Global Journal of Pure and Applied Mathematics.
ISSN 0973-1768 Volume 13, Number 1 (2017), pp. 81-88

http://www.ripublication.com

Calculation of Dynamic Processes in the Welded Seams Received at Arc Ways of Welding

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Abstract

The dynamic processes happening in the welded seams received by arc ways of welding are of considerable interest. The maximum values of tension are created on border of transition of the main metal to strengthening of a root of a seam and in a zone of a likvatsionny strip. The theoretical coefficient of concentration of tension is equal 1.3 which needs to be considered when calculating on the cyclic durability of linear part of pipelines. Near the inclusions concentrated in a likvatsionny strip on limit of the section with a metal matrix, tension grows because of distinction of physical characteristics of a steel matrix and inclusions, the theoretical coefficient of concentration of tension is equal to 1.8.

Keywords: welded seams, the high-concentrated power sources, intensity of tension, a method of final elements.

INTRODUCTION

Program modules take rather widely root and developed for full automation of procedure of the numerical strength analysis of pipelines in the environment of the ANSYS program, one of which is the analysis by the method of final elements (MFE) of dynamic processes of the strained-deformed condition of linear part and welded seams.

The purpose was studying of dynamic processes in the welded seams received by arc ways of welding and in pipe metal.

At metal of a pipe there is a likvatsionny strip formed in the course of production of pipes by controlled rolling. The Likvatsionny strip is sated with nonmetallic inclusions, the last in turn play a significant role in operation of designs because are concentrators of tension.

METHOD AND RESULTS OF RESEARCHES

Modeling of dynamic processes in welded seams is carried out by means of the settlement and program ANSYS complex.

The loading creating dynamic processes in a welded seam is mathematically expressed so:

$$F(t)=(P_0/t_3)((t-t_0)h(t-t_0)-(t-t_1)h(t-t_1)-(t--t_2)h(t-t_2)+(t-t_3)h(t-t_3))$$

where h(t) – Hevisayd's function;

$$t_0=0,\ t_1=t_3,\ t_2=t_V-t_3,\ t_3=t_V.$$

Hevisayd's function is widely used in mathematical apparatus of the theory of management and the theory of processing of signals for representation of the signals passing at a given time from one state into another. In mathematical statistics this function is applied, for example, to record of empirical function of distribution.

Material of a pipe and welded seam contains a likvatsionny strip with a congestion of nonmetallic inclusions which are concentrators of tension and have consecutive communication with metal. Nonmetallic inclusions represent certain clusters in a likvatsionny strip which sizes when calculating correspond to values: width = $0.94\cdot10^{-3}$ m, thickness = $2.4\cdot10^{-3}$ m, and pipe sizes thickness =$15.7\cdot10^{-3}$, length = $40\cdot10^{-3}$. Physical characteristics of nonmetallic inclusions: E = E=$1.6\cdot10^{11}$N/m^2, and metal of the pipe E=$2\cdot10^{11}$ N/m^2.

In the analysis of wave processes the main emphasis is placed on use of a method of final elements as this method possesses high universality and stability. For definition of errors of a numerical method test tasks which have the simple analytical decision are used. As a result of comparison schedules of convergence depending on sampling and coordinate are under construction. The sampling necessary for satisfaction of the set error is determined by schedules of convergence. The comparative analysis is necessary when using numerical methods as at any choice of sampling it is possible to receive not only quantitatively, but also qualitatively incorrect result.

We believe that:

- pipe material isotropic, elastic also submits to Hooke's law;
- deformations are small and are described by linear geometrical ratios;
- we will count tensely deformed condition of a pipe with use of a hypothesis of direct normals and lack of deformations and tension normal the median plane as thickness is much less than its radius.

For the solution of an objective a direct method of integration on time. In fig. 1 and 2 distribution of intensity of tension in a timepoint of $t \approx 0{,}629 \cdot 10^{-5}$sec and $t \approx 0{,}111 \cdot 10^{-4}$sec is shown. Such representation allows to see a variety of the waves arising at action of loading, change of the front of a wave.

