Modeling of destruction of layered ceramic composite plates under shock-wave loads

Radchenko A V[@], Batuev S P and Radchenko P A

Institute of Strength Physics and Material Science of the Siberian Branch of the Russian Academy of Sciences, Akademicheskii 2/4, Tomsk 634021, Russia

[@] andrey@ispms.ru

Modern shockproof protective equipment is a layered structure of several materials. One of the materials widely used in protective structures is high-hardness ceramics. Ceramic materials have low density, high hardness, modulus of elasticity and compressive strength. At the same time, ceramics have low crack resistance and tensile strength. In our work, the interaction of a steel striker with a three-layer barrier is numerically simulated. The material of the upper layer of the barrier is boron carbide, the subsequent layers consist of D16T aluminum alloy and composite anisotropic material (organoplastic). The range of interaction velocities of 400–1000 m/s and meeting angles of 0–70 is considered. Modeling is carried out in full three-dimensional setting. The behavior of the metal layer of the barrier and the impactor material is described by an elastic-plastic model. As a criterion for the destruction of the impactor materials and the metal layer of the barrier, the limiting value of the intensity of plastic deformations is taken. The behavior of B4C ceramics was described by an elastic-brittle plastic medium that breaks brittle under tension. The behavior of an anisotropic composite was described within the framework of a brittle fracture orthotropic material model. Modeling is carried out in a three-dimensional formulation by the finite element method using the author's algorithm and the EFES software package. The influence of the sequence of arrangement of the metal and composite layers on the protective properties of the barrier has been studied.

The study was supported by a grant from the Russian Science Foundation No. 22-21-00407, https://rscf.ru/project/22-21-00407/.