COMPUTER MODELING OF THE STRESS-STRAINSTATE OF WELDED CONSTRUCTION

G.T. Danenova, T.B. Akhmetzhanov
Scientific Supervisor: Prof., Dr. M.R. Nurguzhin
KaragandaStateTechnicalUniversity
Kazakhstan, Karaganda, B.Mira., 56, 100027
E-mail: g.danenova@kstu.kz

КОМПЬЮТЕРНОЕ МОДЕЛИРОВАНИЕ
НАПРЯЖЕННО-ДЕФОРМИРОВАННОГО СОСТОЯНИЯ СВАРНЫХ КОНСТРУКЦИЙ

Г.Т. Даненова, Т.Б. Ахметжанов,
Научный руководитель: профессор, д.т.н. М.Р.Нургужин
Карагандинский государственный технический университет
Казахстан, Караганда, б. Мира, 56, 100027
E-mail: g.danenova@kstu.kz

Аннотация. *В данной работе показано, что при оценке и обеспечении живучести сварных металлоконструкций важную роль играют технологические факторы. Учет их влияния реализуется на основе применения метода конечных элементов. Описана численная методика расчета остаточных сварочных напряжений и деформаций в элементах сварных металлоконструкций. Численнообосновантехнологическийметодповышенияживучестиуказанногоклассаметаллоконструкций.*

Introduction.At the present time the maintenance of the welded construction serviceability over normative service life is provided by the maintenance system on the basis of the guiding documents according to the concept of “safe damage”. However, experience has shown [1, 2] the following:

1. There is no uniform methodological approach to the development of methodical directive. The approach should provide reliability and completeness of conclusions to make an evaluation of residual resource.

2. Numerical values of critical parameters of the defects (that are contained in the guiding documents) are not proved and considerably underestimated in many cases.

3. The criterion of a marginal state is not evident for a product as a whole (not for a separate element, a detail or unit) when estimating a residual resource.

4. Only total data about the buildup of welded design are fixed in the maintaining organizations. There are no data on loadings in various time intervals.

5. Technological factors relating to welding (high residual stresses and great plastic strains) are not considered in the guiding documents.

Materials and methods. The structure of welded metal construction (WMC) survivability estimation has been taken into account the above mentionedfactors. The base concepts of safe operation of WMC are given there. It is necessary to note that the estimation of survivability includes the whole complex of tasks: the estimation of the current object condition; prediction of developing this condition for the near future; recommendations about

optimum period of operation before getting out this object or before its next repair. In this connection it is very important to choose a correct method of calculating the crack resistance parameters of WMC subject to the technology factors related to welding. Such approach demands the defining residual stresses and strains at the first stage of the problem solving.

The complex of investigations of forming residual stresses and strains was realized on the basis of the above mentioned approach. Joints as the short seam executed on a plate of 100x200x6 mm are considered. The scheme of flat tension is accepted. Power of the welding source is $q = 12600\ W$, the speed is $V = 0{,}01\ m/s$. The thermo-physical constants correspond to the data of the St3 steel. The problem was solved by using the program ANSYS.

Results.Some results are shown in figures 1-3. According to the result it is established that forming volumetric residual stretching stresses in zones of the ends of short welds and in places of their crossing is connected to the value of specific energy input rates of welding q_n/δ. It is shown that $q_n/\delta \geq 12{,}5 W/mm^2$ at defining the stress – strain state (SSS) of plates with short welding can be calculated approximately by the pattern of plane stress condition.

