15th International Research/Expert Conference
"Trends in the Development of Machinery and Associated Technology"
TMT 2011, Prague, Czech Republic, 12-18 September 2011

POSSIBILITIES OF APPLYING TECHNOLOGY VIBRATIONAL RELAXATION ON RESIDUAL STRESSES IN WELDING JOINTS AND ITS IMPACT ON THE QUALITY OF WELD CHARACTERISTICS

Mehmed Behmen & Angela Topić
Faculty of mechanical engineering and computing
Matice hrvatske bb , Mostar
BiH

Miron Torlo
Ministry of industry
Mostar
BiH

Mersida Manjgo
Faculty of mechanical engineering
Mostar
BiH

ABSTRACT
The paper presents the results of years of research in developing the technology of relaxation of residual stress and strain on welded joints of large dimensions of structures. The effects of the development of two technologies vibrational relaxation are presented. The first method was developed in the mid-'80s for the aircraft industry "Soko" in Mostar and is based on the stabilization of the structure of tools for assembly of passenger and military aircraft. This method has been used in recent years to relax assembly welds on the bridge structure and bridge cranes. For each specific design, developed through a process of simulation technology is relaxation, which is the implementation monitored continuously with adequate instruments for detecting vibration and stress analysis.
Development of new methods based on research on the parameters of which vibrational relaxation process is realized in the phase of welding and cooling time of the structure.
Comparative analysis of the results of implemented technology identical welded structures point to the advantage of the new method. Specifically during the vibration is much shorter, because the gradient of stress is better, and the risk of material fatigue is minimal. The homogeneity of the weld and fracture energy of the weld and base metal heat affected zone is increased quality of new technology for relaxation, which significantly increases the stability of the realized structures.
Keywords: welding, residual stresses, vibrational relaxation, optimization of structures

1. INTRODUCTION
Economic and technological globalization, which included all the countries of the world has caused the transfer of technology and capital on areas that deliver higher profits to owners of invested capital. Strong market competition in the sector of metal industry and shipbuilding equipment manufacturers conditional on the basis of welding to the realization of its construction in the design stage and performing carry a maximum possible optimization of production costs. The risk of this concept, if well implemented, is a threat to product quality. To meet the quality basics of technical regulations and standards, designer and technologist must know the quality and technological conditions, the projected lifetime and technological conditions of production, installation and maintenance.
Residual stresses due to thermal welding process are undefined size that the designer does not have the stage of designing the structure. The values of these stresses are a function of the welding process, welding parameters, structural rigidity, heat sinks, climate and environment types and characteristics of construction materials.

Classical heat treatment is generally a process that in workshop conditions eliminate residual stresses and stabilize disturbed metallographic structure of the weld and heat affected zone (HAZ). Mounting welds on large structures due to the high cost of heat treatment is usually relaxed introduction of mechanical energy through the vibration treatment or shock waves caused by a controlled explosion effects.
The aim of this study was to comparatively analyze the effect of vibrational relaxation has cooled vibrated welds and welds during welding. Welding Technology and stiffness specimens were identical.

2. EXPERIMENTAL RESEARCH

In a series of specimens of dimensions Č.0362 4x880x (2x440) mm stiffen in the tool with 56 bolts M16 and CO_2 welding process was carried out measuring the value of residual stress and the effects of relaxation with two different technologies based on the vibration.
The rigidity of the connection tubes and tools defined deformeter "HB250" and the value of deformation of 0.01 mm was identical for all specimens. Because of the minimal deformation specimens can conclude the maximum "capture" stress in the structure thereof.
Welding was performed with identical technology for all specimens, because the control system and control of welding parameters implemented on a specially designed mechanism of movement of welding head.
Welding parameters are as follows:
- additional material: VAC 60 mm f0.8
- CO2 flow rate Q = 14 l / min,
- Wire feed speed v = 4.8 m / min,
- vz = welding speed 38 cm / min,
- distance between tip of material h = 12 mm,
- preparation of the groove and the distance plate 0.8 mm,
- current I = 125 A and the voltage U = 19.1 V.

