Fatigue Life Improvement of Welded Elements of Aluminum Alloys by Ultrasonic Impact Treatment

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Abstract
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 fatigue testing of welded specimens showed that the UP is the most efficient improvement treatment as compared with traditional techniques such as grinding, TIG-dressing, heat treatment, hammer peening and laser peening. The UIT/UP technology and the results of fatigue testing of welded elements of aluminum alloys in as-welded condition and after application of UIT/UP are discussed in this paper.

Keywords: aluminum alloys, welding, fatigue improvement, ultrasonic impact treatment, ultrasonic peening

Introduction
The basic system for UP treatment (total weight - 11 kg) includes an ultrasonic transducer, a generator and a laptop (optional item) with software for optimum application of UP - maximum possible increase in fatigue life of parts and welded elements with minimum cost, labour and power consumption. In general, the basic UP system UP-600 shown in Figure 1 could be used for treatment of weld toe or welds and larger surface areas if necessary [1].

Figure 1. Basic ultrasonic peening system for fatigue life improvement of welded elements and structures
Figure 2 illustrates the concept of the fatigue life improvement of welded elements by UP. In case of welded elements, it is enough to treat only the weld toe zone – the zone of transition from base metal to the weld, for a significant increase of fatigue life. The so-called groove, shown in Figures 2, characterized by certain geometrical parameters is produced by UP [1-3].

![Figure 2](image.png)

Figure 2. Profile (a) of weld toe improved by UIT/UP and the view (b) of fillet weld in as-welded condition (left side sample) and after application of UP (right side sample)

**Results**

The welded specimens shown on Figure 3 were fatigue tested in as-welded conditions and after UIT/UP. Investigated materials – aluminum alloys 5083 and 6061-T6. Parameters of fatigue testing: axial loading, R=0. The results of fatigue testing of T-joint made from alloy 5083 are also presented in Figure 3.

![Figure 3](image.png)

Figure 3. Drawings of considered welded specimens and results of fatigue testing of T-join made from alloy 5083: 1- in as-welded condition, 2- after UIT/UP, S-stress range

Figure 4 illustrates the results of fatigue testing of lap joints from alloy 5083 and 6061-T6.

**Conclusions**

Ultrasonic Impact Treatment UIT/UP is a relative new and promising technique for fatigue life improvement of welded elements and structures in different metals including aluminum alloys [1-4]. The fatigue testing of welded specimens made from aluminum
alloys 5083 and 6061-T6 presented in this paper showed that the UIT/UP provided significant increase in fatigue performance of all considered types of welded joints.

References