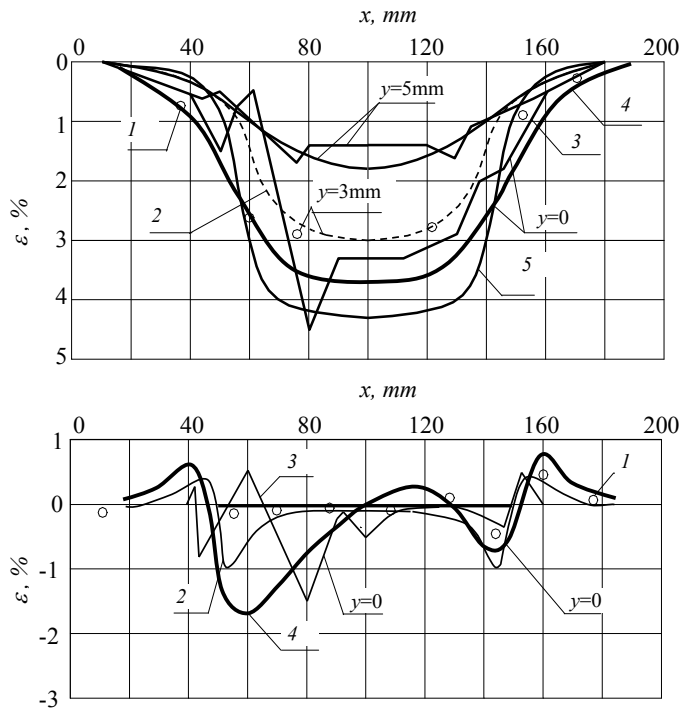
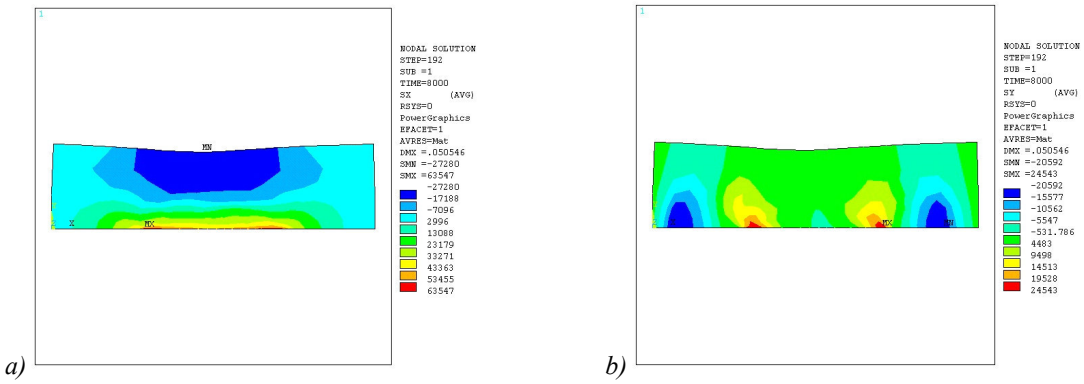


Fig. 1. The diagrams of residual strains in the plate 100x200x6mm

1 - experimental data ; 2 - calculation data by the FEM; 3 - calculation data by the FDM;

4 - calculation data by ANSYS program; 5 - calculation data by the FEM KELAPS

The feature of the approach is the account of redistributing residual stresses during the crack growth. It is established that the factor of residual stresses intensity can be estimated approximately by Wells formula within the limits of a weld ($\ell_{cr} \leq \ell_j$).



a) b)

Fig.2. Stress state of plate: a – stresses σ_x; b - stresses σ_y

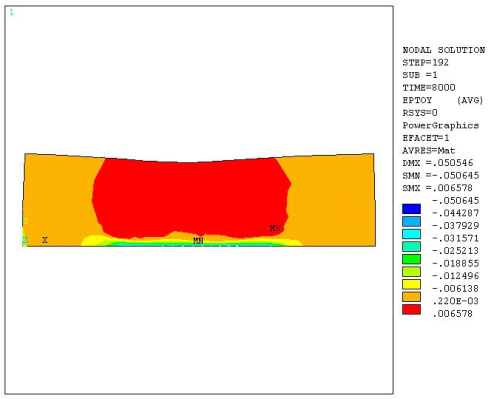


Fig.3. The residual strains ε_y

Conclusion.The calculation of the stress-strain state of units and joint of welded metal constructions also allows applying seriously the methods of regulation and elimination of residual stresses and strains, developing the constructive - technological procedures aimed at formatting more favorable residual stress fields in WMC.

It's shown that it's impossible to completely eliminate the manifestation of residual stresses and strains. But it's possible to reduce significantly their negative influence on the loading capacity of welded metal constructions by controlling them during designing, manufacturing and operating.

REFERENCES

1. Ryakhin, V.A., Moshkarev, G.N. (1984). Service life and stability of welded structures of construction site and road making machines. Moscow: Mashinostroenie [in Russian].
2. Paul Colegrove, Chukwugozie Ikeagu, Adam Thistlethwaite, Stewart Williams, Tamas Nagy, WojciechSuder, Axel Steuwer, ThiloPirling. (2009). The welding process impact on residual stress and distortion. Science and Technology of Welding and Joining, 14(8), 717-725.
3. Schaumann P., Collmann M. (2013). Influence of weld defects on the fatigue resistance of thick steel plates. Procedia engineering, 66, 62- 72.