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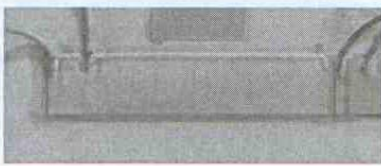
**RIGA, LATVIA**

**STRESS STATE AND STRENGTH OF PIEZOCERAMICS UNDER A STATIC LOAD**

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Structural health monitoring (SHM) of aircraft can be successful, if minimally two requirements are obeyed: (1) SHM system is able reliably detect all kinds of structural damages, and (2) Own reliability of SHM system is high. In ultrasonic SHM system the least defended element is a piezoceramics transducer integrated in structure. Conditions of aircraft operation are very complex: mechanical loading and vibration, environmental degradation, wide range of temperature and others. First of all the transducer is attached to the structural element. It means that it is loaded by alternative operational load. It can induce static or fatigue destruction of transducer. For example, Figure 1 shows a piezoceramics 0.5×10×50 mm transducer installed to an Al panel after about 60,000 cycles of loading with the alternative stress 150/50 MPa. The transducer was glued on a skin of panel in direction of load action. This level of stress is typical for Al alloy structure of aircraft. At least nine fatigue cracks on a surface of the transducer were detected by penetration. This effect associated with low tensile strength of piezoceramics that equal to 40–80 MPa. It is much less than compressive strength (about 600 MPa). The crack-



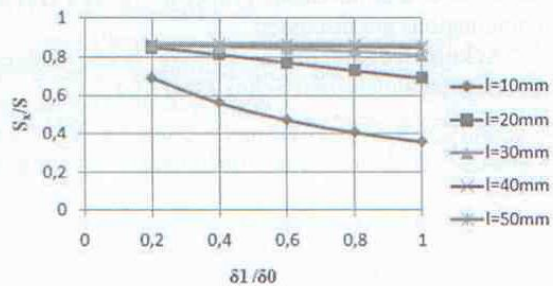
*Fig. 1. The cracks in piezoceramics after cyclic loading.*

resistance of piezoceramics is also low (the toughness about 1–3 MPa·m<sup>0.5</sup>). There are some structural possibilities to protect piezoceramics from effect of mechanical loading. Pre-stressed transducer is good solution as from overloading as from corrosion. However, constraining decreases sensitivity of damage detection.

The influence of transducer parameters and its coupling with structural element to stress and strength is investigated in present paper. The theoretical model of strength for piezoceramics stripe glued to structural element was developed.

The concept of ‘weak chin’ and the results of stress state analysis of three-layers structure with the cracks in one of layers was used. The general tendencies of effect of this structure parameters were defined. The effect of mechanical loading of piezoceramics transducer to its stress state and destruction can be decreased by rational selection of its geometrical parameters and thickness of coupling layer (Fig. 2).

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*Fig. 2. Maximal stress on external surface of a transducer as a function of relative thickness of glue for five values of a length.*