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Abstract. The paper shows that the choice of parameters for assessing roughness, as well as the requirements for roughness, should be justified and established taking into account the functional purpose of the surfaces of parts of specific products and their design features. Requirements for surface roughness are established without taking into account surface defects (scratches, sinks, etc.). If necessary, they are indicated separately. The values of all roughness parameters are recorded with the corresponding symbol and its meaning.

Keywords: surface roughness parameters, direction of irregularities, type of processing, wear resistance, contact roughness.

УДК 621

Single-Impact Modeling in Dynamic Surface Plastic Deformation of Machine Parts

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Abstract*:* The study examines the processing of parts using dynamic methods of surface plastic deformation. The technological capabilities of vibration strengthening treatment, centrifugal-rotational strengthening treatment, and ball-rod hardening were analyzed. Special attention was paid to investigating the formation of surface layer quality parameters of parts under dynamic loading. The obtained results make it possible to identify the regularities of surface layer parameter formation and can be used in the development and optimization of technological processes for dynamic surface plastic deformation of machine parts.

Keywords: Surface plastic deformation, dynamic processing methods, single impact, process modeling, surface quality parameters, machine parts.

An analysis of machining processes using dynamic methods of surface plastic deformation was carried out, in particular vibration strengthening treatment (VST), centrifugal-rotational strengthening treatment (CRST), and ball-rod hardening (BRH). The physical essence of these methods was revealed, their technological capabilities were

determined, the main advantages were identified, and the features of interaction between the working media and the surface of the part were characterized.

Based on the analysis of scientific sources, it was established that the widespread industrial application of dynamic SPD methods is constrained by a number of factors, including insufficient understanding of the physical phenomena occurring during processing and the lack of generalized regularities governing the formation of surface layer parameters. In this regard, further studies are required to determine the mechanisms of the processing phenomena, develop mathematical models, and design standard technological processes with optimization of the main technological parameters.

The formation of surface layer quality parameters during processing by dynamic surface plastic deformation methods was investigated. A detailed analysis of the single interaction between the indenter and the surface of the part was performed. To construct a model of a single interaction for dynamic SPD methods. The case of oblique impact of a smooth rigid sphere with the deformable surface of a part within the range of interaction angles from 75^0 - 90^0. During indentation, only sliding of the ball over the surface of the part was considered, while its possible rolling was neglected.

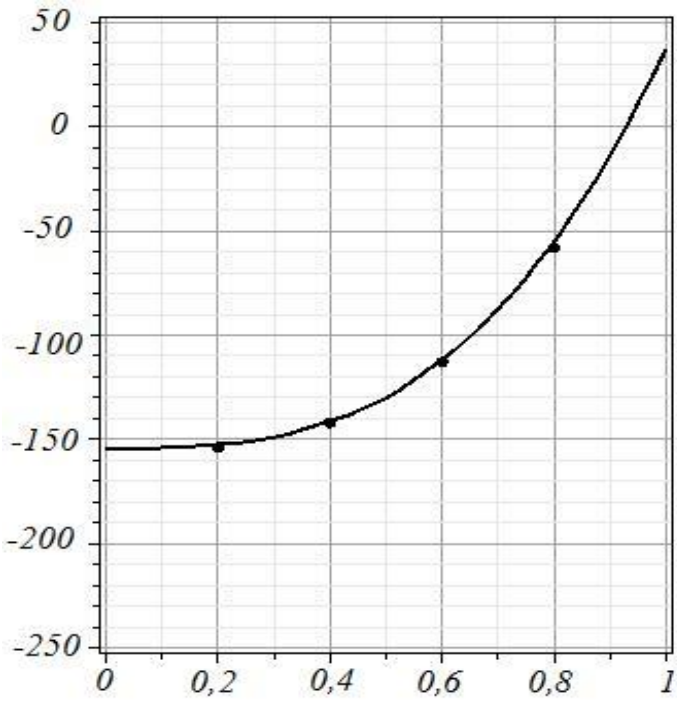

Fig. 1. Distribution of residual stresses in the surface layer of specimens after ball-rod hardening (material – D16; indenter radius – 4 mm; interference – 1.5).

