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МІЦНІСТЬ ЗВАРНИХ, КЛЕЙОВИХ І КЛЕЄЗВАРНИХ З'ЄДНАНЬ ПРИ ЦИКЛІЧНОМУ НАВАНТАЖЕННІ

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Анотація. Проведено порівняльні випробування на циклічну міцність зварних, клеєзварних і клейових з'єднань. Дослідження проведені при симетричному і асиметричному циклі навантаження. Побудовано криві Вейлера- це дозволило вибрати тип з'єднання для якісного усунення тріщин в чавунних деталі.

Ключові слова: електроконтактне зварювання, електродугове зварювання, чавун, клеєвий компаунд, зварних точка, циклічна міцність, цикл навантаження.

Introduction. In presses this the exploitations on cast-iron basic details influence variables after a size and direction cyclic loading. Thus, there are tensions in them, destroying a detail. By reason of this phenomenon is some heterogeneity of structure of metal, microscopic cracks, pores, dislocates [1-4, 6]. Therefore very it is important to define firmness of the different on their nature connections used for the removal of cracks in cast-iron details [5, 7].

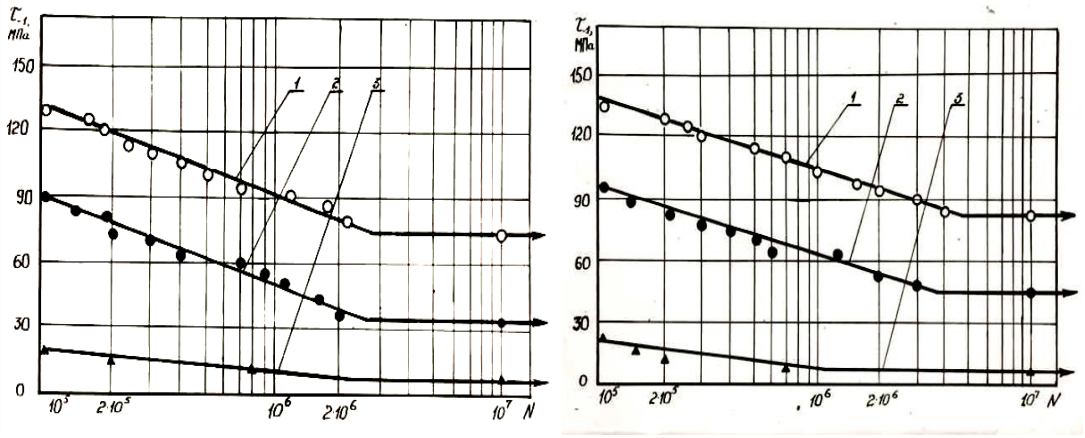
Analysis of results of the last researches. Analysis of the special literature [8, 10], and also the direct looking after repair harts allowed to set that the most widespread defects of base details are cracks and wears of landings surfaces. From data of GOSNITI [11, 12], 15-22% corps of boxes of change of transmissions and 8-11% of distributing boxes of tractors have cracks, and also accordingly: 10-16% and 9-14% of threadbare to the maximum state landings surfaces. The origins of these defects are bound to the combined action of remaining internal tensions and external cyclic loading [13]. It is related to the features of material and construction of details, character, size and direction of action of the internal and external loading [3, 7], operating on cabinet-type details.

To the analysis of cross-coupling of welding points and glue layer on works ability of glue welding connections from easy alloys the far of research works is devoted [11, 14].

Research aim. The aim of this research was establishment of objective picture of distribution of tensions at the cyclic loudening of these types of connection: weld-fabricated, glue and glue welding, using at the removal of cracks and resistance to the corrosive effects of the environment.

Methodology of researches. For the receipt of comparative objective results, tested weld-fabricated and glue welding connections with simultaneous determination of rational chart of placing of welding points on the surface of detail [13, 14]. Researchers conducted at tension of the purpose-made standards that consisted of two elements : cast-iron plate (SCH- 18) with the sizes of 100x 60x a 10 mm and steel protective straps (Steel 20) with the sizes of 100x 60x 0,8 mm. In connection with unavailability of reliable data about nature of the cyclic loading that test cast-iron details during exploitation, tests are conducted at axial tension - compression on symmetric and asymmetric to the cycles of loudening. It allowed with the necessary degree of exactness modeling work of connections in conditions close operating [9].

