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Viscoelastic Resistance of the Surface Layer of Steel Products to Shock Attack of a Spherical Pellet

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Abstract. The results of experimental studies of a separate contact dynamic interaction of a spherical non-deformable pellet with a plastic flat metal surface at different angles of attack ($20° \le \alpha \le 90°$) at high speeds ($v \approx 100\, m/s$) are presented. A method is described for determining the nature of the viscoelastic resistance of a surface layer attacked by a pellet during contact displacement along the normal to the surface and rigid plastic resistance during tangential displacement, which can be used to establish the processing regimes of products by a mass flow of abrasive particles, in particular, shot-blasting cleaning. The results of comparing the obtained and known theoretical data with each other and with experimental studies are presented.

Introduction

The basis of the study of the processes of abrasive deterioration, machining of product surfaces with a mass flow (stream) of working solid particles for hardening or cleaning the surface layer is one or another theoretical model of the interaction of an individual spherical body (pellet) with a deformable flat body (barrier) that creates plastic resistance to penetration attacking pellet. Of interest, in this case, are the stresses in the contact zone and the deformations in the form of a hole in the shape of a hole left by a separate pellet, the parameters of which are taken as the basis for determining the quality (condition) of metal surfaces processed by the jet-flare method.

Many scientific works have been devoted to the solution of such problems, which are aimed both at the description of impact contact with an obstacle of an individual particle [1-9], and the mass jet stream of particles with access to hardening of the surface layer [10, 11], cleaning surfaces [12-14] destruction of the surface layer [15, 16] and optimization of various technological processes [17, 18].

Given the complexity of the analytical determination of the pattern of resistance of products to shock attack of a solid spherical particle, many works in this direction are devoted to numerical modeling of the dynamic interaction of bodies [6, 19, 20].

Most authors in analytical studies are inclined to the elastoplastic resistance of the attacked steel barrier by the indenter [7, 14, 21] with experimental justification. The change in dynamic hardness in the calculations is taken into account by the coefficient of dynamism [1, 3], which requires additional research.

In the case of shot-blasting treatment of metal surfaces, which is carried out by a shot with a diameter of $0.8 \le d \le 2.0 mm$ at an attack speed of $100\, m/s$ or more, in contact at the very beginning of the introduction of the pellet at a depth of $0.01 \ldots 0.1 \mu m$ (total $5...10 \mu m$) according to the Mises criterion [5], a plastic flow occurs in the metal, that is, it is observed phase of developed plastic deformation [22]. In addition, under such conditions, many authors ignore elastic deformations due to the smallness of the critical velocities causing the onset of developed plastic contact deformations and describe the behavior of a plastic material by the plastic impact theory [5].

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