IMPROVEMENT OF STRENGTHENING AND REPAIR OF FRAME STRUCTURES WELDING METHODS

V.I. Savulyak, S.A. Zabolotniy, D.V. Bakalets

Dr.Sci.Tech., vsavulyak@mail.ru
Cand.Tech.Sci., zab82@mail.ru
Postgraduate, bacalets_dima@mail.ru.

Abstract: *The frame constructions of transport and technological machines perceive the static load and dynamic load as a result of hat in the process of exploitation cracks and other damages on certain areas are appeared. By the problem of establishment of elements of strengthening in dangerous areas, and also proceeding in descriptions of durability of such areas with the engendered cracks, there is a danger of damage of parent metal frames due to negative processes, which can take place during welding.*

For indemnification of these negative consequences a scarf-welding method is developed, which provides for placing in the area of temperatures, which provide its melting, soldering material on the basis of copper between details which weld. It is well-proven researches, that renewal and strengthening of steel constructions by the use of the developed technology of welding and soldering with the use of solders on the basis of copper except for the increase of descriptions of durability provides effective slushing defence of surfaces of details in the thermal affected zone

Keywords: *strengthening, cracks, technology of welding and soldering.*

1. Entry

Sufficient cause that limits the term of exploitation of frames of trucks are tireless destructions as cracks. It is explained by that during motion of car on it's frame, except weight of underspring parts, vertical dynamic forces (at the move of inequalities of road) and horizontal dynamic forces, that arise up at braking, acceleration and motion on turns, operate [1]. In addition on cars with the set additional loading-unloading equipment, during its using there are additional vertical forces (effort) as a result of action of that the elements of frame yield to the alternating loads and as a result become deformed [2].

Horizontal forces do not cause in a construction the frame of substantial deformations and practically do not have influence on its firmness. Vertical dynamic forces, in same queue, considerably influence on firmness of construction of frame and it is mostly led to appearance of fatigue cracks of different kinds and orientations, that cause the change of the tensely-deformed state of all system [3].

Systematic researches of tireless destructions of details of machines began from middle of the last century. Presently the question of tireless durability is spare large attention [1-5]. Leaning on the accumulated knowledge in area of tireless durability, and improving quality of the repaired details it is possible to find the ways of achievement of high operating reliability of the repaired frames, why and the devoted work.

It is necessary to mark that the most progressive direction of increase of longevity and operating properties of details of machines consists in combining of technologies of repair of cracks that appeared in the process of exploitation of welding methods, in combination with the different processes of strengthening technologies. It allows most to a full degree to satisfy the modern queries of practice.

This work is devoted to the study and research of the combined process of welding and concomitant soldering, for the increase of durability and corrosive firmness of the weld-fabricated connections with concomitant healing of damages as cracks, filling of copper its fusions.

2. Basic part

Strengthening and repair of zones of frames with the engendered cracks is possible by the way of establishment (welding on) of additional elements [4]. Such flowsheet of repair provides necessary descriptions of durability, but its defect is weakening of metal in the temperature affected zone and by reduction in this zone of corrosive firmness. These defects can be removed by the way of using of an offer technology that combines the processes of welding and soldering. Technology envisages the use of solders with the necessary temperature of melting for the increase of durability of the weld-fabricated connections in a fall-over, and also increase of corrosive firmness of heat-affected zone. A feature is that a solder is set between basic elements that weld, and melted due to the heat of welding bath (Figure 1).

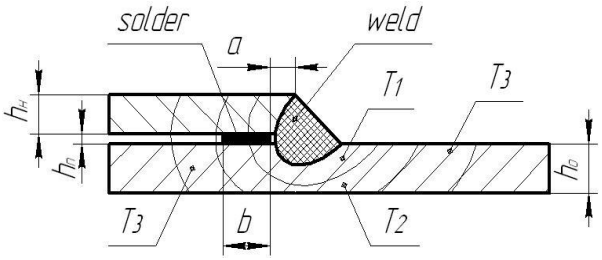

Figure 1: *Scarf-welding method*

By researches [5] it is set that renewal and strengthening of steel constructions by the way of damages healing by alloys on the basis of copper provides braking of cracks, increases their vitality notably.

