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RESEARCH INTO THE MICROMECHANICS OF THE PLASTIC-ELASTIC BEHAVIOUR OF ANISOTROPIC COMPOSITE MATERIALS UNDER STATIC LOADING BY THE ACOUSTIC EMISSION METHOD

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The main topic described in this paper is based on the results of the research about unidirectional composite materials failure under static tension load as well as includes an attempt to evaluate the nature of such failure by using the acoustic emission (AE) method.

During the research the square plates were used as samples of composite materials. One part of the samples was stressed in longitudinal direction of fibres; another part was stressed in transverse direction of fibre. During the experiment with samples where stress was directed longitudinally fibres, some samples were exposed to three-fold or sixfold load up to 20-40% of the breaking load. At the same time the simultaneous recording of total AE and the deformation of samples on the basis of strength measurement data were carried out.

For the samples, which were stressed transversely fibres, AE method had shown that the moment of failure initiation in the internal structure of samples was recorded by 5-6% earlier than the strength measurement showed (Fig. 1). In conclusion the samples exposed to overload, both the AE method and the strength measurement showed that in this case the failure begins almost 10% earlier.

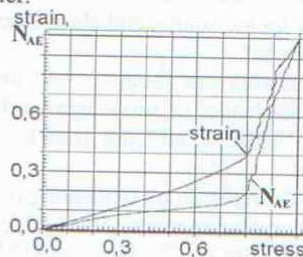


Fig. 1. Dependence of AE and deformation on the sample loaded across the grain.

For the samples, which were stressed longitudinally fibres, the diagram of their deformation (dependence of deformation on the load) had shown a linear dependence in the whole load area right up to the sample failure.

However, the analysis of AE signals accumulation showed that the accumulation of AE signals has a S shape, which implies a three-stage micromechanical process of the internal failure of a sample. For the samples without aging: stage 1 is intensive growth of total AE at the initial moment with deceleration, stage 2 (a longer one) is stabilization of total AE growth velocity, stage 3 (approximately 10% before the failure) is acceleration of intensive growth.

The main conclusions:

- Three-fold or sixfold aging under small values of load (up to 20% of the breaking load) has a small influence on the behaviour of AE signals accumulation curve.
- Three-fold aging under large values of load (up to 40% of the breaking load) has a considerable influence on the behaviour of AE accumulation curve; however, in both the first and the second cases, aging does not exert any influence on the ultimate strength under the given load conditions.