



**BASING THE PARAMETERS OF CONTACT WELDING COATING OF FORMED POWDERY COMPOSITE TAPE TO THE SURFACE OF A FLAT PART**

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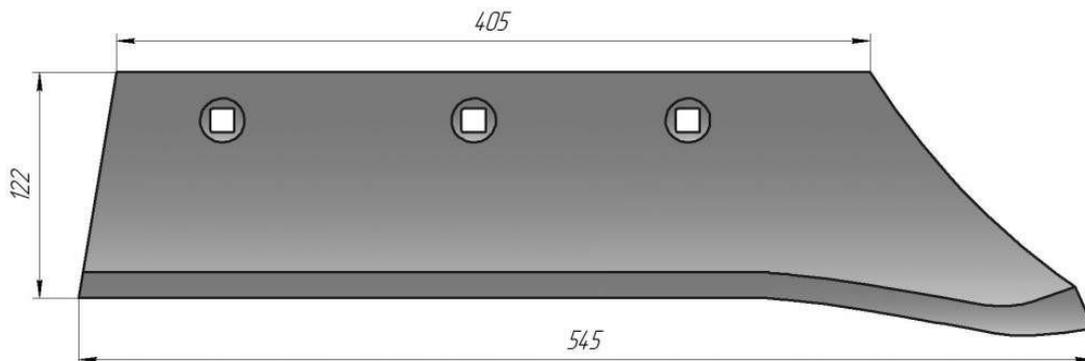
Plow, plowshare, working body, steel tape, welding material, welding coating, composite material.

**ABSTRACT**

*This article presents the results of research and calculations on the basis of parameters such as current strength and current pulse when covering the powdery composite tape formed by contact welding on the surface of a flat part.*

**Introduction.** In order to cover the powder composite tape formed on the working surface of the flat-surface working body by contact welding, the dimensions of the tape should be equal to the dimensions of the surface to be welded. For example, usually in the studies conducted on increasing the resource of ploughshares, a layer of 25-30 mm wide on the ploughshare blade and 55-65 mm wide on the dolt is covered by welding. Based on this, it was decided to cover the ploughshare blade with a 30 mm wide powder composite tape.

**Models and methods.** The thickness of the resulting weld layer is formed as a result of deformation of the welding material under the influence of heat and pressure force released when the current pulse passes through the welding surface. It was found that the thickness of the powdery composite material formed in the operating modes of the current pulse can vary from 5 to 30%.



**Figure 1. The overall dimensions of the chisel-shaped plowshare**

Current strength in contact welding can be determined by the following expression [1; pp.208-212]:



$$I = 170 \cdot 10^3 \cdot \frac{b}{\sqrt{\rho_T}} \quad (1)$$

where  $b$  is the width of the roller-electrode (or the width of the tape for thin tape-shaped welding materials) in cm, ( $b = 0.4-0.6$  cm);

$\rho_T$  – specific electrical resistance of the weld,  $\mu\Omega \cdot \text{cm}$ .

In roller contact welding, taking into account shunting, the amount of current is obtained to some extent greater than in spot contact welding. The time of the current pulse is relatively short.

If we take into account the fact that the welding points overlap each other by about a third and the additional current required for shunting, then the total current is equal to:

$$I_{pay} = I_{as} \left( 1 + \frac{1}{2 - 1/3} \right) = (1 + 0.6) I_{as} = 1.6 I_{as}, \quad (2)$$

For some materials, the values of the  $K_{sh}$ -shunting coefficient are equal to the following.