As a basis for solders for realization of experiments a copper and alloys of copper with zinc, manganese and other elements are used. A copper in a pure form in the molten state is characterized by high fluidity, well moistens the surface of steels, carboloies, nickel and nickeliferous alloys; flows in the thinnest capillary gaps and gives the strong and plastic soldered connections.

Copper-zinc solders represent the double alloys of copper and zinc in different correlations. Diagram of the state of alloys of the system copper - zinc brought around to Figure 2. The most interest is presented by alloys that contain less than 34% of Zn and have a monophase structure of *a*-hard solution. With the increase of content of zinc the plasticity of solders goes down, causing the embrittlement of the soldered connections.

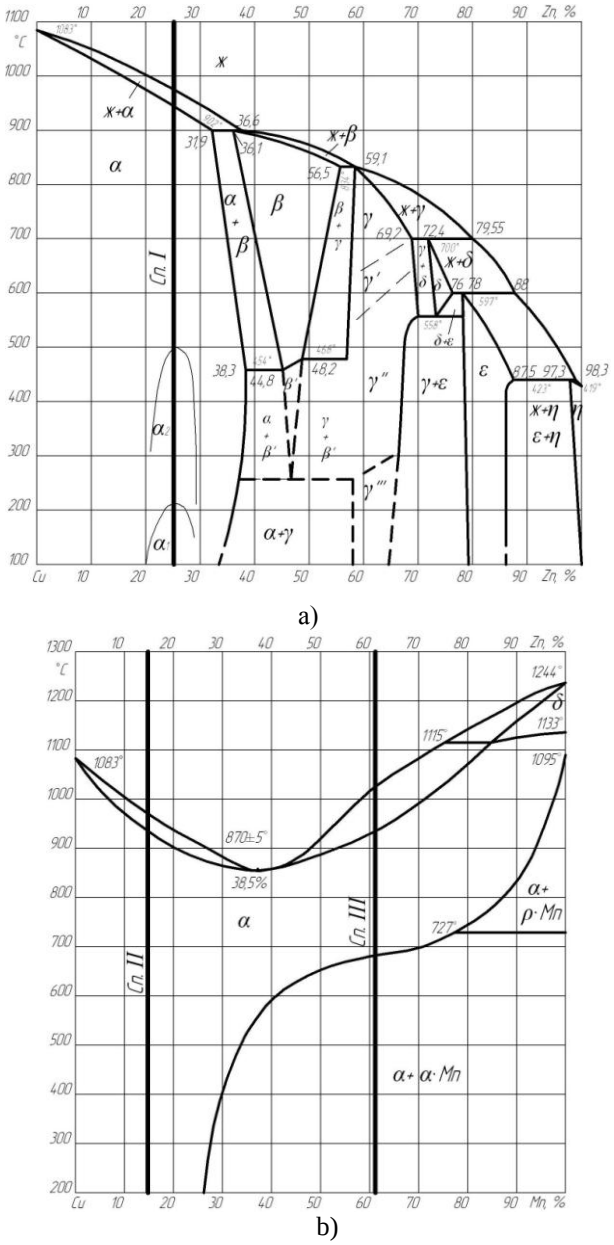

Figure 2: Diagram of the state of alloys of the system: a) copper - zinc; b) copper - manganese.

Next to the well technological properties of copper-zinc alloys as a solder have high corrosive firmness [6]. Solders that have a structure of *a*-hard solution, keep sufficient durability even in the conditions of subzero temperatures. The lack of these solders is the evaporation of zinc from high temperatures that worsens the terms of work with them.

