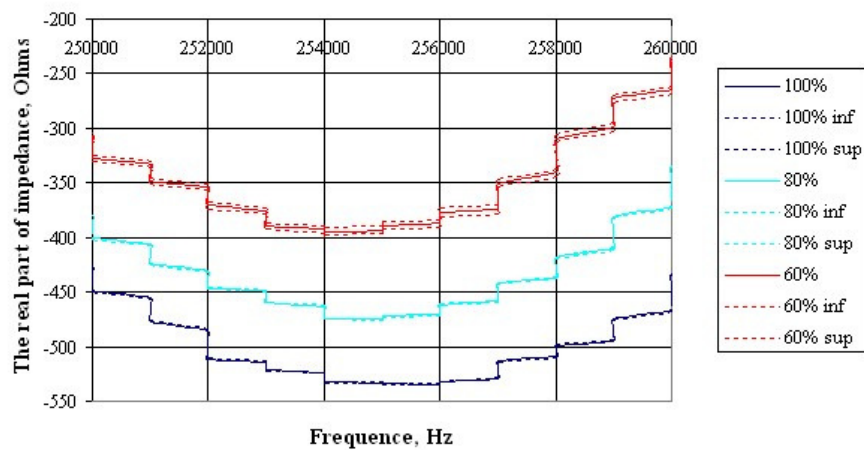


Figure 3. Real part of electromechanical impedance and its 95% confidence interval for three states of a bolt-joint

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