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METHODS OF EXAMINATION STRESS IN THE WELDING PROCESS

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Abstract: *Stress in the welding process create during thermal cycles. The first part describes the methods of examination of experimental flexibility stress cycle during welding as well as identifying the size of the residual stress after welding. The second part of the article is devoted to tackling stress in the welding process modeling and numerical simulation using finite element method together with the results of solutions for single-layer and angular weld of steel. Solution stresses cycle in the process of welding numerical simulation has greater scope for different materials and attachments welded and heat input.*
Key words: *stress, welding, numerical simulation, FEM*

1. INTRODUCTION

In the technological process of melt welding method is due to the heat flow to weld and its surroundings to the thermal expansion of welded metal parts. Uneven heating or cooling, or rigid clamping of welded metal components give rise to transitional and variable stress during welding, which may cause local or even a total distortion of welds. In fact, deformation or stress system is creating due to thermal cycles of welding.

The time course of stress cycle can be determined using experimental methods, flexibility, numerical solution methods based on theoretical modeling and the flexibility and numerical simulation using numerical methods.

2. EXPERIMENTAL MEASUREMENT OF STRESS

The research of stresses are generally used the physical phenomenon that is causally linked to the tension. It is famous for a number of experimental methods. The most popular method for measuring the stress are, (The team of authors. 2001, Puchner, 1976), Fig. 1

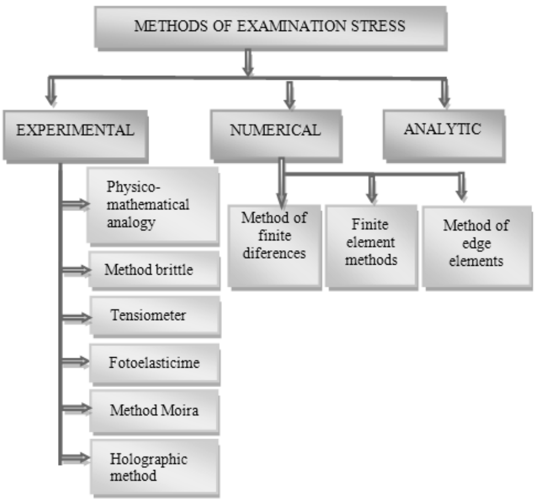

Fig. 1. Method for measuring the stress

2.1 Physico-mathematical analogy

Some phenomena can express the same mathematical relationships. Such physical systems are analogous. After determining patterns of one system, there is the possibility to use them to solve another problem. To address the flexibility and strength and heat transfer in practice are most often used the analogy of an electric field. The advantage of similar methods is its clearness.

2.2 Method of brittle paint

To determine the direction of the major deformation under load models can use the method of brittle coatings. They are specially lakes of natural or synthetic resins.

2.3 Tensiometer

Used for precise measurement of length changes in strain gauges, measuring the elastic deformation of the surface components. Since the stress can be directly measured experimentally, the measured deflection of the load bearing components only. The measured distortions are determined corresponding to the voltage equations of elasticity. Stresses are then expressed according to the measured deformations and material constants *m* and *E*.

2.4 Fotoelasticity

The optical method for determining stress patterns in transparent construction details or the surface details. Measured surface detail can be abraded and polished. The following modified surface layer affixed photoelastic sensitive. The light metal burden in the model polarized light on affixed layer appear izoclime and izocromates and that can be evaluated by the separation voltage.

2.5 Method of Moira

Moira method is based on the mechanical interference of two grids and the original (undistorted) and the base. The basic grid is applied to the surface of the body burden and deformed together with the body. Laying the grids for both themselves arise Moira pattern.

2.6 Holographic method

To measure the deformation using a double exposure of the surface shape of the subject under review with no load and load. Holography is an optical method for recording and displaying three-dimensional object under examination. The interferograms can determine the size of distortions in different directions coordinate system from which to calculate the surface tension.

Method of experimental flexibility is the development of improved technical facilities. Developed transients modern digital recorders, miniature sensors and transmitters to boosters that allow measurement of physical quantities such as temperature, pressure, deformation, and so on. Currently, experimental methods are often substituted by numerical simulation using computer technology.

3. NUMERICAL FEM RESOLVING TENSIONS

The development of computer technology extended the use of computational methods to address the technical practice. The biggest development has made the finite element method. The power cycle MAG welding method for basic materials, steel 11 375 and 17 242 of angular weld, was solved by modeling and numerical simulation using the FEM program ANSYS file. The solution of stress analysis, thermal welding parameters were taken from an experiment carried out to determine the course of thermal fields. In response to the tensions generated by the welding process using finite element method is necessary to resolve the course of the thermal field. The shape and size of the thermal field depends on several factors, the most important are:

- the size and shape of the heat source is expressed gauge of welding heat input Q
- thermal conductivity matrix expressed by the coefficient of thermal conductivity λ
- temperature of base material - heater
- speed of welding w
- welding material, dimensions, particularly its thickness.