For St. 3 steel – 90-110

For corrosion-resistant steels -110-130

For titanium - 100-150

For aluminum alloys - 90-120

For brass - 90-120

The current pulse and salt operation times can be determined by the following formula for finding the shunting coefficient  $K_{sh}$  [1; pp.110-113]:

$$K_{sh} = \frac{I_{pay}^2 \cdot \rho_T \cdot h \cdot \sigma_T}{T_{erish} \cdot \sqrt{\lambda \cdot \gamma \cdot c} \cdot \delta \cdot P_{pay} \cdot v_{pay} \cdot \sqrt{t_{pay} + t_{salt}}} \quad (3)$$

in which  $I_{pay}$ - current power, A;

$\rho_T$  – specific electrical resistance of the weld,  $\cdot \text{cm} \cdot \mu\Omega$

$h$ - thickness of welding material, mm;

$\sigma_T$ - strength limit of steel;

$T_{erish}$  - liquefaction temperature of steel,  $^{\circ}\text{C}$ ;

$\delta$  – thickness of the weld layer, mm;

$P_{pay}$ - the pressure applied to the welding material by the roller electrode, MPa;

$v_{pay}$ - welding speed, m/s;

$b$ - the width of the roller-electrode, ( $b = 4-6$  mm);

For example: If  $I_{pay} = 11.2\text{kA}$ ;  $d = 1$  mm;  $b = 5$  mm;

$R_{pay} = 10 \cdot (0.3 \div 0.5) d$ , kN;

$\sigma_T = 250$  MPa for st.3;  $R_{pay} = 3$  kN;  $K_{sh} = 110$ ;  $T_{erish} \cdot \sqrt{\lambda \cdot \gamma \cdot c} = 2130$  J/( $\text{cm}^2 \cdot \text{s}^{1/2}$ );  $h/\delta = 1$ ;  $\rho_T = 140$   $\Omega \cdot \text{cm}$ , then we calculate the product  $v_{pay} \cdot \sqrt{t_{pay} + t_{salt}}$ :

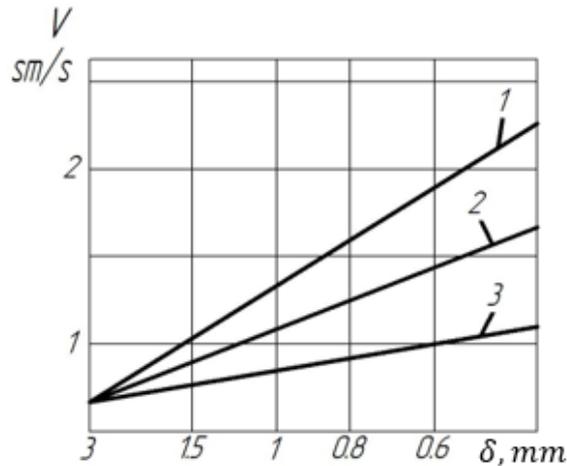
$$v_{pay} \cdot \sqrt{t_{pay} + t_{salt}} = \frac{I_{pay}^2 \cdot \rho_T \cdot h \cdot \sigma_T}{K_{sh} \cdot T_{erish} \cdot \sqrt{\lambda \cdot \gamma \cdot c} \cdot \delta \cdot P_{pay}} \quad (4)$$

$$v_{pay} \cdot \sqrt{t_{pay} + t_{salt}} = \frac{125 \cdot 10^6 \cdot 140 \cdot 10^{-6} \cdot 2500 \cdot 1}{110 \cdot 2130 \cdot 300} = 0.62$$

is formed.

**Determination of contact welding speed of shaped powdery composite materials.**

K.A. Kochergin said[1; p. 211], in practice, there are defined values of the speed of contact welding for metals of different composition and thickness (Fig. 2).



1-St.3 for steel; 2-for corrosion-resistant steels and titanium; 3-for aluminum and brass alloys.

