Description for the general public

From the analysis of the published research on the multiaxial fatigue criteria and fatigue life calculation problem results that the proposed models are successful only for assigned and limited number of materials and for a given fatigue loading regime. As results, new models are still being proposed. Among such models, one group called the critical plane approach is very popular. The idea of this concept is based on observation of preferred orientation of initial crack paths. Thus, it is assumed that only stress components defined in the specific plane orientation are crucial in the fatigue damage evaluation. Multiaxial fatigue criteria based on this idea assume that there is a scalar function that relates the varying in time stress components in the critical plane and some set of the material coefficients. The function resulting from the multiaxial fatigue criterion includes the material coefficients that in classical approach are functions of the fatigue limits obtained under cyclic tension compression and torsion loadings. In general case, those coefficients are not constant but as revealed in the project they are functions of the fatigue life. Consideration of the mentioned variability of the material coefficients is crucial for the proper fatigue life calculation.

The main aim of the planned research is building and verification of an innovative fatigue life calculation algorithm applicable to random loading. The originality of the proposed algorithm consists in the proper analysis of a scalar function which reduces multiaxial stress/strain state to uniaxial one. Consideration of the mentioned variability of the material coefficients is important to obtain the correct form of the reduction function and as result, the better agreement between calculated and experimental fatigue lives. The second aim of the planned research is building and verification of the proper fatigue life calculation algorithm with the application of the strain and energy-based multiaxial fatigue criteria. It will allow the correct calculating of fatigue life under the low cyclic fatigue regime.

Verification of the proposed algorithm requires a large amount of experimental tests that are planned in the research project. The experimental tests are required not only under random loading but also under uniaxial and multiaxial cyclic loading. Tests under cyclic loadings are necessary in order to select the most appropriate materials, i.e. materials exhibiting distinct variability of the analysed coefficients. Experimental research will include also the observation of the cyclic hardening and the initial fatigue crack paths in order to explain the relation between the number of cycles to failure and the variability of the material coefficients.