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ANALYSIS OF POSSIBILITIES OF MISUSE OF THE WEAPON SYSTEM CZ 83 PA RUBBER

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A b s t r a c t :

The article deals with possibilities of misuse of the non-lethal weapon system CZ 83 PA Rubber (product of CZ Uhersky Brod) for firing standard ball ammunition with metal projectile that is not intended for this type of weapon. The evaluated weapon system consists of modified semiautomatic pistol CZ 83 and non-lethal cartridges of calibre of 9 mm PA Rubber with a rubber spherical projectile. The results of theoretical analysis and also the results of practical firing tests that are unique from internal ballistic point of view are shown in the article.

List of symbols

Symbol	Unit	Characteristic
d_0	m	diameter of discharge hole at barrel wall
E_{odp}	J	energy to overcome resistance forces

Symbol	Unit	Characteristic
f	J.kg^{-1}	force
h	m	thickness of barrel wall at position of discharge hole
l	m	trajectory of projectile inside barrel
l_ψ	m	reduced length of free combustion volume
m_q	kg	mass of projectile
p	Pa	pressure of propellant gases in the space behind projectile
p_{per}	Pa	perforation pressure
p_0	Pa	initial pressure
R	N	resistance force
s	m^2	cross-section area of bore
t	s	time
v	m.s^{-1}	velocity of projectile
φ	1	coefficient of fictivity
θ	1	heat parameter of propellant gas expansion
τ	Pa	shear stress at cartridge case wall
ψ	1	relative quantity of burnout propellant

1. Introduction

Among important requirements on non-lethal weapon systems firing rubber projectiles there is also the exclusion of misuse of this weapon for firing with standard lethal ammunition. In case of attempt to misuse such weapon system, the weapon must not fire or, when firing is possible, the projectile must not leave the barrel and destruction of the weapon that would endanger shooter and his surroundings must also be excluded. One of the contemporary systems that should fulfil above mentioned requirements is the system CZ 83 PA Rubber that consists of a modified pistol and relatively powerful ammunition with a rubber projectile.

2. Design and function of weapon system

The pistol **CZ 83 of calibre 9 mm PA Rubber** is a single purpose semi-automatic handgun firing rubber non-lethal spherical projectiles (Figure 1). The design of this weapon is derived from that of the pistol CZ 83. The pistol consists of 4” long fixed smooth barrel of calibre of 6.8 mm, dynamic breech bolt with ejection window on the right side, double-action trigger mechanism, and double-sided safety. This weapon system is a product of the company Ceska zbrojovka, a. s., Uhersky Brod.

Figure 1 – Pistol CZ 83 with cartridges of calibre 9 mm PA Rubber

Fixed cartridges 9 mm PA Rubber are fired from ordinary cartridge chamber whose shape does not exclude possible loading of lethal cartridges of certain calibres with metal projectiles. Cartridges of similar shape and dimension calibres (e.g. 9 mm Luger, 9 mm Makarov, 9 mm M 82, 7.62 mm Tokarev, 7.65 mm Browning) cannot be loaded into chamber and fired without any modification. From commonly used cartridges, only cartridges of calibre 9 mm Browning court (or 380 ACP) can be loaded and fired from the system (Figure 2).

The ballistic system comprising the pistol CZ 83 of calibre 9 mm PA Rubber and the cartridge **9 mm Browning court** that is not intended for this weapon is very unique due to its non-standard function during a firing with metal projectile, when some of protective elements prevent the metal projectile to leave the barrel and also exclude destruction of the weapon due to extreme increase of pressure of propellant gases inside the barrel. Among these design protective elements are (Figures 3 and 4):

- reduced internal diameter of barrel (30 % reduction in comparison with diameter of cartridge chamber);
- additional discharge hole in the barrel wall in the area of cartridge chamber (diameter 4.5 mm);
- weakened barrel wall in the area of cartridge chamber by recess in the upper part of pistol frame into which the barrel is pressed (overall thickness of the barrel wall is weakened by 1.65 mm, among others also at level of breech's ejection window).

Figure 2 – Cartridges 9 mm Browning court *(left)* and 9 mm PA Rubber *(right)*

Introduced protective elements prevent misuse of the non-lethal weapon for firing with unsuitable ammunition whose lethal effect is apparent.