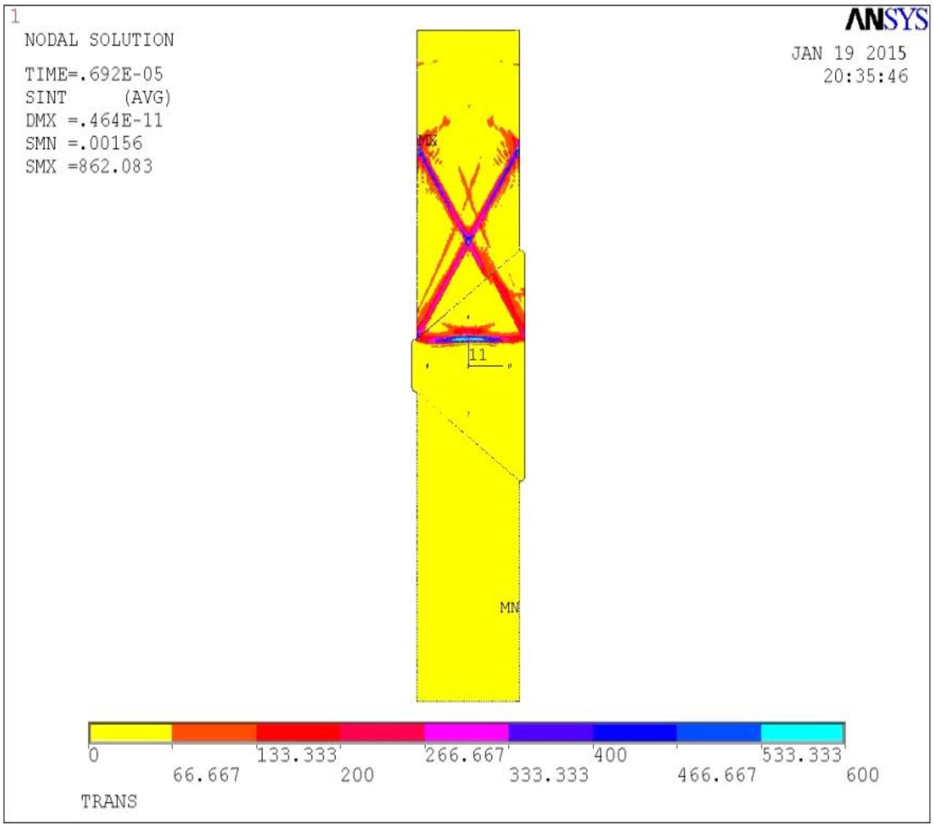

Figure 1. Nature of change of intensity of tension in a pipe wall on border metal seam in $t \approx 0{,}629 \cdot 10^{-5}$sec timepoint