**Figure 2. Graph of the dependence of contact welding speed on the thickness of the welding material**

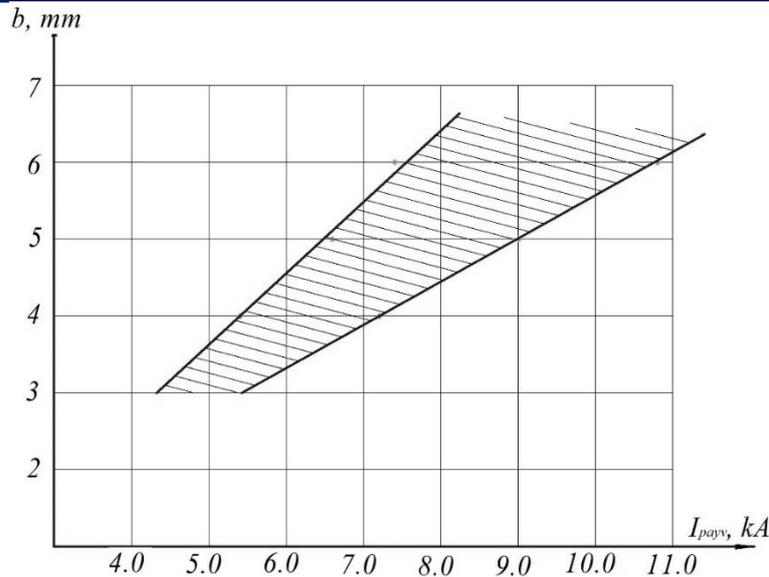
From the graph in Figure 2 above, given that  $n_{pay} = 1.4 \text{ cm/s} = 14 \text{ mm/s}$ , then the time cycle  $t_{pay} + t_{salt} = 0.2 \text{ s}$  is generated.

$t_{pay}/t_{salt}$  it is difficult to calculate the ratio, so this issue is selected depending on the coefficient of overlap of the welding points  $k$  and other indicators of the welding mode. In most cases  $t_{pay}/t_{salt} =$  by 1-2, only in some cases 2.5 has equal to [1; p. 212]. For example, if  $t_{pay} = 0.06 \text{ s}$ ,  $t_{salt} = 0.14 \text{ s}$ , if  $t_{pay} = 0.08 \text{ s}$ ,  $t_{salt} = 0.12 \text{ s}$ .

It is known that in order to create a quality weld in contact welding, sufficient current density must be provided during a specified current pulse. In this case, it is necessary to take into account the possibility of supplying up to 15 kA current of the contact welding device intended for welding welding materials to the working surfaces of the details. In addition, the working width of the roller-electrode in the contact welding device is usually 4-6 mm. Based on this, the ability of the device to provide the required current density can be seen from the graph below (Fig. 3).

As a result of these considerations and laboratory studies conducted on the study of current strength, current pulse time and density, it was determined that the current density during contact welding of the formed powder composite tape is equal to  $J_{pay} = 110-150 \text{ A/mm}^2$ .

In earlier studies [2; p. 107] the limit values of the current strength and current pulse times, which ensure obtaining a quality weld layer, are defined. It states that when the width of the weld to be covered by welding is 4-6 mm, the current strength should be equal to 7-10 kA, and the current pulse time should be equal to 0.08-0.12 s. These limits are based on the structure and hardness of the resulting weld layer as follows.



**Figure 3. Graph of the relationship between current and roller-electrode width (width) in contact welding coating of formed powdery composite material**

When the influence of the current on the hardness of the weld layer was studied, it was observed that the hardness first increased with the increase of the current, and then, after the current strength reached a certain amount, the hardness decreased. The reason for this is that as the temperature increases, first the matrix becomes plastic, then it begins to liquefy, and then the hard alloy of the refiner also liquefies and mixes with the matrix, and the structure of the weld layer changes from a heterogeneous structure to a homogeneous structure. A similar relationship was also found in the study of the effect of changing the time of the current pulse on the hardness of the weld layer. Also, after the current pulse time increases by a certain amount, a decrease in the hardness of the weld layer was observed. The reason for this can be explained as above.

**Summary.** Based on the above-mentioned Figure 2 and considerations, the following conclusions were formed: the width of the roller-electrode for contact welding coating of the formed powdery composite material  $b = 4-6$  mm, current strength  $I_{pay} = 7-10$  kA, current density  $J_{pay} = 110-150$  A/mm<sup>2</sup>, and the current pulse time should be  $t_{pay} = 0.06-0.12$  s, the pause time between pulses should be  $t_{salt} = 0.08-0.14$  s. In this case, the pressure applied to the roller-electrode should not be less than  $P_{pay} = 25$  MPa.

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