

Politechnika Śląska
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Praca doktorska

**Ocena trwałości zmęczeniowej laminatów
polimerowych w stanie lepkosprężystym z
uwzględnieniem zjawisk cieplnych**

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Evaluation of fatigue durability of polymeric laminates in viscoelastic state considering thermal phenomena

PhD thesis - Summary

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The presented PhD thesis deals with theoretical modelling and experimental evaluation of self-heating effect occurring due to the energy dissipation on strength and fatigue process of polymeric laminates used in transport means building. The main goal of the conducted research was the development of theoretical models, which describe occurrence of the self-heating effect and experimental verification of them and development of fatigue models, that allow evaluation and prediction of degradation degree of cyclically loaded polymeric laminates with occurrence of the self-heating effect.

Basing on bibliographic survey in the area of modelling of strength and fatigue of polymeric laminates it was stated that the self-heating effect is often neglected in engineering calculations. As preliminary research shows, self-heating effect has an essential influence on behaviour and degradation of polymeric laminates and for some excitation parameters it could be a dominating factor in the fatigue process. In connection with above the hypotheses were formulated, that there exists a relation between energy dissipated in the form of heat and mechanical properties of cyclically loaded polymeric laminates, and that the necessity of development of appropriate strength and fatigue models, which consider self-heating effect, has been emphasized.

In order to verify presented hypotheses three theoretical models, which describe steady-state self-heating temperature distribution in cyclically loaded one- and two-dimensional systems made of polymeric laminates were developed. An extensive experimental research concerned with character of evolution of mechanical properties of laminates for various temperatures and excitation frequencies has been carried out. The conducted dynamic thermomechanical analyzes allow for generalization of Arrhenius principle, which describes kinetics of thermochemical reactions taking place during occurrence of the self-heating effect and heating-up, by introducing the dependence of mechanical properties of laminates on heating rate. The fatigue experimental research of laminates was carried out and empirical and theoretical-empirical models, which describe fatigue with consideration of the self-heating effect, were developed. The obtained results were characterized by the sufficient accuracy and conduct the soundness of formulated hypotheses.

Key words: thermal fatigue of polymeric laminates, dissipation of mechanical energy, self-heating effect, viscoelastic behaviour of polymeric laminates, generalized Arrhenius principle.