Behaviour of rods during striking interaction with the screen protection of an explosive substance

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The given work is aimed at the numerical study of particularities of the striking interaction of cylindrical rods made of metalloceramics TiB2+Fe in comparison with rods made of steel and tungsten-nickel-iron (TNI) at the interaction with space-separated multilayer plates, shielding an explosive substance. The solution of the problem is done in full three-dimensional production within the framework of mathematical model [1].

For estimation of initiating abilities of an explosive substance at shock-wave loading (when $p > p_{\min}$) there was used the criterion of detonation initiation in the form of [2]:

$$\int_{t_0}^{t} p^2 dt = K \ ,$$

where K - a constant of the material, P- pressure in an explosive substance, $p_{\min}$ - a minimum pressure, at which detonation initiation in an explosive substance occurs.

The first screen consists of a 10 mm asbotextolite layer and a 3 mm duralumin substrate. The second screen made of 10 mm steel is located at 10 mm from the first one. Further at the distance of 50 mm is located a 30 mm charge of an explosive substance protected with a layer of 3 mm duralumin and 20 mm foam plastic.

The screens are located at some angles α_i to axis of a cylindrical rod. The strikers had similar geometry (d_0=4,5 mm, L_0=105 mm).The calculations were carried out within the range of impact velocities V_0=1…6 km/s and angles of approach to screens α_i=30^o, 45^o.

Results of mathematical modeling of the process of the striking interaction of a steel rod with screens at impact velocity 1 km/s are presented on the. At $\alpha_1=\alpha_2=30^o$ its ricochet and destruction occurred. A crater of the depth h/d_0=0,5 was formed in the steel screen. At angles $\alpha_1=\alpha_2=45^o$ in the second steel screen the rod formed a crater of the depth h/d_0=1,13 and stopped.

Figure 2 shows the interaction of the steel rod with screens at impact velocities 2 km/s (t=122 mks, the top figure), 4 km/s (t=51 mks, the central figure) and 6 km/s (t=33 mks, the bottom figure).

There was a research of influence of the rod material on the breach process of the protective construction and detonation initiation in an explosive substance at impact velocity 2 km/s and angles of the approach 30^o.

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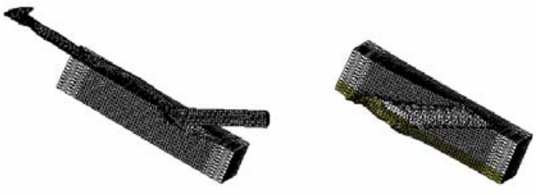
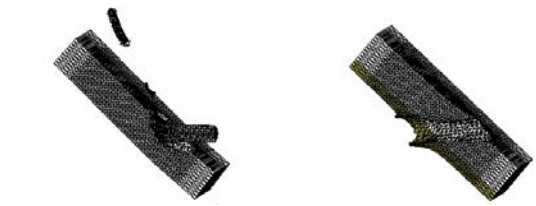


$\alpha_1 = \alpha_2 = 30^\circ$



$\alpha_1 = \alpha_2 = 45^\circ$

Figure 1.

2 km/s

4 km/s

6 km/s

Figure 2.

Figure 3 shows configurations of TiB_2+Fe, steel and TNI rods during penetration into the protective construction. Having similar geometries, the rods possess different masses, hence different kinetic energy.

At the breach of the first two-layer screen the most loss of velocity was observed in the metalloceramics rod V/V_0 = 0,93, the least – in the TNI rod V/V_0 = 0,97. At the breach of the first screen the metalloceramics rod loses only 4% of its mass while the steel rod - 15%. At the same time the relative length L/L_0 of the metalloceramics rod decreased at 10%, theTNI rod - at 20%, and the steel rod - at 27%. After the second steel screen the velocity of the metalloceramics rod decreased up to 55% of impact velocity, the steel rod – up to 72%, and the velocity of the TNI rod remainder decreased up to 93%. After the second screen the relative length of the steel rod was 20% of the initial length, the length of TNI and metalloceramics rods 47% and 49% accordingly. The steel striker lost 69% of its mass while metalloceramics and TNI rods lost about 40%.

In all cases there occurred detonation initiation of an explosive substance.

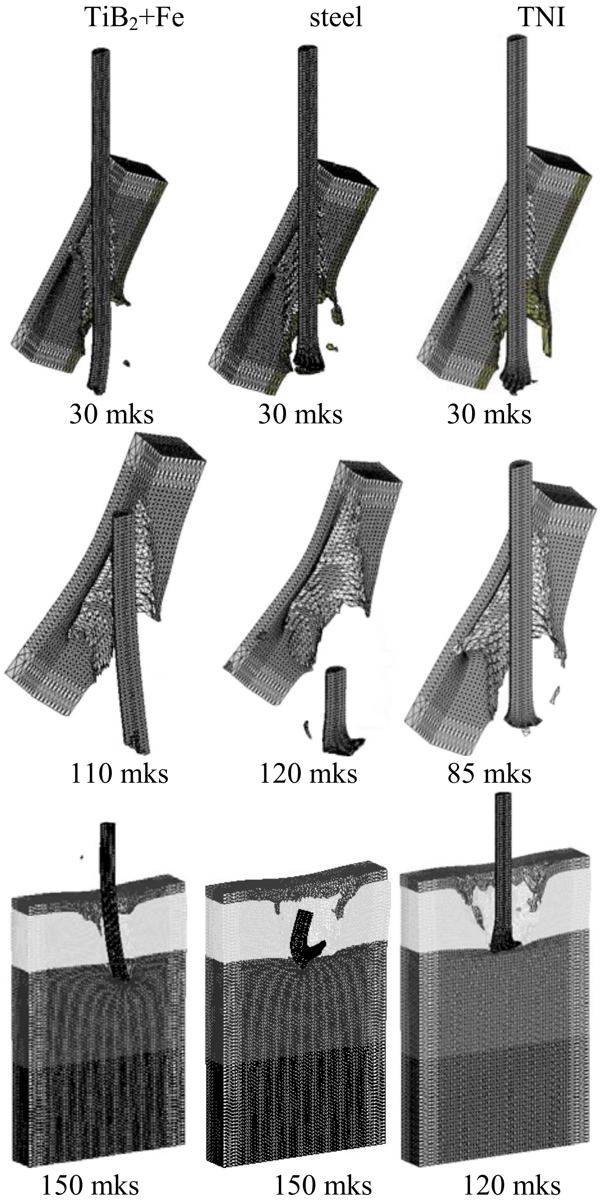


Figure 3.

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References

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