Welding is done in one pass for identical processes of heat stress for all specimens. Heat sinks in tool were identical as confirmed experimentally realized recording of quasi-steady temperature field (Fig. 1) which is symmetrical to the axis of the weld. Figure 2 shows the specimen in the tool with welding equipment

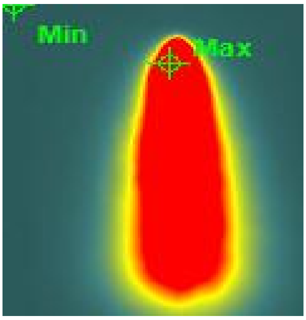

Figure 1.

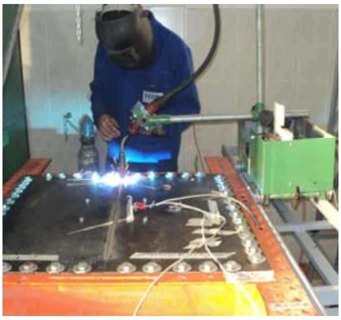
Figure 2.

Measurement of stress was performed by electron tensometry sensor 6/120LY for x and y axis and the tensor-type rosette ribbons 1.5 / 120LYRY61 to define the principal stresses and their orientation with respect to the axis of the weld. Processing of measurements was performed on the device "SPIDER 8" connect with the computer. Sensor systems are present in the central part of the specimen at identical elevations of the weld axis and distance from the size of the tool.
Location vibrator is set to reverse in the central part of the specimen tube system - a tool. For the vibrator was used to direct current electric motor coupled with a disk on which is placed eccentrically interchangeable weights. Use the rheostat and variable weights adjusted the parameters of vibration: frequency and amplitude.

Control of vibration parameters was carried out by sensory systems and to electroinduction type HOTTINGER - DW20 and ultrasonic sensors and KD37V KD41V involved in a SPIDER system 8 and the memory unit of a computer.
Parameters of vibration cold specimens were as follows frequency 56Hz and amplitude = 0.5 - 0.7 mm, while vibrating with 1000 or 6.7 x104 vibrating pulse in a test tube welding phase f = 56Hz, a = 0.3 mm, t = 600s a number of pulses 3.36 x104.

3. INTERPRETATION OF RESULTS ON EXPERIMENTAL RESEARCH

Based on the analysis of the diagram as a function of relative deformation (stress) - the time for all specimens in both technologies, it is evident that:

- relaxation parameters must be absolutely controlled (amplitude, frequency, structure, relaxes, relaxation time). Specifically, the frequency and amplitude significantly affect the quality bath and facial quality welds. Control of stress as a function of time is important because it stresses the value uxiy direction does not relax at the same time function. Excessive vibration during action causes the introduction of new tensions and mild fatigue.

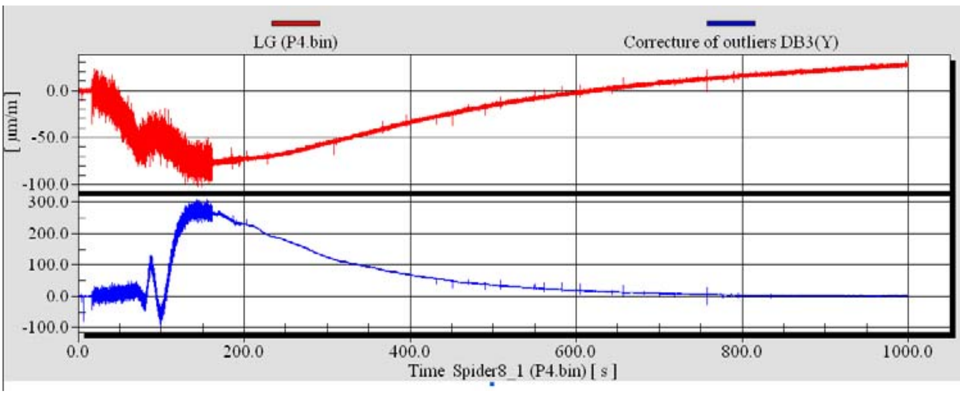

Figure 3. Test tube No. 4 - vibrated cold (relative deformation uxiy direction as a function of time)