The solders on the basis of alloys of copper with a manganese have a comparatively subzero temperature of melting, enough high durability and plasticity. The solders of this system did not get distribution, but they are very perspective, so as the constructions soldered by them have higher durability as compared to connections that is

soldered by copper-zinc solders, during work with temperatures 500 - 600 ° C.

On the department of The Technology of Increase of Durability of VNTU a scarf-welding method was worked out, that envisages placing of soldering material on the basis of copper between details that weld, in the zone of the temperature field, where its melting is provided (Figure 1).

The necessary condition of realization of the method that is described higher is a reasonable choice or calculation of parameters of the welding-soldering process, the complete melting of solder will take place at that, and quality connection of details will appear.

It follows for this purpose it is necessary to define: welding modes, taking into account the thickness of profile of frame in the zone of welding on h_o and protective straps $h_н$; composition of soldering material; thickness $h_п$ and width of *b* strake of solder; its distance from the welding guy-sutures *a* depending on the depth of melting and geometry of guy-sutures in the transversal crossing. A possible gap between details is regulated by the GOST 5264-80, depends on the thickness of details and can present to 2 mm, what sufficiently for establishment of soldering material.

Determination of the optimal modes of the combined welding it is expedient to conduct a method design of process with the use of the specialized software on the basis of certainly-element analysis [7]. A model that allowed to analyse in time the thermal fields in the process of welding and cooling of detail is worked out, namely to determine the changes of temperatures in the different points of volume of material of detail and solder.

Verification of adequacy and tuning of model was executed by realization of model experiment. On an analogical chart temperatures were measured in points T_1-T_5 of the model, on length of plate of solder and in points of T_5-T_{10} on its width (Figure 3).

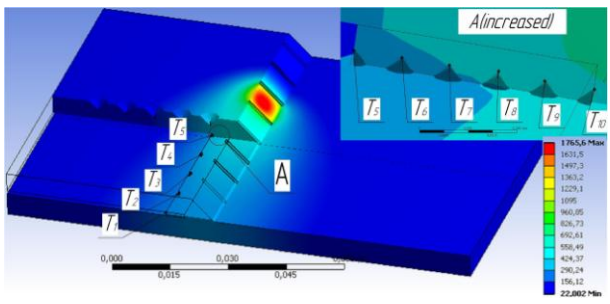

Figure 3: *Model*

Developed computer model of construction in the form of two plastins with the throat of 5 mm and strakes of solder of 5x1mm and set modes of welding allowed to get thermogram for the indicated points (Figure 4). It is evidently from a chart, that a temperature in the point of T_1 is minimum and arrives at a temperature of 932 ˚C on the third second after the beginning of welding. For providing of the complete melting of solder its temperature of melting must be some less. For the choice of solder it is expedient to use the diagram of the state that shows, that such temperature is sufficient for melting of solder with the concentration of components, that fits the area of diagram of the state of alloy Cu - Zn located on the right of line of Cn.I (Figure 2a). In case of using of solder on the basis of copper with a manganese it follows to choose an alloy from an interval between the lines of Cn. II – III (Figure 2 b).

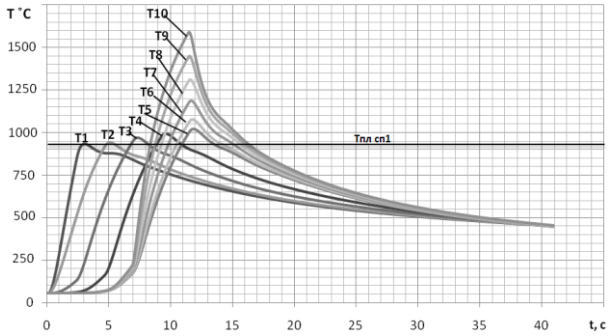

Figure 4: *Temperatures in the points of heat-affected zone (model calculations)*

In the case when it was necessary to provide melting of solder with the set concentration of components in accordance with operating requirements, changed (expected) the welding modes (strength of current, speed, angle of slope of electrode). In the cases when the complete melting of solder due to a heat that was distinguished during welding became impossible, a construction tepefied preliminary. The macrosections of the connections got at the different modes are shown on Figure 5. In all cases a copper was fully melted, filling an interval between plates from the side of the weld-fabricated guy-sutures.

