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Analysis Of The Retailoring Methods And The Workability Of Deposited Surfaces

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Abstract. This work is devoted to the conduction of the analysis of methods and means of retailoring of parts in the conditions of technical repair facilities as well as of the workability of deposited surfaces. The results of the research show that the most important processing methods of reconditioning of component parts severely worn in the course of exploitation are various ways of deposit welding with subsequent mechanical handling. Furthermore, low efficiency of mechanical handling of retailored parts' surfaces is conditioned on their low workability that results from the specific status of weld pad.

Component parts are reconditioned by means of a technological influence which changes the geometric shape, the dimensions, or the internal state of material.

As a rule, the procedure of component parts reconditioning is a combination of operations of various means of building-up with their subsequent mechanical processing.

For the purpose of rebuilding of the geometric shape, the dimensions, and the surface of component parts they use following process operations: building-up of surface layers of material onto the worn surface; soft mud shaping; replacement of a component part as well as mounting of additional elements with subsequent removal of a material part using a certain method of mechanical processing.

1. Timeliness of the research

In comparison with other reconditioning methods, deposit welding helps make a layer of necessary thickness and chemical composition, of high hardness and wear resistance on the surface of a component part, while the original cost of building-up is quite low. In the course of subsequent mechanical handling, they achieve the necessary geometrical shape, prescribed dimensions of the part as well as required parameters of surface coarseness.

Currently, at the repair facilities of agricultural business, they use a wide range of building-up methods of worn surfaces, the listing of which is presented in table 1 [1].

The deposit welding is used for the reconditioning of component parts of agricultural machinery which are severely worn in the course of exploitation. They include the parts of following types: "single-diameter and stepped shafts", "disc plates, flywheels, and sheaves", "spider center caps, plugs", "splined shafts" [2, 3]. In particular, it is typical for undercarriage parts of cat tractors as well as work tools of agricultural machinery [3], while the building-up can be executed up to 10 mm.

In order to correct analogous defects of standard parts, at TRF of the agricultural business systems, they use various technological methods [3]. For instance, lower track wheels of cat tractors are reconditioned using 12 methods; crank axles - 8; rolling axles - 3; journals - 7; splined surfaces - 15, etc.

Component parts of the type "splined shaft" are also reconditioned through the use of a range of processes [3]: plastic working; short-circuit arc surfacing with plastic working; CO2 spline deposition on side surfaces; CO2 deposit welding or deposit welding under a flux layer through the helical line, while all of these methods are followed by mechanical handling of splined surfaces.

Table 1 — Methods of components parts reconditioning by means of building-up in the conditions of technical repair facilities (TRF)

Methods of building-up	The rate of reconditioned component parts, %
Deposit welding under a flux layer	32
Short-circuit arc surfacing	12
Deposit welding in an atmosphere of shielding gas	20
Flux-cored wire welding	10
Plasma spraying	1,5
Electric contact deposit welding	6
Galvanic methods	5
Electromechanical deposit welding	1
Electroslag facing	1,5
Pouring with supernatant liquid	2
Reconditioning by means of polymers	5
Other building-up methods	5

2. Methods of research, authenticity and validity of the results

The effectiveness of the defined reconditioning process which meets the requirements of GOST 19677-74, GOST 17524-80 is defined by the correlation of the price of a new component part as well as the original cost of reconditioning taking into account resource recovery factor and specific capital costs [3]. Furthermore, the original cost of reconditioning includes the expenses for building-up of worn surface, its mechanical handling, and other operations directed to the recovery of resource of a component part. Thus, the effectiveness of the reconditioning of worn component parts in a TRF system depends on technological characteristics of the applied building-up method of worn surface and its subsequent processing. For instance, the usage of high-alloy wear-resistant depositions, which significantly raise the wear-resistance of a component part, increases the original cost of the building-up operation as well as notably raises the expenses for subsequent mechanical handling of reconditioned surfaces. In such cases, technological variants of reconditioning are chosen in conjunction with mutual technological and economic restrictions of building-up methods and sizing, taking into account their impact on the recovery factors of component part resource.

As follows from table 1, currently, at the repair facilities of agricultural business, they mostly use deposit welding under a flux layer, deposit welding in an atmosphere of shielding gas, short-circuit arc surfacing, and flux-cored wire welding. These methods are widely applied because of their flexibility which allows to deposit a wide listing of recovered component parts, as well as because of the good quality of built-up surfaces with relatively low original cost.

Deposit welding under a flux layer gives following advantages: high productiveness, especially when multielectrode head sections and fluctuating electrodes are used; process stability; high-quality alloying with basic metal; the possibility to produce deposited layers of large thickness (over 8 mm) and to control chemical composition. Herewith, as a result of significant warming of the deposited component part, we observe the change of physical and mechanical characteristics and possible deformation of the component part.

