The Effect of the Size of Surface Defects on the Fatigue Strength of Shot-peened Springs

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ABSTRACT

The effects of simulated surface defects on the fatigue strength and on the crack initiation and crack propagation processes of a shot-peened AISI 9254 spring steel were investigated. The specimens were in the form of helical springs. Manufacturing defects representing die marks were simulated by creating surface notches which were 3.12 mm in length transverse to the spring wire, 0.8 mm in width, and varied from 115 μm to 570 μm in depth. Two different stress relieving and shot-peening procedures were used prior to fatigue testing. One group of specimens (Group 1) was stress relieved at 400 °C and then shot-peened for 30 minutes. The other group of specimens (Group 2) was stress relieved at 415 °C and then shot-peened for 45 minutes. X-ray stress analysis revealed that the shot-peening effect was less effective with increase in notch depth. It was also found that the compressive residual stresses induced for Group 2 were higher than for Group 1.

Fatigue test were carried out under axial loading at an R value of 0.44 and and a stress range of 451 MPa (65.5 ksi) at a frequency of 34 Hz. Group 2 specimens were found to have a higher fatigue resistance than did Group 1 specimens owing to a higher level of residual compressive stess induced by shot-peening. In both groups the fatigue resistance decreased with increase in defect depth as a result of both a decrease in residual compressive stress with depth as well to the increase in the stress concentration factor with depth.