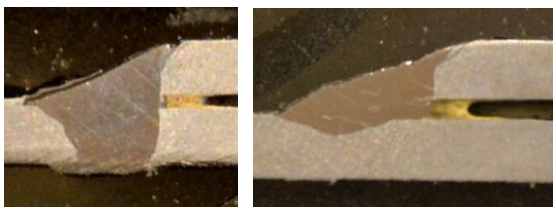

Figure 5: *Macrosections of the weld-fabricated connections*

a)

b)

Figure 6: *Borders of alloy between steel and copper: a) from the side of the weld-fabricated guy-sutures; b) from the opposite side from the weld-fabricated guy-sutures.*

The microstructure analysis of zone of alloy between steel and copper showed the presence of clear border without includings and unalloys. It is educed the interpenetration of metal of the weld-fabricated guy-sutures and solder in some cases (Figure 6a). Such interfusion is local however, it does not spread in the depth of the weld-fabricated guy-sutures and that is why does not influence on mechanical properties of connection. Other edge of copper solder (Figure 6b) due to high fluidity and forces of surface-tension spreads on certain distance for surfaces permanent, providing this same its additional corrosive defence.

For determination of margin of safety of standards brewed on the technology described higher, a test was conducted on a bursting machine by us.

As a result of tests of displacement it is set, that destruction of all standards took place out of the weld-fabricated guy-sutures and area of soldering, in the temperature affected zone. It is educed as a result of tests on the extracentral tension, that destruction of place of soldering has binding character, takes place on a curvilinear surface and in some places passes on the parent metal of detail non-destructive solder that testifies to high durability of such connection.

Conclusions

The technology and the row of practical recommendations are worked out, in relation to the use of the combined welding with the using of solders on the basis of copper for conduction of repair of transversal cracks of frames of a transport technique, by the way of establishment of strengthening protective straps.

The method resulted in the article is based on the use of the programs of finite-element analysis, gives an opportunity to determine clearly the optimal parameters of the mode of the combined welding.

Renewal and strengthening of steel constructions by the way of using of the combined welding with the use of solders on the basis of copper except the increase of descriptions of durability of such connection provides corrosive defence of the thermal affected zone.

References

[1] Maksapetyan, H.V., Kochynyan, H. D., *Determination of the tense state of frames of trucks at different baskets*, The Collection of Scientific Works of Armenia SHI, 1977.

[2] Mironov, E.I., Ivanova, Z.V., *New method of experimental estimation of loading of manipulators of the delimber-bucker setting*, Moscow, 1983.

[3] Troshchenko, V.T., Hamaza, L.A., Pokrovskyi, V.V., [and other], *The Cyclic Deformations and Fatigue of Metals*, The Scientific Thought, Kyiv,1985.

[4] Bakalets, D.V., Savulyak, V.I., *The Increase of Reliability and Proceeding of Metalwares of Transport and Agricultural Machines*, The Collection of Scientific Works of Vinnytsya National Agrarian University. The Engineering sciences Series, 2012.

[5] Savulyak, V.I., Bakalets, D.V., *The Influence of Healing Cracks by Copper Alloys on Durability of Steel Constructions*, The Announcer of Vinnytsya Polytechnic Institute, 2012.

[6] Lyapina, O.V., *The Physicochemical Processes on the Surface of Tapes of Copper Alloy*, The Prykarpattya National University by Vasyl Stefenyk, Ivano-Frankivs'k, 2006.

[7] Savulyak V.I., Zabolotniy S.A, Shenfeld V.Y. *Thermal fields and deformations during restoration details of transport techniques*, Bulletin DREAMS them. Vladimir Dal., Lugask, 2009.