Effect of Ultrasonic Peening on Initiation and Propagation of Fatigue Cracks in Welded Elements

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The ultrasonic impact treatment (UIT) is one of the new and promising processes for fatigue life improvement of welded elements and structures. In most industrial applications this process is known as ultrasonic peening (UP). The UIT/UP technique is based on the combined effect of high frequency impacts of special strikers and ultrasonic oscillations in treated material. The beneficial effect of UIT/UP is achieved mainly by relieving of harmful tensile residual stresses and introducing of compressive residual stresses into surface layers of material, decreasing of stress concentration in weld toe zones and enhancement of mechanical properties of the surface layers of the material. The UltraPeen system shown in Figure 1 could be used for treatment of weld toe or welds and larger surface areas if necessary. The fatigue testing of welded specimens showed that the UIT/UP is the most efficient improvement treatment as compared with traditional techniques such as grinding, TIG-dressing, heat treatment, hammer peening application of LTT electrodes.

Figure 1. Ultrasonic peening system UltraPeen for fatigue life improvement of parts, welded elements and structures

The results of fatigue testing of welded specimens made of low alloyed steels (yield strength 370 and 460 MPA) with surface fatigue cracks of different depth and internal weld defects are discussed in this paper. Parameters of fatigue testing: axial loading, R=O. The welded specimens were fatigue tested in as-welded conditions and after UIT/UP. It is shown that efficiency of the application of UIT/UP to the welded elements with surface fatigue cracks depends on the depth of the crack. For instance, in case of the fatigue crack with the depth of 1 mm the UIT/UP provides 3.5 times increase in fatigue life of welded element in comparison with the service life of welded joint in as-welded condition. It is shown that the internal defects of welding decrease the efficiency of UIT/UP by 10-45%. Crack path is also analyzed, considering the propagation of fatigue crack in base plate, weld and welded attachment.