A POSSIBILITY OF COMPLEX ESTIMATION OF THE WELD COLD CRACKING RESISTANCE

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A new approach of complex quantitative evaluation of the weld resistance to cold crack initiation is offered. It essence consists in solving the following problems: close similarity of the test conditions to those in which the welds in welded structures are carried out; estimation of the complex influence of the technological and constructional parameters, determination of the critical conditions for crack initiation; evaluation of the technological strength reserve. The ways of solving those problems and the results obtained are described as well as the possibilities to apply the new approach presented.

INTRODUCTION

Tendency to cold cracking is the main problem of high strength constructional steel weldability.

For its solving a new approach is offered,the essence of which is reduced to the solutions of the following problems:
a) close similarity of the test conditions to those in which the welds in the welded structures are carried out;
b) estimation of the complex influence of the technological and constructional parameters;
c) determination of the critical conditions for crack initiation and propagation;
d) quantitative evaluation of the technological strength reserve.

To solve the problems specified a theoretical-experimental method is applied.The principle basis of its analytical part is the local restraint intensity R_{FL} [1]. It is defined as ratio between the intensity of the force factor f_y (x), arisen as a result of impeding from transverse shrinkage and the realized

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transverse displacement b_y (z) of a point on the groove surface having specified coordinates.

The experimental data are obtained by means of technological test set. Figure 1 shows diagrams of several of its modules. Common to all of them is that the samples (1) of the studied steel have a shape allowing their firm fixing to the solid plate (2) by wedges (3).

By changing the groove shape (Fig.1-d) identical thermal deformation and structural-hydrogen state in the area of the module control weld and in the respective joint of a certain welded construction can be achieved.

The method of analytical determination of the internal forces and the local restraint intensity in modules having butt control weld (Fig.1-a) is described in details in [2].It could be also applied to butt welds of welded constructions.

An important advantage of the complex approach offered is the introduction of modules for fillet welds (Fig.1-b,1-c). This allows not only similarity of the test conditions for butt and fillet welds, for which up to now completely different in character technological tests are used, but also provision of a possibility to estimate another parameter of technological strength-lamellar tearing.The combination of the experimental technological set with the criterion of „local restraint intensity" allows the quantitative evaluation of the combined effects of technological and constructional parameters on the initiation and growth of weld cold cracks under conditions most similar to those in which welds of the tested construction are carried out.This in fact is the solution of the first two problems.

For the research purposes the predominating development of one parameter only (restraint intensity, weld heat input, weld excentricity, etc.) is possible. Thus quantitative estimation of its importance for the technological strength of a certain weld can be made.

The solution of the third problem is achieved by discrete increase of the local restraint intensity which leads to increase of the local welding stresses. Cold cracking is connected with the critical values of these stresses, with the magnitude of the local restraint intensity respectively.

At certain internal forces [2] it is not a problem with the help of appropriate numerical method (for example finite elements method) to calculate the value and distribution of critical local stresses. Software for personal computer is developed.

To solve the fourth problem it is enough to find the difference between the critical local tensile stresses determined by the respective technological module and the maximum local tensile stresses in the estimated welded joint. In practice instead of the local stresses the local restraint intensity can be used which gives a number of advantages.

RESULTS

As examples Fig.2 shows analytically obtained dependencies between the local restraint intensity R_{FL}, the thickness "s" of the samples, the weld heat input "q" and the restraint length "b_3". They are calculated for the module in Fig. 1-a.

With a view to supporting the possibilities of the offered complex approach some experimental investigations have been carried out. To estimate the influence of the groove shape welds of low alloyed steel intended for ship hulls of 30 mm thickness have been tested, having basic mechanical features R_e=400 and R_m=560 MPa and carbon equivalent 0,41% (according to IIW).The technological module in Fig.1-b has been used in the tests.In double bevel groove,cracks did not occur in any of the test elements while in single bevel groove cracks occured also at restraint lenght 300 mm. The effect of the groove shape has been confirmed which in this case provokes increase of the local tensile stresses in the weld root where cold crack occurs and develops.

The complex approach offered allows to reflect more completely the actual conditions arising in the weld and to determine more correctly the optimal welding conditions to avoid cold cracks formation.

REFERENCES

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2. Christov, St., „An approach for determining the internal forces and inherent stresses in procedure test SEV-19-HT", Doc. IIW-IX-1506-88.

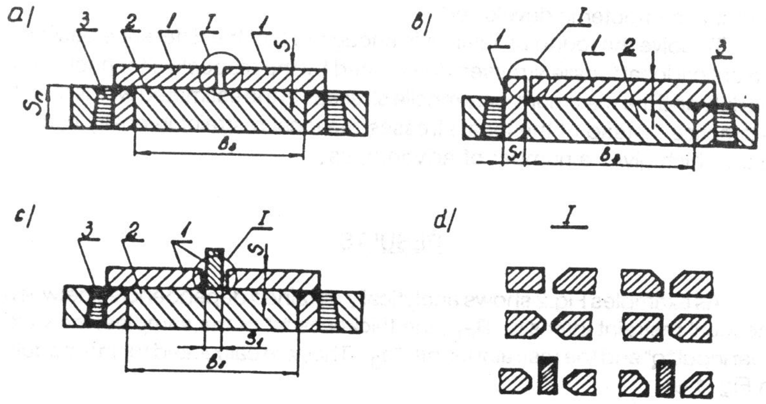

Fig.1. Technological set of welded joints testing:
a-butt; b-filet; c-T-shaped; d-examples of bevel groove.

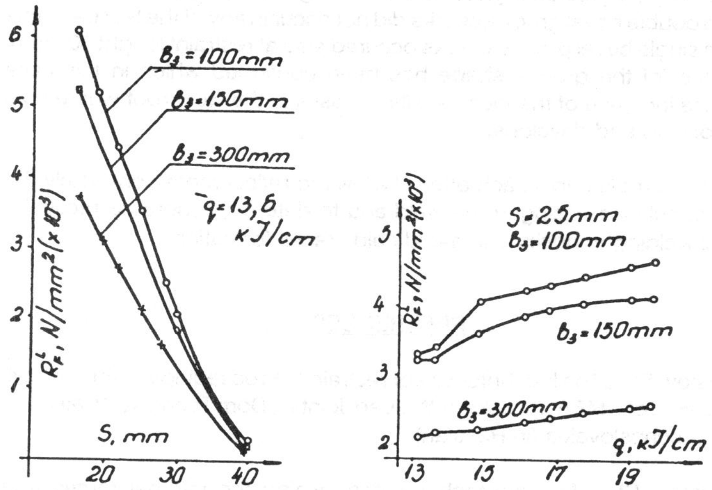

Fig.2. Analytically obtained dependencies of local restraint intensity R_{FL} on the samples thickness and the heat input q.