The restrictions of this method include the complexness of depositing of a small diameter (up to 60 mm), the impossibility to gain a thickness of deposited layer less than 2 mm, while deposit welding under a flux layer is highly effective when the layer is thicker than 3 mm [4, 5]. The characteristics of deposited surfaces under a flux layer depending on the flux brand and the used wire are presented in table 2.

Table 2 — The characteristics of deposited metal under a flux layer

Flux	Electrode	Hardness, HRC_3	Relative wear resistance
AN 348 A	Welding (Sv) – 08G2S	20…22	1,02
AN 348 A	Sv – 18HGSA	31…33	1,18
AN 348 A	Nonconsumable (Np) – 20	17…27	1,08
AN 348 A	Np – 80	34…35	1,24
AN 348 A	Np – 30HGSA	34…36	1,17
ZHSN - 1	Sv – 08	47…51	2,75
ZHSN - 2	Sv – 08	36…40	1,65
ZHSN - 5	Sv – 08	35…38	1,62
ANK - 18	Sv – 08	38…47	2,62

Short-circuit arc surfacing is highly productive, up to 2.6 kg/h; in contrast to deposit welding under a flux layer, the heat-affected zone is much smaller, from 0.6 to 4 mm, the detail is warmed insignificantly. The welding bead is intensively cooled down through heat removing into the detail and into the environment, and becomes tempered. The weld pad is heterogeneous by its structure and hardness.

In the repair industry, they widely use deposit welding in an atmosphere of shielding gas, in particular, in an atmosphere of carbon dioxide, an inactive gas, or steam vapor as well as with gas-flame shielding. The productivity of this method of building-up is 25-33 per cent larger than the productivity of deposit welding under a flux layer, the heat-affected zone is smaller which helps produce the depositing of beads with a diameter over 10 mm. For the deposit welding in an atmosphere of shielding gases, they use wires Sv-08G2, Sv-30HGSA etc., the hardness of deposited surfaces equals respectively to HB 220...390; as well as flux-cored wires PP-3H2V8T, PP-30H5G2SM, PP-30H12SMT etc. with the hardness HRC3 40-46. The productivity of deposit welding by means of flux-cored wires equals to 10 kg/h; this method is used for the reconditioning of component parts of agricultural machinery with intense abrasive wear; increased wear resistance is provided by means of a high-carbon weld pad.

Table 3 — Hardness of surface deposited by means of short-circuit arc and flux-cored electrodes

Short-circuit arc surfacing		Deposit welding using flux-cored wires	
Surfacing wire	Hardness of the weld pad, HRC_3	Surfacing wire	Hardness of the weld pad, HRC_3
Sv – 08	12…32	PP – 3H63F-0	40…46
Np – 20	13…35	PP – U15H12M-0	40…42
Np – 40	15…45	PP – U15H7T-0	40…44
Np– 60	25…60	PP – R18T	61…64
Np – 80	25…65	PP – 3H2V8T	40…44
Sv – 30HGSA	15…60	PP – 3H13-0	52…54

Deposit welding by means of flux-cored materials is not so widely used because of the high cost of deposit materials, their cost is 5-10fold higher [6] than the cost of full-metal wires and ribbons; as well as because of low workability of such layer, especially in the course of reconditioning of complex profiled surfaces.

In order to recover huge wears of massive component parts of the type "wheel", at the repair facilities, they use electroslag facing which is characterized by low special original cost and high wear resistance of deposited surfaces. However, this method is not widely used due to the following technological restrictions: minimal thickness of the applied surface is 6-8 mm, and the analysis shows that the rate of such component parts, e.g. lower track wheels of cat tractors, does not exceed 25-30%; large heat-affected zone that hinders selective reconditioning of a worn component part.

Most component parts are delivered for reconditioning when their work surfaces are worn to a maximum of 0.2-0.3 mm, i.e. their working capacity is recovered by heating of an insignificant thickness of worn surface. Thus, electroslag facing is effective within large repair programs and high concentration and specialization of manufacture. In a real economic situation, the methods are most appropriate which are characterized by high flexibility of technological processes as well as the possibility to recondition a higher listing of component parts.

For component parts with small wear, the reconditioning by means of electric contact deposit welding is suitable. The essence of this method consists in the heating of welding filler by high-density current as well as in the deposition of pressure onto in; as a result, metallic bond is created because of partial surface melting and diffusion. The productivity of this method equals to 1000 mm2/min, the coating thickness is up to 1 mm, the waste of welding filler does not exceed 5%, the heat-affected zone does not exceed 0.3 mm.

For component parts with relatively low wear (up to 0.3 mm), the methods of electrolytic build-up are used: chromium coating (the hardness of the surface amounts to 1200 HB, the coating thickness amounts to 0.3 mm2/h); steeling results in the coating thicknesses up to 3 mm; electrolytic polishing of component parts of the type "shaft, hornet".

