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Regularities of striker wear under single impacts on rock

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Abstract

Using the developed test rig, a series of single impacts n was applied to different points of a granite plate, and after each impact the mass loss Δm and the diameter d of the blunting area formed on the cone-shaped tip of the striker were determined; the strikers were made of steels 38XM, 55C2, У8 and X12МФА, including steels that had undergone cold treatment. From the form of the dependences Δm = f(n) obtained (Fig. 1), it was concluded that the striker wear process for all the steels analysed proceeds in 3 stages. At stage I (at n < n*), Δm amounts to milligrams and decreases with each subsequent impact at a noticeable rate ($tg\alpha_1$ ~0.3–0.4 mg/impact). At stage II (from n* to n**), Δm is only a few tenths of a milligram, and the rate of its decrease with increasing n slows down sharply ($tg\alpha_2$ ~0.007–0.013 mg/impact). At stage III (at n ≥ n**), the mass loss becomes practically independent of the number of impacts ($\alpha_3 \approx 0$). This value of Δm was taken as the impact-abrasive wear rate K [mg/impact] of the given steel at the steady stage of the process, and the value I = 1/K as its impact-abrasive wear resistance.

[Figure 1 — see original PDF, page 1] Dependence of the mass loss Δm of a striker made of 38XM steel on the number of impacts: dashed line — calculated mass $m_{пл}$ of metal subjected to plastic deformation; dash-dotted line — percentage of Δm in $m_{пл}$

Based on the values of the stresses arising on the contact area between the striker and the rock at the moments of impacts n*, n**, calculated with the developed mathematical model, it was concluded that the values $\sigma_к$*, $\sigma_к$** correspond to the stresses on the contact area starting from which the striker metal is capable, under dynamic conditions, of fracturing ($\sigma_к$*) or deforming plastically ($\sigma_к$**). At small d (stage I), the stresses $\sigma_к$ developed on impact exceed the true fracture stress $\sigma_к$* of the given steel, and spalling of the steel occurs on the contact area, which is recorded as a considerable Δm. At large d (stage II), the stresses arising are insufficient to fracture the striker material but sufficient for its plastic deformation, which, on contact with the rock, is accompanied by a substantially smaller but still noticeable loss of metal mass. At stage III, the undeformed metal of the contact area is scratched by the rock fracture products; the value of Δm is small and is determined by the wear resistance of the steel used. It was established that the number of impacts until the striker tip is completely blunted and the resulting total depth of the craters for the most wear-resistant steel (X12МФА after cold treatment) are 2.9 and 3.4 times higher, respectively, than for the least wear-resistant steel (38XM).

It is shown that the work expended on fracture of the striker material and on its elastic deformation during a single penetration into granite at the steady stage of the process amounts to ~1 % and ~5

%, respectively, of the impact energy.