COLLAPSE OF A CIRCULAR CAVITY IN A SOLID LAYER UNDER MECHANICAL ACTION

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Abstract: The numerical and analytical solution of the hydrodynamic problem of collapse of a cylindrical cavity in a freely spreading layer of viscoplastic substance under impact is presented. The assumption on the thinness of the layer (the thickness of the layer is much smaller than the size of the striker) allows one to reduce the solution of the two-dimensional boundary value problem to the integration of a system of two ordinary differential equations of the 1st order which is performed numerically. The calculation results obtained under the assumption of the constancy of the compression rate of the layer indicate high parameters of converging flows and the absence of their focusing during the collapse of the cavity, which is facilitated by the backpressure of gas in the cavity, the inhibitory effect of the contact friction of the layer on the surface of the impactor as well as the outflow of matter from the outer boundary of the impactor.

Keywords: viscoplasticity; thin layer; gas cavity; impact; plastic flow; dissipative heating; temperature

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Figure Captions

Figure 1 The layout of the gas cavity (*1*) in the solid layer (*4*) between the striker (*2*) and the anvil (*3*) in the device with a free flow of matter

Figure 2 Stress profiles in the solid layer: *1* — σ_z; *2* — σ_r; *3* — σ_φ; and *4* — pressure p

Figure 3 Axial stress profiles for a layer with a cavity diameter 2 (*1*), 1 (*2*), 0.1 (*3*), 0.01 (*4*), and 0.001 mm (*5*)

Figure 4 Dependence of the limiting compression pressure of the layer on the thickness of the layer (*a*) and the radius of the cavity (*b*)

Figure 5 Dynamics of the parameters of the collapsing cavity with $a_0 = 0.5$ and $h_0 = 1$ mm: *1* — radius α; *2* — neutral line q; *3* — layer thickness h; *4* — plastic heating of the walls T_p; *5* — the same taking into account heating from gas; *6* — gas pressure; and *7* — wall velocity V

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