EVALUATION OF THE PROTECTIVE PROPERTIES EFFICIENCY OF MONOLITHIC AND SPACED PROTECTIVE SCREENS OF SPACECRAFT

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Spaced structures consisting of one or two thin screens are widely used as passive protection for spacecraft. Conducting experiments on impacts in the hypervelocity range (more than 5 km/s) is a very expensive undertaking and practically impossible to implement for sufficiently massive particles. Therefore, the main method for studying hypervelocity impact (HVI) is a numerical experiment. The methods used to model HVI can be divided into three main groups: methods based on the Lagrangian approach (for example, the finite element method, FEM), methods based on the Eulerian approach, and meshless methods. The Lagrangian finite element method clearly describes contact boundaries, material interfaces, and complex shapes of structures.

In this paper, within the framework of the Lagrangian approach, the hypervelocity interaction (HVI) of an aluminum particle simulating space debris with a monolithic and spaced barrier made of an aluminum alloy of equivalent thickness is studied numerically and by the finite element method. The modeling is carried out using the author's 3D software package EFES, which ensures the conservation of mass when the destruction condition is met. The implemented destruction algorithm allows describing the fragmentation of the material, the formation of new contact boundaries without distorting the computational grid. A comparison with experimental data on the crater depth during a hypervelocity impact is carried out. Evaluations of the effectiveness of the protective properties of monolithic and spaced barriers in the velocity range of 3–15 km/s are carried out.

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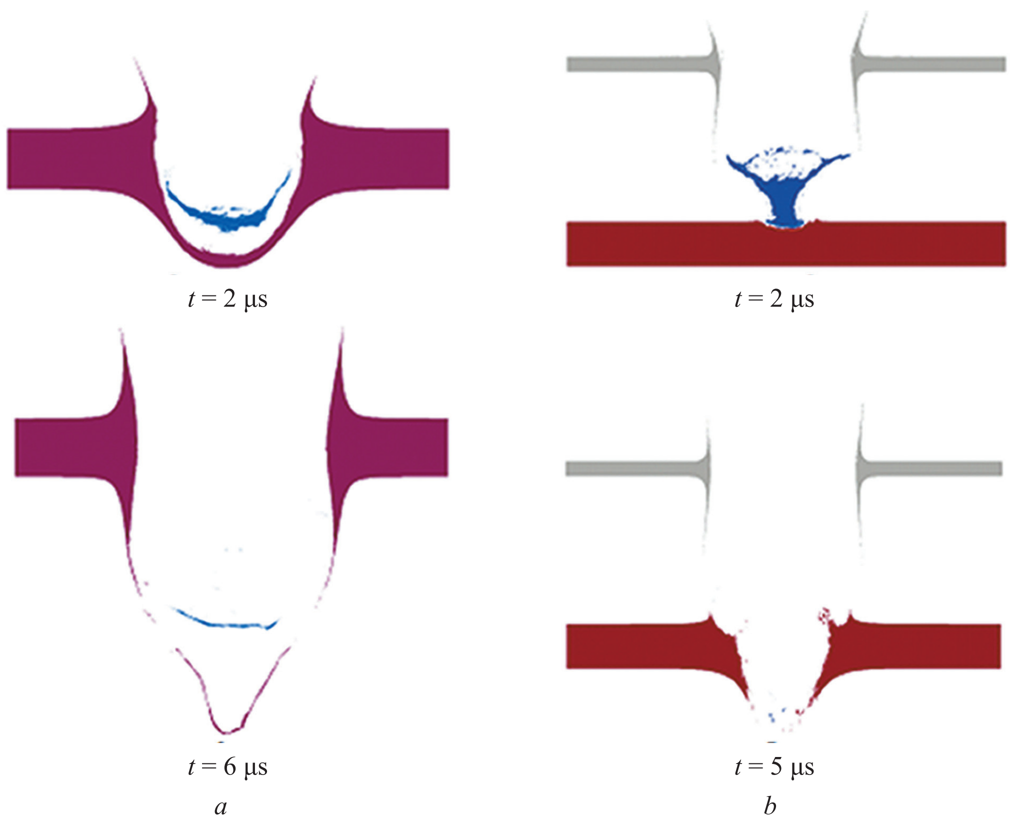

Fig. 1. Chronograms of the interaction of the particle with a monolithic (a) and spaced barrier (b). $\upsilon_0 = 7$ km/s