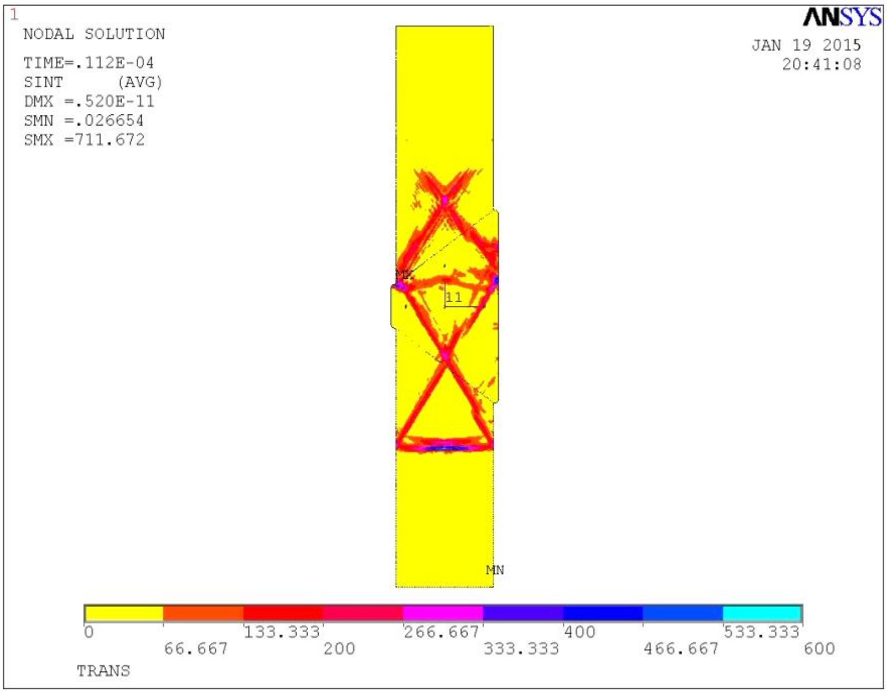

Figure 2. Nature of change of intensity of tension in a pipe wall on border metal seam in t≈0,111·10^{-4}sec timepoint

The maximum deflection characterizing change of movement of a longitudinal wave owing to a meeting with border metal seam is established.

In fig. 3 and 4 numerical change of intensity of tension on border metal seam which increases from 260 to 580 pieces is shown.