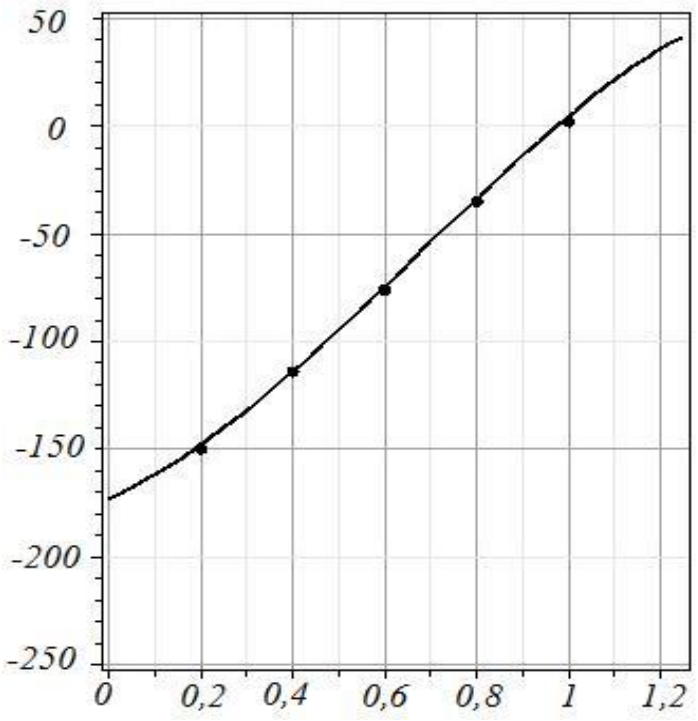

Fig. 2. Distribution of residual stresses in the surface layer of specimens after ball-rod hardening (material – D16; indenter radius – 4 mm; interference – 4.5).

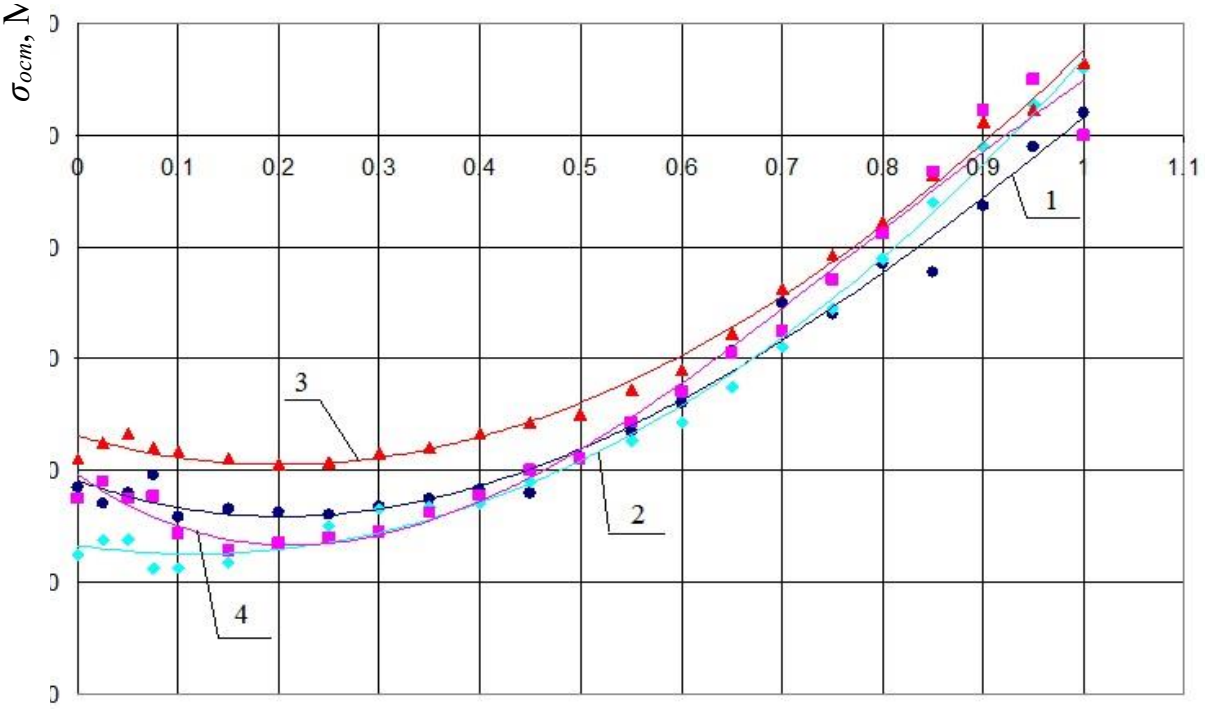

Fig. 3. Influence of interference and indenter radius on the distribution of residual resses in the surface layer (1 – R4, interference 1.5; 2 – R4, interference 4.5; 3 – R interference 1.5; 4 – R8, interference 4.5).

The results of residual stress studies in the surface layer of parts processed by ball-rod hardening (BRH), along with computer simulation results, are shown in Figures 1–3.

Based on a combination of theoretical and experimental data, a methodology has been developed for designing technological processes using dynamic methods of surface plastic deformation, taking into account the maximization of material strengthening potential. Calculations are carried out using previously presented mathematical relationships, and the optimal solution among the large number of possible design options is determined based on a comprehensive set of theoretical process models.

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Анотація: У роботі розглянуто процеси обробки деталей динамічними методами поверхневого пластичного деформування. Проаналізовано технологічні можливості вібраційної обробно-зміцнюючої обробки, відцентрово-ротаційної обробно-зміцнюючої обробки та обробки кулько-стрижневим зміцнювачем. Особливу увагу приділено дослідженню формування параметрів якості поверхневого шару деталей у результаті динамічного навантаження. Отримані результати дозволяють встановити закономірності формування параметрів поверхневого шару та можуть бути використані при розробленні й оптимізації технологічних процесів динамічного поверхневого пластичного деформування деталей машин.

Ключові слова: поверхневе пластичне деформування, динамічні методи обробки, одиничний удар, моделювання процесу, параметри якості поверхні, деталі машин.