CONTROL OF THE MAGNITUDE AND DISTRIBUTION OF RESIDUAL MACRO-STRESSES BY ROLLER ROLLING

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To increase the fatigue strength of parts, surface plastic deformation (SPD) by rolling is widely used. This creates a residual stress state that affects the fatigue strength of such parts. This paper shows the possibility of controlling the level and distribution of residual macrostresses in the surface layer of parts by rolling in several passes. This makes it possible to optimise the modes of SPD for critical heavily loaded parts subjected to cyclic loading during operation.

It has been experimentally established that compressive residual stresses induced in the surface layer by plastic deformation (SPD) play a significant role in improving the durability of parts experiencing cyclic loads. However, the residual stresses can change under cyclic loads. If the total stresses (from the external load plus residual stresses) on the surface of the product reach the yield strength of the material. In this case, local plastic deformation occurs, which relieves the level of residual stresses in the surface layer and can even lead to a change in their sign. Under the action of alternating loads, the stability of the residual stress state will be determined both by the nature of residual stress distribution over the depth of the surface layer, and the magnitude and sign of residual stresses on the surface.

Consequently, purposeful regulation of the magnitude and distribution of residual macro-stresses will increase their stability in the process of cyclic loading of parts and, as a consequence, increase the fatigue resistance of parts after hardening SPD.

The analysis of the obtained results allows us to draw the following conclusions: with the increase of the rolling force from 3kN to 10kN the residual compressive stresses increase by 2.5 times and reach 1800MPa for the force of 10kN; rolling in one or two passes with the same rolling force does not change the stress state of the surface layer of the specimens; when rolling in two passes, the stress state on the surface is determined by the force of the last (second) pass.

The last conclusion has far-reaching practical consequences - it is possible to control residual stresses on the surface by repeated rolling.

Re-rolling changes the stress state not only on the machined surface, but also changes the distribution of residual stresses along the depth of the hardened layer.

Thus, the above results unambiguously indicate that multiple deformation at different parameters of rolling is an effective way to form a given stress-strain state of the surface layer.