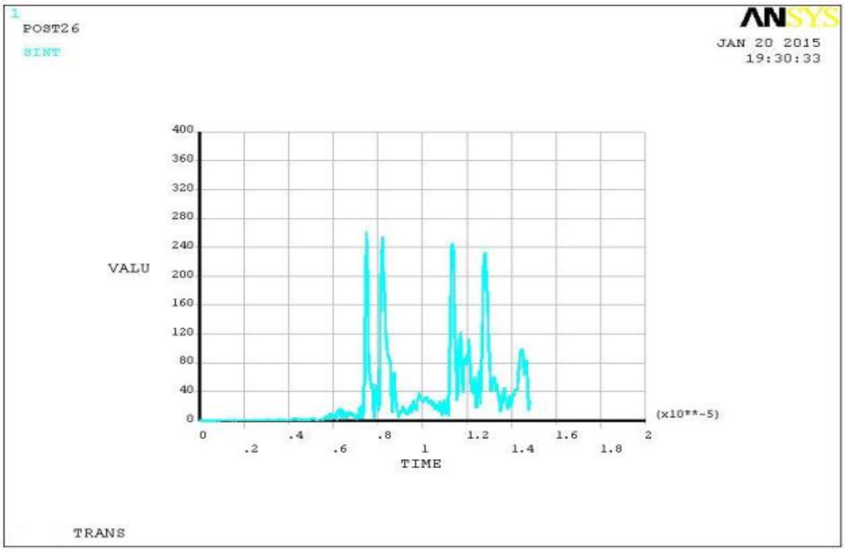

Figure 3. Numerical change of intensity of tension in metal

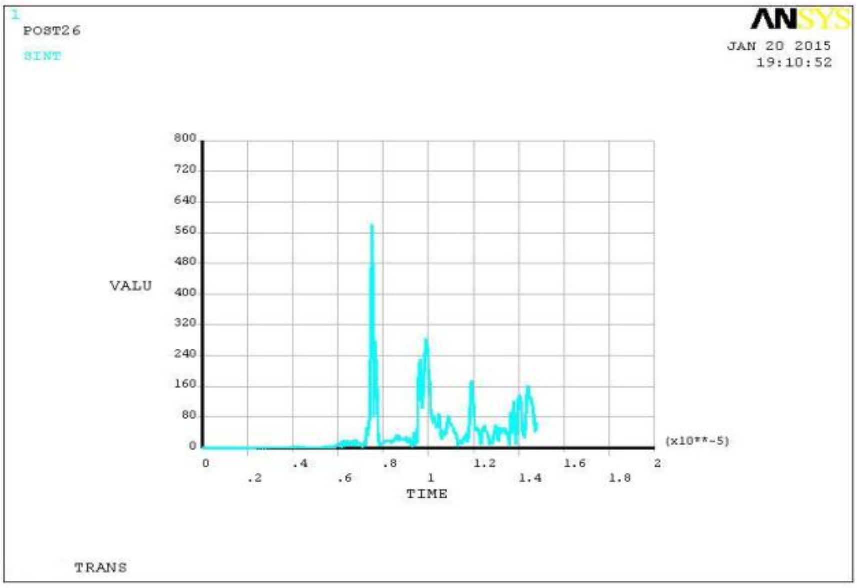

Figure 4. Numerical change of intensity of tension on border metal a seam

In fig. 5 and 6 curves of movements of Ux (t) which allow to estimate quantitatively and qualitatively the wave processes arising when passing a wave through a likvatsionny strip with nonmetallic inclusions are presented. On border metal – the likvatsionny strip intensity of tension increases (fig. 5) and considerably increases in the most likvatsionny strip to 850 units (fig. 6).

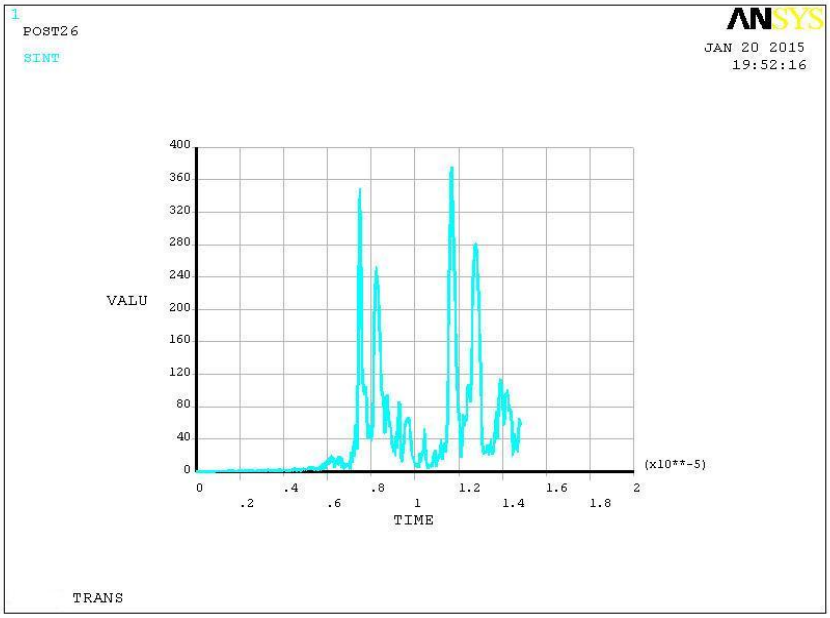

Figure 5. Quantitative change of intensity of tension on border metal – a likvatsionny strip

