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FATIGUE IMPROVEMENT OF WELDED ELEMENTS BY ULTRASONIC IMPACT TREATMENT

Yuri Kudryavtsev^(*)

Structural Integrity Technologies Inc. (SINTEC), Markham, Ontario, Canada

^(*)Email: ykudryavtsev@sintec.ca

ABSTRACT

The ultrasonic impact treatment (UIT) is one of the new and promising processes for fatigue life improvement of welded elements and structures. In industrial application this process is also known as ultrasonic peening (UP). 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 and laser peening. The description of UIT/UP technology and the results of fatigue testing of welded elements of steels and aluminium alloys in as-welded condition and after application of UIT/UP are discussed in this paper.

Keywords: fatigue improvement, welded elements, ultrasonic impact treatment.

INTRODUCTION

The UIT/UP technique is based on the combined effect of high frequency impacts of special strikers and ultrasonic oscillations in treated material (Kudryavtsev, 2008). 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 (Kudryavtsev, 1989) and also on smaller scale by decreasing of stress concentration in weld toe zones and enhancement of mechanical properties of the surface layers of the material. The basic system for UIT/UP treatment (total weight - 11 kg) is shown in Figure 1.



Fig. 1 - Ultrasonic impact treatment system for fatigue improvement of welded elements and structures

It 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, labor and power consumption (Kudryavtsev, 2013). In general, the basic UIT/UP system UP-600U shown in Figure 1 could be used for treatment of weld toe or welds and base metal also if necessary.

RESULTS AND CONCLUSIONS

The welded specimens were fatigue tested in as-welded conditions and after UIT/UP. The investigated materials were steels and aluminum alloys of different strength. Parameters of fatigue testing: axial loading, $R=0$. The results of fatigue testing of welded joints made from aluminum alloy 5083 are presented in Figure 2.

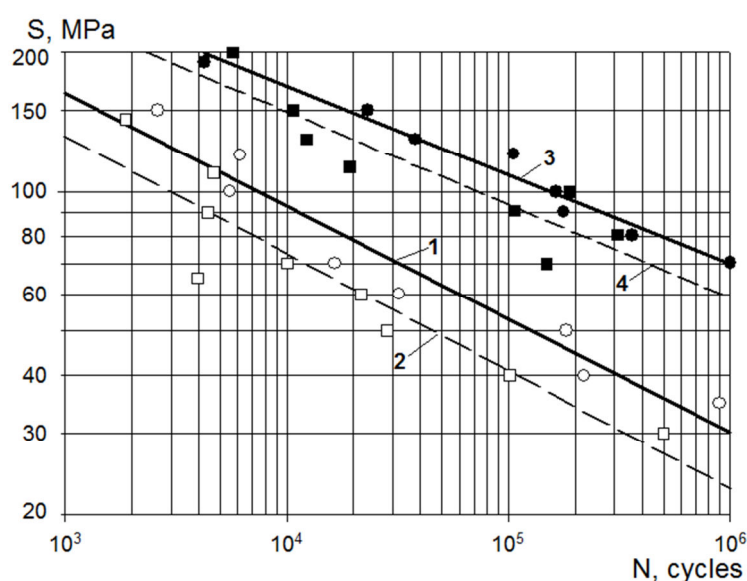


Fig. 2 - Results of fatigue testing of lap joints made from aluminum alloy 5083: 1, 2- in as-welded condition; 3, 4- after UIT/UP; 1, 3 - technology of welding A; 2, 4 - technology of welding B.

These and other numerous results of fatigue testing of welded specimens made from steels and aluminum alloys showed that the UIT/UP provided significant increase in fatigue performance of all considered types of welded joints and materials and that the UIT/UP is the most efficient improvement treatment as compared with traditional techniques such as grinding, TIG-dressing, heat treatment, shot peening and hammer peening.

REFERENCES

- [1] Y. Kudryavtsev. Residual Stress. Springer Handbook on Experimental Solid Mechanics. Springer - SEM. 2008. pp. 371-387.
- [2] Y. Kudryavtsev, V. Korshun and A. Kuzmenko. Improvement of Fatigue Life of Welded Joints by Ultrasonic Impact Treatment. Paton Welding Journal. 1989. No. 7. pp. 24-28.
- [3] Y. Kudryavtsev and J. Kleiman. Fatigue Improvement of Welded Elements and Structures by Ultrasonic Peening. Proceedings of the ASME 2013 Pressure Vessels and Piping Conference PVP2013. Paper Number PVP2013-97185. July 14-18, 2013, Paris, France.