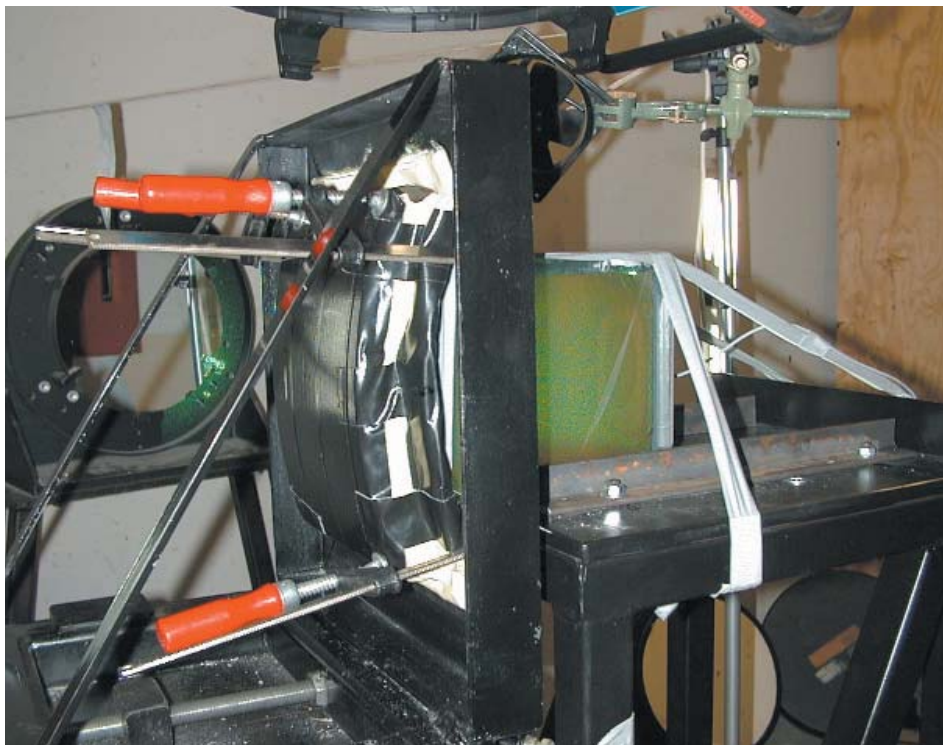


Products and Services

Blunt Trauma

We offer contract research in the fields of:

- trauma effect analysis
- instrumented penetrating and non-penetrating impact experiments
- behind personal armour pressure wave characterisation



Experimental set-up to measure pressure waves in tissue simulant bulletproof armour mounted on gelatine block

The Ministry of Defence has been our main customer for a long time, so TNO build up an extensive experience with the study of ammunition effects and (personal) ballistic protection. Nowadays this expertise is important for civil applications too as amongst others homeland security, police, safety of transport, VIP protection

Blunt trauma

Small arms projectiles can be effectively stopped by bullet-proof vests. Even at a successful defeat, however, injury to a person wearing the vest may still occur. Less-

lethal kinetic energy ammunition is designed to incapacitate humans for a certain time interval, without causing severe injury. Designers, manufactures and users of bullet-proof vests as well as less-lethal ammunition are starting to realise that understanding the effects on the human body at projectile impact is crucial. When either a projectile is defeated by a bullet-proof vest or when a non-lethal round is impacting an unprotected human body, compression waves will be transmitted through the body. The stress waves at impact lead to an injurious effect the so called blunt trauma.

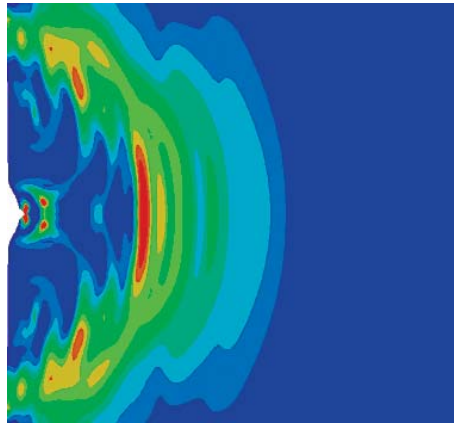
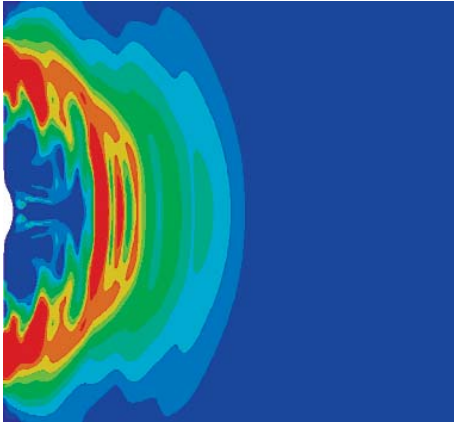
Experiments

TNO has developed experiments to measure and characterize these waves to determine their potential of injury. Impact experiments are conducted with either a small arms round impacting a bullet-proof material supported by tissue simulant material or a less-lethal kinetic energy projectile impacting an unprotected tissue simulant. As tissue simulant either gelatine or silico-gel, Sylgard™, is used.