The essence of mechanical handling consists in the removal of allowance which was formed in the course of reconditioning process. The size as well as physical and mechanical features of the allowance are defined by technological parameters of the preceding building-up method.

The size of the built-up layer is determined with account of component part wear and the allowance for subsequent sizing [4]:

$$A_l = (P_n - P_w) + Z_{al} \quad (1)$$

where P_n and P_w are the sizes of a new and a worn component part respectively, mm;

Z_{al} is the allowance for machining, mm.

The size of the allowance is conditioned by the parameters of irregularities and geometric properties of deposited surface [7]. At this, the authors have noticed that the height of irregularities significantly grows when using multielectrode and multi-layer deposit welding. According to the research, the size of the allowance (fig. 1) depends on geometric parameters of deposited surfaces.

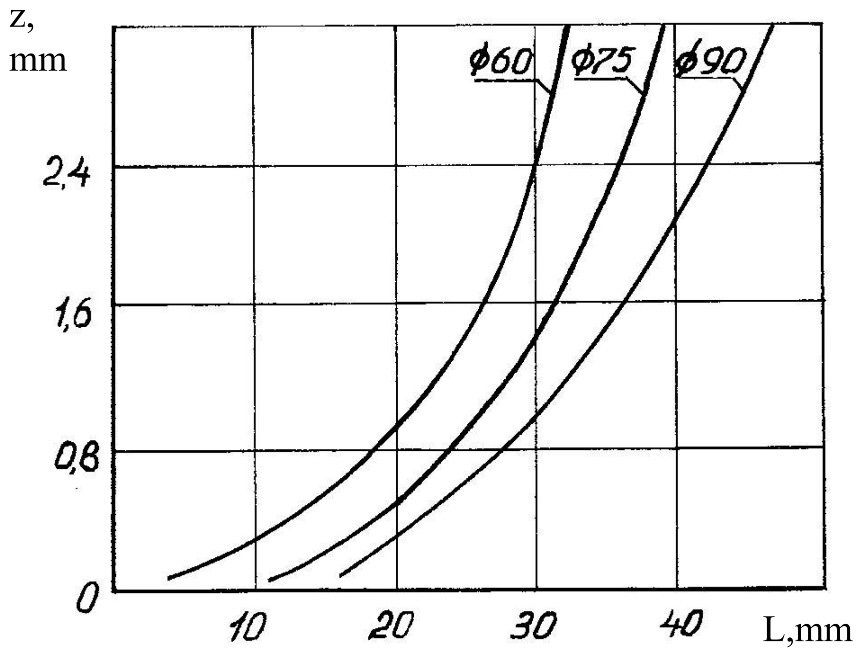

Figure 1 — Dependence of the allowance for machining on the diameter and the length of deposited surface

3. Results of the research

Specific particularities which define the workability of deposited surfaces, according to the researches [7, 8, etc.] are the following: significant macroirregularities, lappings, interstices, abscesses which exceed 2 mm; unequal distribution of alloying elements, heterogeneity of the micro-macrostructure in its thickness and cross-section which leads to significant hardness fluctuations up to 1.5-2fold; the presence of non-metallic impurities and a large allowance. The above listed factors result in periodic blows, vibration, high temperature and strength in the cutting zone which are 1.5-1.8fold larger than in the course of steel turning with close mechanical features, as well as their significant fluctuations: Q = 623-1523°K, Pz=150-3000 H. Hard processing conditions destroy the cutting edge of the tool to 68-94%, and lead to intense wear which 2-4 times exceeds general mechanical standards, while the cutting speed decreases to 15-25%.

Despite the development and the recommendation to implement promising methods of building-up of worn component parts, currently, due to economic and technological reasons, various methods of short-circuit arc surfacing are mostly used. The highest productivity and the lowest labor intensity and energy output are provided by edge cutting machining of built-up surfaces, in the course of which processed surfaces are hardened by means of cold working.

Based on the presented research and practical experience of repair facilities, we can conclude that the most important technological methods of reconditioning of component parts of agricultural machinery intensively worn within the process of exploitation are various methods of deposit welding with subsequent mechanical handling. Furthermore, low effectiveness of mechanical handling of retailored surfaces is conditioned by their low workability which results from the specific state of weld pad.

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4. Conclusions

Accordingly, direct transfer of technological parameters and technical means of mechanical processing, especially edge cutting machining, from automotive-tractor and agricultural mechanical engineering into the technological process of reconditioning results in an ineffective use of machining facilities, overexpenditure of cutting tools, high labor intensity of processing by its low productivity. The solution of the problem of mechanical handling and of the increase of general effectiveness of reconditioning, apart from the quality improvement of deposit welding, lies in the development and implementation into repair industry of progressive cutting tools which provide productive cutting modes and condition high sustainability and durability.

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