3.1. Addressing thermal finite element analysis of stress

The solution of stress analysis, thermal numerical simulation using finite element method is necessary to create a simulation model. Simulation model, Fig. 2, was created based on the actual experimental samples (Rehakova 2001).

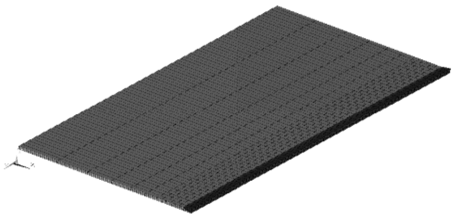

Fig. 2. Geometrical model and generated net

The simulation model is necessary to define the thermo-physical properties (specific heat capacity, coefficient of thermal conductivity, bulk density) of the basic and auxiliary materials.

The initial conditions were based on baseline experimental sample. Such a simulation model was loaded by a moving heat source volume on the actual heat input welding parameters determined from the experiment, (Rehakova 2001, Sobota 2002, Hagara 2004). For analysis of stress is important to correctly specify the values of mechanical and thermo-physical properties depending on the change in temperature, especially modulus of elasticity E and the longitudinal thermal expansion of h. When for the welding is used for additional material of equal or approximate the chemical composition in order to achieve the same mechanical properties of the weld as the basic material. Therefore, we consider the simulation with the same thermophysical and mechanical properties of the basic and additional material.

The task was designed as a symmetrical and nonlinear physics.

3.2. Results of numerical simulation

Calculated temperature field course was used for calculating structural stresses generated during welding. Misses stresses distribution is shown in Fig. 3 single-layer and Fig. 4 angular weld.

The maximum stress of steel 11 375 in the transformation γ of iron and α change in crystal lattice K12 to K8. The completed weld spot the smallest stress because molten metal has a low modulus of elasticity. Welded material can be deformed due to the excess yield strength. Minimum yield strength is for the welded material, structural steel 11 375 to 235 MPa. Plastic deformation occurs in areas where yield strength has been exceeded.

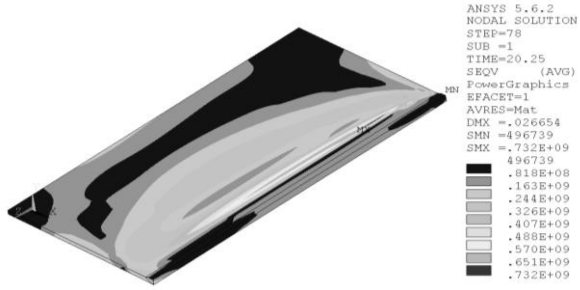

Fig. 3. Misses stresses at the time of 19.25 s.

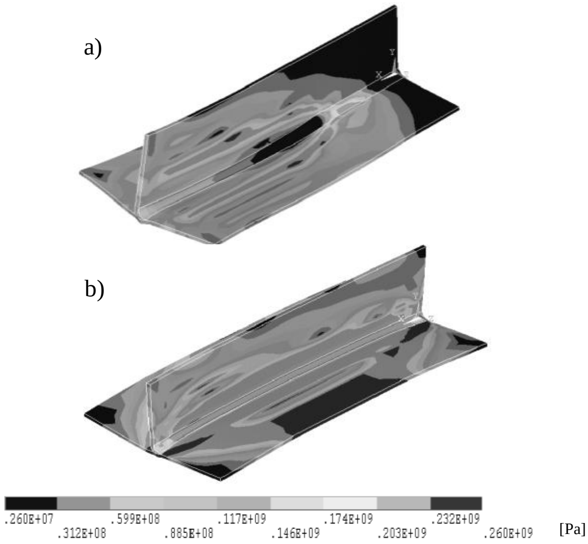

Fig. 4. Misses stresses a) at the time of 30 s b) after cooling

4. CONCLUSION

The developed simulation model to solution the thermal and stress cycle can be used for a wide range of basic and auxiliary materials, other technologies melt welding method as well as different initial and boundary conditions. The advantage of FEM using powerful computers to optimize the solution for the task is in good time and costs. The variability of solutions to the problem using computer technology is increasingly used as an initial experiment.

5. KNOWLEDGEMENT

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