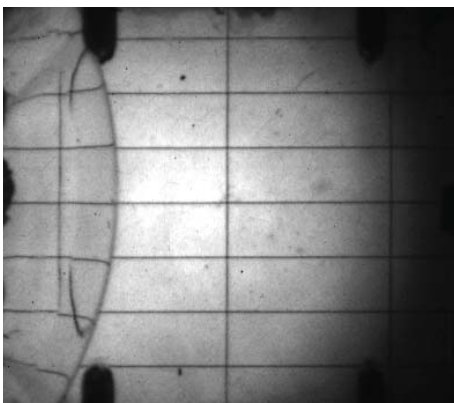
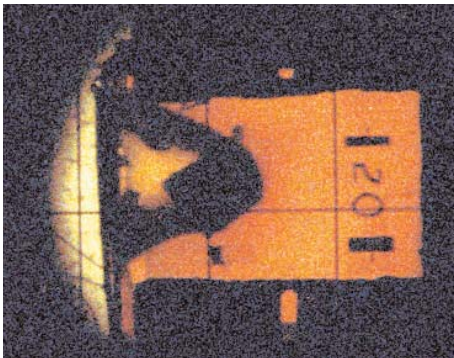
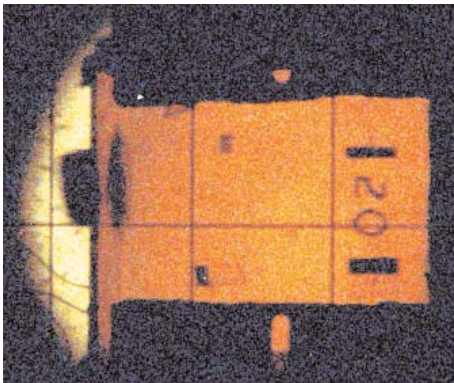
The compression wave transmitted into the tissue simulant, its intense pressure and impulse transfer may cause tissue damage, it is important to determine these parameters. Preferably this should be done in a non-intrusive way. To this end an optical measurement method was designed based upon the discontinuity in the density within the gelatine by the pressure wave. Using a step-wise change in index of refraction the compression wave and its time history can be visualised. By using the visual distortion of a grid line pattern the peak pressure can be determined quantitatively.

Simulation

With the finite-element code AUTODYN™ simulating the compression waves into tissue simulant have been carried out. AUTODYN is an engineering software tool specifically designed for non-linear dynamic problems. With this code simulation of the event of a small calibre round impacting a bullet-proof material, and partial penetration thereof as well as subsequent transmission of pressure waves into the tissue simulant (placed behind the material) has been realized.



AUTODYN simulations of pressure waves through a tissue simulant.



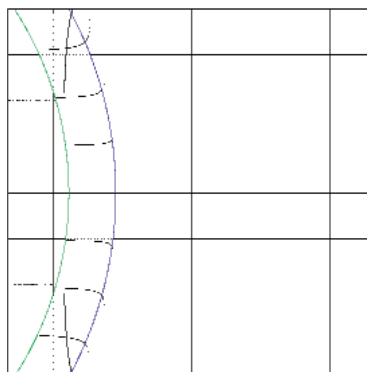
Visual distortion of grid lines, caused by the pressure waves.

Advantage

By correlating pressure histories and resulting injury, as determined for various personal protective armour systems, optimization of materials for personal ballistic protection for a specific projectile threat becomes possible, making not only the ballistic resistance, but also the behind armour effects - at projectile defeat- more accessible for analysis.

Studies to reduce blunt trauma effects by using a material interface between armour and body, i.e. a trauma liner, have been carried out which make optimization of such a layer feasible.

Less-lethal kinetic energy ammunition can be optimized for its main objective: incapacitating personnel over a limited time period, yielding a reduced probability of serious (remaining) injury. The method as described enables determining critical levels to ensure use of less-lethal kinetic energy projectiles will not cause injury.



TNO Defence, Security and Safety

'TNO Defence, Security and Safety' is the title under which TNO operates as a strategic partner for the Dutch Ministry of Defence and makes innovative contributions to enhance the safety and security of the Netherlands both at home and abroad. We also use our accumulated knowledge for businesses, industries and foreign governments.

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