Multiaxial fatigue behavior of 30HGSA steel under cyclic tension-compression and reversed torsion

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The 30HGSA steel is a very attractive metal due to its high hardenability, strength and resistance to wear for element production in many industries, including aerospace engineering. Those parameters can be achieved only in a process of thermal treatment, which includes hardening and tempering. Its strength properties depend on element's dimensions, so it is usually used for elements with thicknesses not exceeding 60 mm The 30HGSA steel is often a material of choice for parts of riveted constructions and manufacturing of heavy loaded parts such as spindles, levers, gears, flanges, bushings, axles, shafts, compressor blades etc. In the aviation industry it has a wide application in the production of airframes, engines and its components like struts, and chassis shaving.

Most of those elements are subjected to complex cyclic loading, which can result in fatigue damage. Therefore, to correctly construct parts, it is crucial to examine the fatigue behaviour of the 30HGSA steel. In this paper we examined behavior fatigue under cyclic in-phase tension-compression and torsion for 30HGSA steel for cylindrical specimens. Tests are conducted at room temperature in ambient air with the biaxial MTS servo-hydraulic machine. The three types of experiments: (i) – uniaxial symmetrical cyclic compression-tension loading for high-cycle range, (ii) - cyclic reverse torsion high-cycle loading, (iii) – combined cyclic tension/compression and reverse torsion loading. The fatigue limits data measured in (i) and (ii) loading condition are approximately comparable to Huber-Mises-Hencky (HMH) criterium. The measured fatigue limit under cyclic torsion loading was at 60% of the stress amplitude determined for cyclic tension-compression loading.

Based on the experimental data, we determined the 'σ-τ curves' – limit curves (obtained for a fixed number of cycles). The results were later used to perform the analysis with two failure criteria namely Gough-Pollard (GP) and Debski-Golos-Debski (DGD) for the case of complex cyclic loading. The comparison of obtained data with analyzed criteria shown relatively good agreement between them.