FRACTURE OF HIGH-STRENGTH STEELS WITH STRUCTURAL STRESS CONCENTRATOR UNDER CYCLIC LOADING

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Significant increase of bearing capacity of parts is achieved by using high-strength materials and surface plastic deformation (SPD). The high efficiency of SPD in increasing the fatigue strength of parts with constructive stress concentrators is well known.

Specifics of fatigue failure of roller-rollerized 30ХГСН2А (HRC 50-52) steel shafts with a coupling bushing under reversed bending is discussed in this paper.

It is revealed that fatigue failure occurs both in compression and tension zones, with the first fatigue cracks being formed in the zone of compressive bending stresses near the edge of the coupling sleeve.

It should be noted that, having reached a certain value, the fatigue crack in the compression zone does not spread further and the failure eventually occurs from the origin in the zone of tensile stresses from bending. However, if conditions periodically arise during operation in which the part is subjected to bending in the opposite direction, even under insignificant stresses, then the failure occurs from the fatigue center in the compression zone.

The stress-strain state of the surface layer in different zones (compression zone, tensile zone and neutral zone) in the initial state (after SPD) and at different stages of cyclic loading has been studied by X-ray tensometry method. Different stability of residual stresses in different zones has been revealed and the mechanism of formation of the first fatigue cracks in the compression zone near the edge of the bushing has been proposed. It is established that high level of residual stresses induced by rolling in the compression zone is one of the main reasons of earlier appearance of fatigue cracks in this zone. The reason for the appearance of cracks in the compression zone is an intensive plastic deformation, which occurs due to summation of compressive residual stresses induced by rolling and externally applied compressive stresses taking into account their concentration at the bushing edge. Therefore, it is reasonable to reduce the level of residual stresses in the zone of compressive stresses while maintaining the strength properties of the surface.

A technological scheme of the rolling has been proposed, which made it possible to significantly increase the cracking fatigue strength in the compression zone of shafts with a coupling bushing without reducing the fracture fatigue strength in the tensile zone, which is achieved by changing the epureure of residual compressive stresses while maintaining the maximum degree of the surface layer's accentuation.