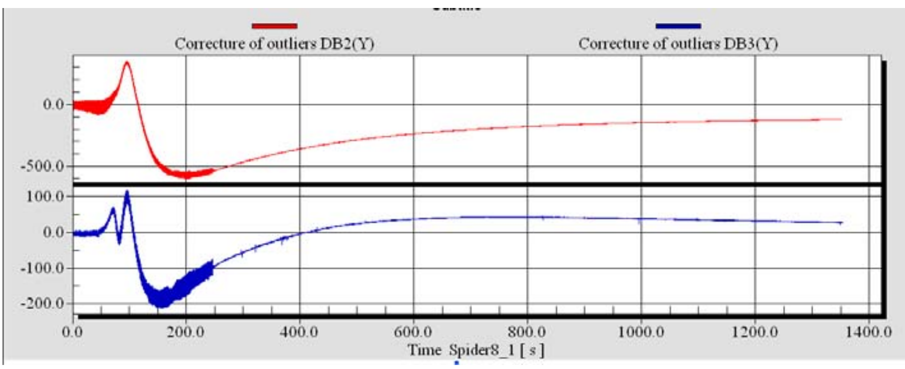

Figure 4. Test tube No. 5 - warm and without vibration (relative deformation uxiy direction as a function of time)- And if energy intake in hot vibrated specimens was lower during the active process by 50% was shorter, only a pronounced effect of relaxation principal stress was higher by 8.3% to 13.2% compared to the cold vibrated specimens.

3.1. Interpretation of results of fracture mechanics

Influence of parameters of different technologies vibrational relaxation on the mechanical properties of the weld and heat affected zone was done through the examination of fracture energy on an instrument Charpy pendulum. The aim of this study was to determine the effect of vibration during welding on the homogeneity of the weld and the eventual change in the structure - the class of grain and its influence on toughness. For these reasons, for both technologies are tubes made from the weld zone and HAZ-a through examination and determine the average value of impact toughness, crack initiation energy, energy spread of crack and the percentage of ductile fracture. Through analysis of the results concludes the following:

- the hot zone of the weld characteristics of vibrated specimens were compared to the cold vibrated
  - the impact strength increased by 9.94%
    - the energy of crack initiation is higher by 22.27%
    - the energy of rupture increased by 1.54%
    - the percentage of ductile fracture increased by 8.38%

- for the zone ZUT
  - the impact strength increased by 2.15%
  - the energy of crack initiation is higher by 1.39%
  - the energy of rupture increased by 2.54%
  - the percentage of ductile fracture increased by 1.255%.

4.CONCLUSION

Development of technology of welding residual stress relaxation has a good perspective of the technology of relaxation in the welding process. Specifically, the contemporary possibilities of the simulation the effects of vibration on complex structures with modern equipment for the detection of stress and vibration effects can introduce this technology as a replacement for heat treatment in service and in particular in terms of assembly. In this way the possibilities for optimization of design and technology with reduced costs of production. This effect was especially pronounced in realizing large structures in the wider sphere of construction and engineering.

5. REFERENCES

[1] Kovač R.: “ Effect of mechanical vibration on the formation of the structure of aluminum alloys, "Ph.D. dissertation, FTN Novi Sad 1980year

[2] Behmen M. Bugarin M. : “ Relaxation of residual stresses on the tools for the assembly of the aircraft, "study, VI Soko Mostar, 1987/88.

[3] Torlo M. „ Vibrelaksacion of residual stresses in dimensionally large structures, "Master thesis, Faculty of Mechanical Engineering Zenica 2,001th

[4] Pučko B. Gliha V. Charpy toughness of vibrated microstructure, ISSXI0543-5846 ”METABK”44(2)103-106

[5] Manjgo M. Behmen M. Torlo M. Burzić Z. Grabulov V. and other.: Scientific research project: "Development of technology vibrational relaxation of welded joints" project funded by the Government of the Federation 2010/11.