Bio-mechanical model for interaction of striking elements with protected and unprotected bio-specimen

Dr. I. Kobylkin, Dr. A. Letnikov

Bauman Moscow State Technical University

The paper dwells upon the interaction of rifle weapon bullet and non-penetrating elements (NPE) with human thorax using bio-mechanical model.

Contact loading upon thorax at impact energy of tens or hundreds Joules is characteristic for many transport accidents, for example, when thorax is hit by a steering wheel, front sit back, safety belts and so on. But for such type loading, opposite to NPE, the effective area is greater. Nevertheless, in spite of the local character, NPE impact is not corresponded by the penetration, thus ribs and sternum convert the local impact into distributed one.

One can simplify the model ("impact energy – one-dimensional deformation") and describe the deformation of thorax using T. Lobdell's model, which is a four-element model with concentrated parameters. In the case of high-velocity and concentrated non-penetration impact by a body of small mass upon non-protected or slightly protected (textile structure) bio-specimen the model needs modification.

The paper presents a modified bio-mechanical model, which describes the interaction of elements for system "NPE-bio-specimen" or "NPE/protection structure/bio-specimen". Generally, main tests and studies of individual body armors use plastic substrate. The model implies the substitution of coating tissue with high deformability by plasticine substrate.

One shows the followings on the base of test studies:

1) permissible limit of impact energy for fire on bio-specimen by rubber bullets of 24-36 mm is 85 J;
2) caving in of substrate material of 24 mm is permissible limit;
3) for the permissible limit of caving in for substrate material when considering NPEs varying in mass and velocity, the product of mass and velocity in power 4/3 is a constant.

The paper discusses:

1) complex characteristic of NPE impact, which allows to select NPE parameters to provide non-lethal influence upon an bio-specimen
2) test data, which formed the base of calculated variants of the modified model.

Keywords: bio-mechanical model, non-penetrating element