Results of researches. It was set as a result of the conducted experimental researches, that in each of the considered cases, the mechanism of distribution of tensions carries various character (fig. 1). Comparison of research of data shows that the limit of endurance glue welding connection is higher, than at weld-fabricated (point welding) in 1,91 and 2,05 time, accordingly, to every cycle of loudening. Lowest durability at the cyclic loading has glue connection.



a) **b)**

Fig. 1. Strength properties comparison types joints when loading cycles used:
a) symmetrical, asymmetrica; 1-glue welding, welded, glued.

High value of threshold of endurance at glue welding connection of explaining that a glue layer perceives considerable part off-loading, the same, welding points. Guy-sutures serve like demfer between a hard steel protective strap and cast-iron detail. It beneficially affects on the increase of cyclic durability of connection. Thus, there is a redistribution of size of loudening on all plane of protective strap, the concentration of tensions goes down in a near welding zone. Education rigid connection between the steel plate and cast iron parts, by a small number of relatively far from standing, relative to one another, welding points, to create a strong bond with little or no stress concentrations.

High threshold at strength of glue welding compound because the adhesive layer receives a significant portion of loading and unloading thereby welding point. Adhesive joint between the damper is a rigid steel plate and cast iron parts. It has a beneficial effect on improving the fatigue strength connections. At the same time, there is a redistribution of magnitude over the whole plane load pads, reduced stress concentration at the weld zone.

In asymmetric loading cycle endurance limit of the test compounds in 1,16 ... 1,22 times higher than in the symmetric. This is due to the different nature of the beginning destroying when loaded with different coefficients of asymmetry. In the case of asymmetric cycle glue welding initial focus of destruction has arisen in the peripheral areas near welding zone and then spread to the weld point and the adhesive layer. In symmetric first destroyed the glue joint (adhesion failure) and, only then, arose microfracture near welding points. Start destruction adhesive layer occurred in the marginal areas and then extended to the entire area under the cover plate. The fracture behavior of this compound in both cycles is the same. However, the asymmetric, there was the appearance and rapid destruction of the fragile zones of the adhesive joint.

On the basis of experimental data have been identified safety factors for each type of connection. In most cases, calculations on the strength of parts operating under cyclic loading, performed as a screening. Safety factor is determined for allegedly dangerous section details. In this happens, site appearance microfracture.

Strength condition defined by the equation:

$$n = \lfloor n_z \rfloor \qquad (1)$$

where $\lfloor n_z \rfloor$ - the required amount of safety, for cast iron base parts of 2,8..3,0.

Since the chapel of endurance in the asymmetric cycle is less than in the symmetric, the safety factors have been identified for these conditions according to the formula:

$$n = \frac{\tau_{-1}}{K_{\sigma_d} * \tau_a + \varphi_\sigma * \tau_m} \quad (2)$$

where τ_{-1} - the ultimate endurance compound mPa;

K_{σ_d} - reduction ratio limit of endurance;

τ_a - peak voltage cycle mPa;

φ_σ - coefficient of influence of constant normal stress;

τ_m - mean stress cycle mPa.

The results of the calculations showed in Table 1.

Table 1.

Safety factor of the joins

Name of parameters	Name of the weld (welding of point-valued)	Glue welding	Glue
Endurance limit, mPa	36,0	74,0	6,0
Safety factor	1,44	2,87	0,24

Sufficient safety margin has only glue welding.

Analysis of the literature [7, 9] shows that the strength of the connection depends on glue welding flowsheet setting of welding points. To determine the rational scheme of the formation of connection tested one-, two-row and checkerboard scheme setting of welding points. Tests were conducted with a constant factor based on the asymmetry 0,1 and 10^7 cycles [16]. Used samples with single and double plate.

Based on the results of the above study researches the graphs (Fig. 2), dependence endurance connections from scheme setting of welding points for single-sided and double-sided pads.

Less cyclical strength have connections with single-sided joint bar and line arrangement of welding points. Reducing their strength due to the weakening zone adhesive layer, which is experiencing dangerous for her uneven stress on the separation of the end zones overlap. Fatigue failure of this occurs in the heat-affected zone, which is the highest stress concentrator. This area is dangerous, because of the large hupkosti material and its low ductility. Data from these studies cavity correlated with the results presented in [5, 6].

Higher endurance limit at the two surfaces glue welding joins compared with single-row due to the fact that they occur big redistribution of maximum stress of the heat-affected zone in the area of overlap, not under heating, have higher performance. Destruction two surfaces compounds occurs in an area remote from the welding core.