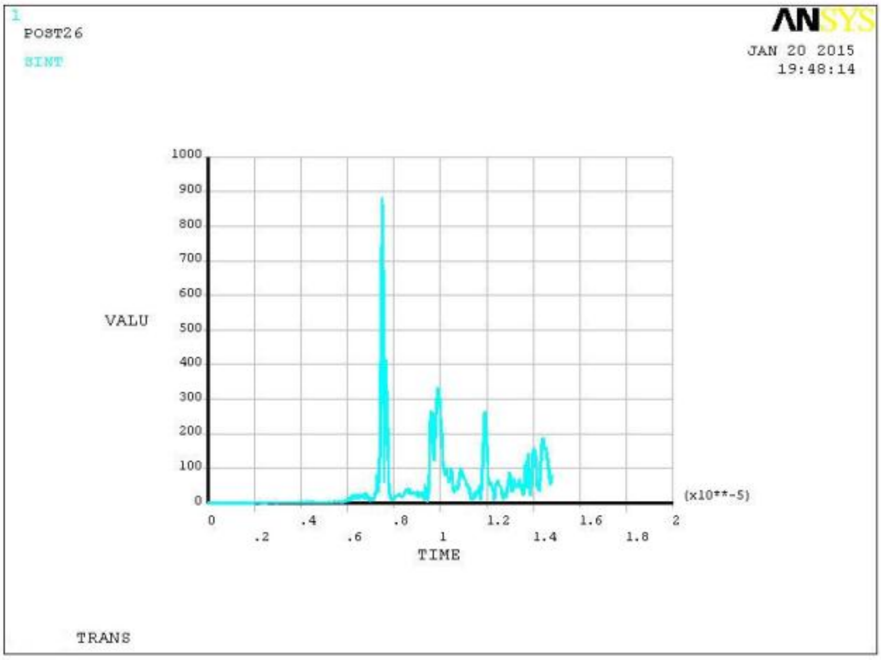

Figure 6. Quantitative value of intensity of tension in a likvatsionny strip

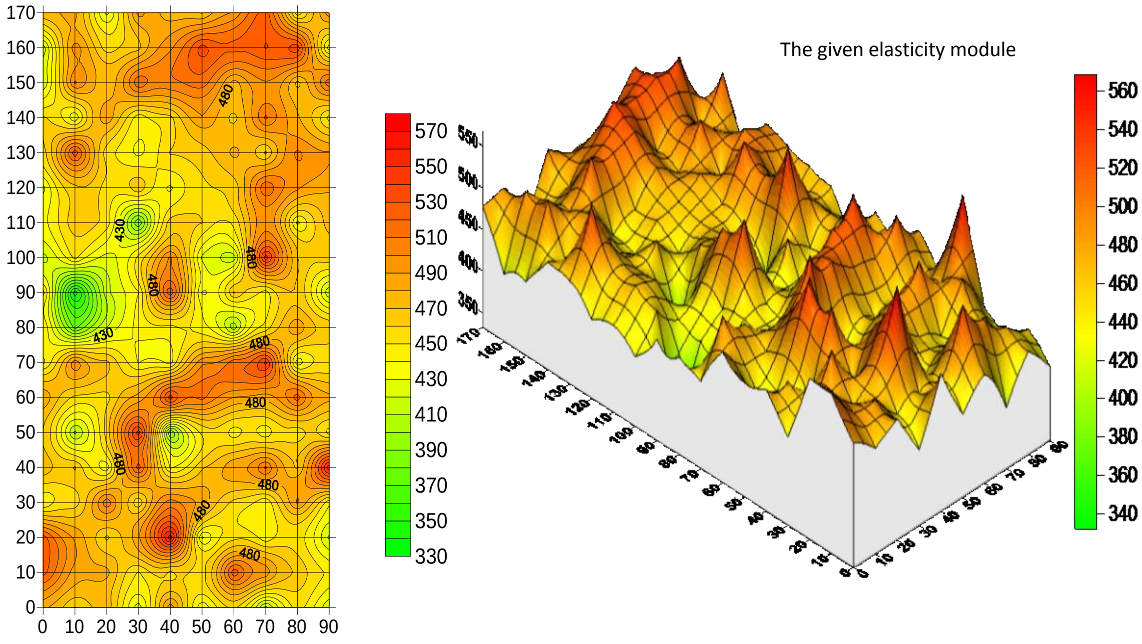

Figure 7. Topography of distribution of properties on experiment land area the given elasticity module (E, GPA)

Near inclusions of a likvatsionny strip of tension from 18 to 35% because inclusions and a metal matrix have distinction of physical characteristics grow under the influence of the set loading on average, the theoretical coefficient of concentration of tension made 1.8. Also increase in tension is observed on border metal – a seam root (to 35-38%) that it is connected with change of the sizes in a seam root, theoretical coefficient of concentration of tension made 1.3 [1].

