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ULTRASONIC MEASUREMENT OF RESIDUAL STRESSES IN WELDED JOINTS

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ABSTRACT

The objective of the study described in this paper is to identify the residual stress (RS) distribution and relaxation in standard welded specimens, large-scale welded panel and real structure. The RS were measured after welding and in the process of fatigue loading of welded elements by the UltraMARS system that is based on using ultrasound.

Keywords: residual stresses, ultrasonic measurements, fatigue loading.

INTRODUCTION

The RS are one of the main factors determining the engineering properties of materials, parts and welded elements and this factor should be taken into account during the design and manufacturing of different products. Although certain progress has been achieved in the development of different experimental techniques, a considerable effort is still required to develop efficient and cost-effective methods of residual stress analysis (Kudryavtsev, 2008). The application of an ultrasonic non-destructive method for residual stress measurements had shown that, in many cases, this technique is very efficient and allows measuring the residual stresses both in laboratory conditions and in real structures in field for a wide range of materials (Kudryavtsev, 1985, 2016).

RESULTS AND CONCLUSIONS

The measurements of welding residual stress were performed in standard welded samples for fatigue testing, large welded panel and real structures. The residual stress measurements in lab and field conditions were performed by using the UltraMARS system shown on Figure 1.

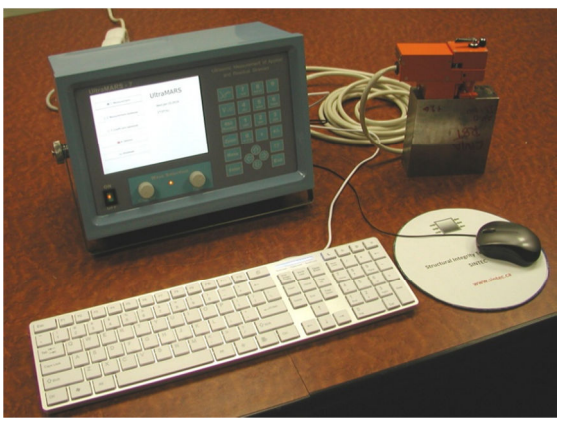

Fig. 1 - Ultrasonic Computerized Complex for residual and applied stress measurement UltraMARS-7

In field conditions the residual stresses were measured in a number of welded structures including the pressure hull of a submarine. Four zones were selected for RS measurement in the welded elements of the hull of submarine. Figure 2 shows the results of residual stress measurement in one of the selected zones of the hull of submarine. In this case both components of residual stresses are tensile at the distance from the weld toe of 20 mm. The longitudinal component of residual stresses reaches 295 MPa.

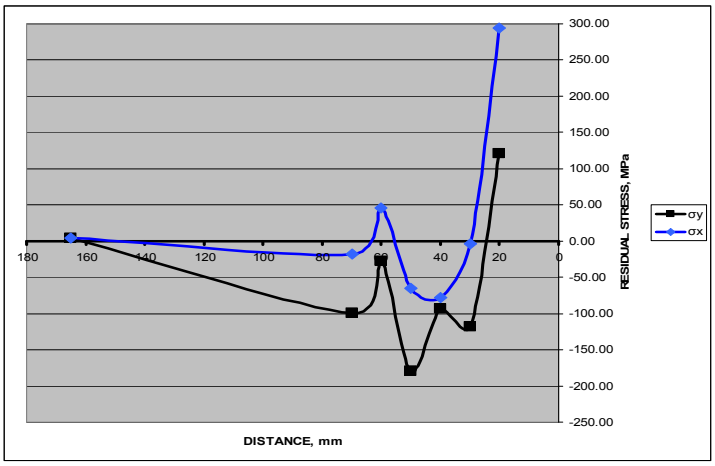

Fig. 2 - The distribution of residual stresses near the butt weld of pressure hull of submarine (horizontal axis represents the distance from the weld): σx and σ_y are the components of residual stresses that are parallel and perpendicular to the weld.

A comparison of residual stresses determined by measurements using the ultrasonic method and by numerical simulations showed a reasonable agreement both for standard welded specimens and the large welded panel.

SUMMARY

Certain progress has been achieved during the past few years in improvement of traditional techniques and development of new methods for residual stress measurement. The developed advanced ultrasonic method, based on it portable instrument and the supporting software can be used for non-destructive measurement of applied and residual stresses in laboratory samples and real parts and structural elements in many applications for a wide range of materials.

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