Application of chess layout welding points can remove harmful stress concentrations of the heat-affected zone in the marginal zone of overlap. There is a process of maximum stress redistribution of welding spots on the entire plane overlap. Eliminates the possibility of unequal separation on the masonry of the details. Using such a scheme reduces the number of welding points, while retaining the strength performance and reduce glue burned off.

Knowledge of the magnitude of strength loss compounds under the influence of the external environment provides the opportunity to establish effective application of each of them and to avoid premature failure of parts.

Each batch of samples (glue, glue welding and welded joints) was aged for 30, 60 and 90 days. The exposure was performed in: air, 3% solution of salt, water, oil and diesel fuel. Based on the results of experimental studies determined the amount of softening of each of them.

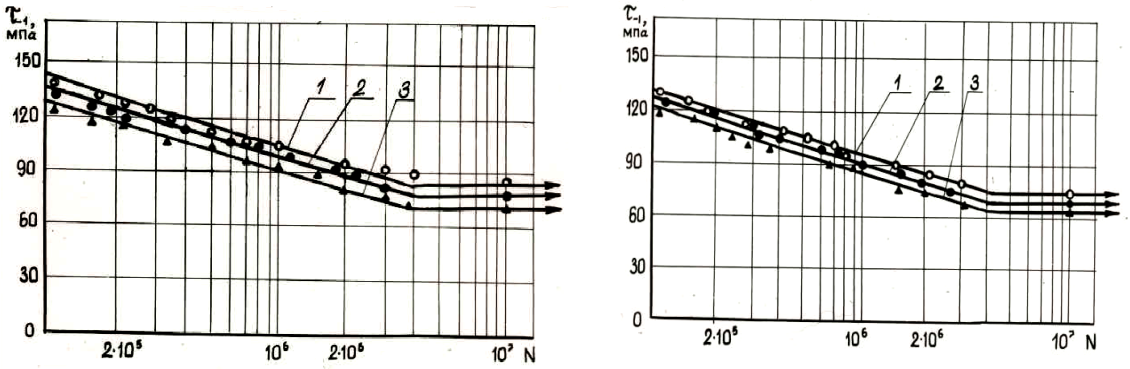


Fig. 2. Strength glue welding connections under cyclic loading programs included in its development of various arrangements of welding points: a) – single, b) -double lining; 1 - single row, 2 - two-row, 3 - chess.

It is established that a greater reduction in strength occurs in 3% aqueous Nacl solution. This environment has the greatest softening effect on the compared connection. As shown by the research results, glue welding has better resistance to softening the effects of the corrosive environment, and the adhesive is the smallest. During 30, 60 and 90 day strength cleverdog reduced, respectively: 1,5% , 2,7% and 3,7%; welded - 3,9%, 7,7% and 9,2% adhesive to 8,0%, 14,0% and 18,0% were.

The magnitude of strength loss glue welding connection associated correlation relationship for all kinds of tests in the test environments. This confirms the assertion that reducing their strength is associated only with the defeat of the edge zones of the adhesive layer. The presence of the adhesive layer protects the weld point from damage by corrosion. Its absence in welding connection increases its loss of strength in comparison with glue welding.

Conclusions. Thus, our experimental studies revealed next:

a) glue welding compound has high strength under cyclic loading;

b) the endurance limit of this compound in asymmetric loading cycle has a lower value than in the symmetric;

c) a sufficient margin of safety under cyclic loading has only glue welding;

d) rational technological scheme of placement of welding points is chess;

e) the best indicators of the strength of the cyclical loading have glue welding connection with the use of two-way pad.

f) found that a greater reduction in strength occurs in 3% aqueous Nacl solution.

g) for 30, 60 and 90 day strength glue welding reduced, respectively: 1,5%, 2,7% and 3,7%; welded - 3,9%, 7,7% and 9,2% adhesive to 8,0%, 14,0% and 18,0% were.

Karabinesh S., Gordienko A. **The strength of welding, glue and gluewelding joints under cyclic loading**

Comparative tests are conducted on cyclic strength of the connections weld-fabricated, glue welding and glue. Research is conducted at symmetric and asymmetric cycles of loading. The curves of Veylera are built, what allowed to choose the type of connection for the quality removal of cracks in cast-iron details and resistance to the corrosive effects of the environment.

Keywords: elektrickontakt welding, welding, cast-iron, glue additive, welding point, cyclic strength, cycle of loading.

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