Difference of properties of inclusions and metal of a seam was shown by the nanotest. A theoretical basis of this technique is the analytical solution of a so-called problem of Hertz [2].

Results of tests are visualized by topography of distribution of properties on the land area of experiment and presented on fig. 7 and 8 characterizing quantitative change of characteristics of hardness and the given elasticity module on color intensity.

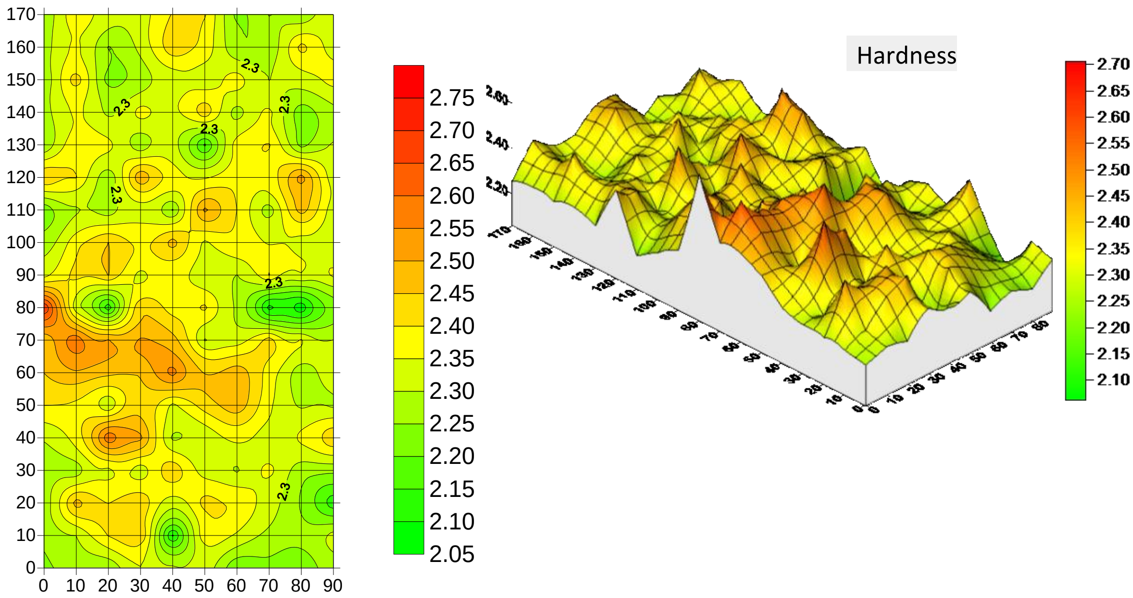

Figure 8. Topography of distribution of properties on experiment land area hardness (N, GPA)

The analysis of the results received during nanoexperiment allowed to establish that the firmness of nonmetallic inclusions makes 2.5 ÷ 2.7 GPA, and the given module of elasticity of 530 ÷ 570 GPA that is about 20% higher than a steel matrix (according to skilled data steel has the hardness of 1.5 ÷ 2 GPA and the given elasticity module on average of 465 GPA [2]).

CONCLUSIONS

Modeling of dynamic processes in the welded seams received by arc ways of welding allowed to establish that the level of tension changes. Considerable change happens on border metal – a seam root from from 260 to 580 and in a likvatsionny strip to 850. Mathematical interpretation of change of intensity of tension is shown. The theoretical coefficient of concentration of tension is equal 1.3 which needs to be considered when calculating on the cyclic durability of linear part of pipelines. Near the inclusions concentrated in a likvatsionny strip on limit of the section with a metal matrix, tension grows because of distinction of physical characteristics of a steel matrix and inclusions, the theoretical coefficient of concentration of tension is equal to 1.8.

ACKNOWLEDGEMENTS

Work is performed within the state task in the sphere of scientific activity No. 11.1196.2014/K of the Ministry of Education and Science of the Russian Federation of 17.07.2014.

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