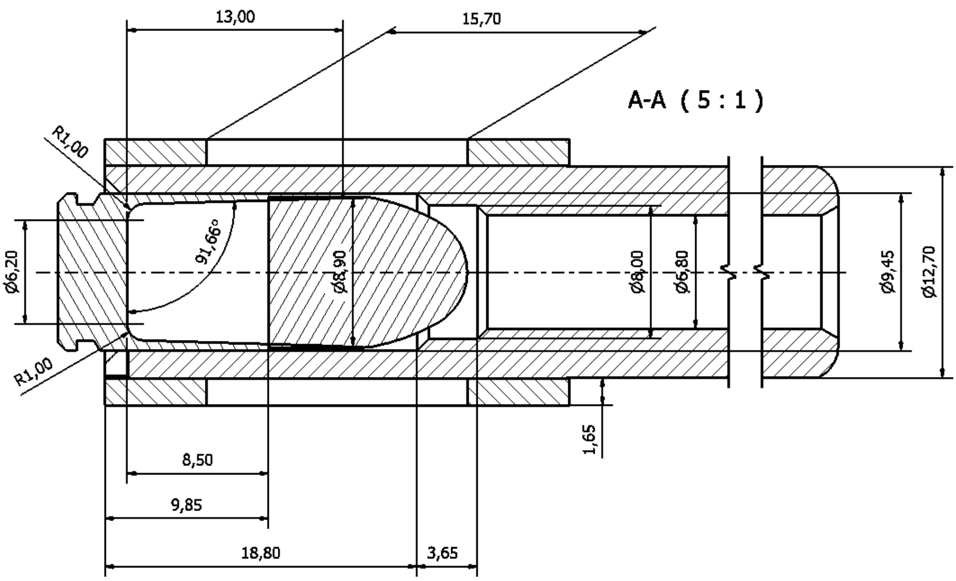

Figure 3 – Drawing of barrel of pistol CZ 83 PA Rubber with loaded cartridge 9 mm Browning court

Figure 4 – Detail of the ejection window and the back part of the barrel of the pistol CZ 83 PA Rubber with adjusted cartridge chamber
(discharge hole is placed on the transition of the weakened part of the barrel wall into full part)

In this article, the technical possibilities of misuse of the described system are assessed and the ballistic analysis of the system is also carried out. Furthermore, simulation of mechanical rupture of the cartridge case during the shot by effect of pressure of propellant gases was realised and the discharge of gases from the hole after opening of combustion space was briefly described. Achieved results were verified by a firing experiment.

The cartridge 9 mm Browning court can be loaded into the cartridge camber of pistol CZ 83 PA Rubber due to its similar outer dimensions with cartridge 9 mm PA Rubber and initiated by impact of firing pin. The **firing experiment**, during which was fired a cartridge 9 mm Browning court, was carried out with this ballistic system. The round with fully jacketed monoogive projectile and lead core that is standard product of company Sellier & Bellot, a.s. Vlasim was used for the firing. The basic characteristics of the round are shown at Table 1. The weapon was placed on the universal firing bench STZA 12 and prepared for remote firing (Figure 5).

Table 1 – Basic characteristics of cartridge 9 mm Browning court FMJ (S&B)

Mass of projectile FMJ – RN	Mass of propellant charge	Initial velocity of projectile[1]	Overall length of cartridge
6.0 g	0.226 g	291 m.s^{-1}	24.9 mm

Figure 5 – Loaded gun placed on universal firing bench (Prototypa Brno, a. s.)

After the ignition of the primer and consequently the propellant charge, the first period of internal ballistic cycle begins. When the initial pressure p_0 is reached the projectile is pushed out of the cartridge case and starts to move towards the muzzle of barrel. When the trajectory of 2.0 mm is reached, the projectile hits the forcing cone that significantly reduces diameter from 9.45 mm at the muzzle of the cartridge chamber into 6.8 mm in the barrel bore. Propellant gases cause an elastic-plastic deformation of the cartridge case that fits closely on the wall of the cartridge chamber and accomplishment of its sealing function. Acting pressure also causes elastic radial deformation of the barrel wall.

When the projectile touches the forcing cone, it starts to slow down. The burning of the propellant charge continues at closed combustion volume. The increasing pressure impresses the projectile into forcing cone (Figure 6). During the impressing,

[1] *Length of barrel 90 cm.*

the projectile travels 7.9 mm more and obtains a stepped shape (Figure 7, 8). The overall trajectory of the projectile in the barrel is 9.9 mm. The projectile stops when limiting deformation is reached, from this instant the remaining part of the propellant charge burns at constant volume that is about twice greater than initial combustion volume c_0.

Figure 6 – View into cartridge chamber with projectile impressed into forcing cone

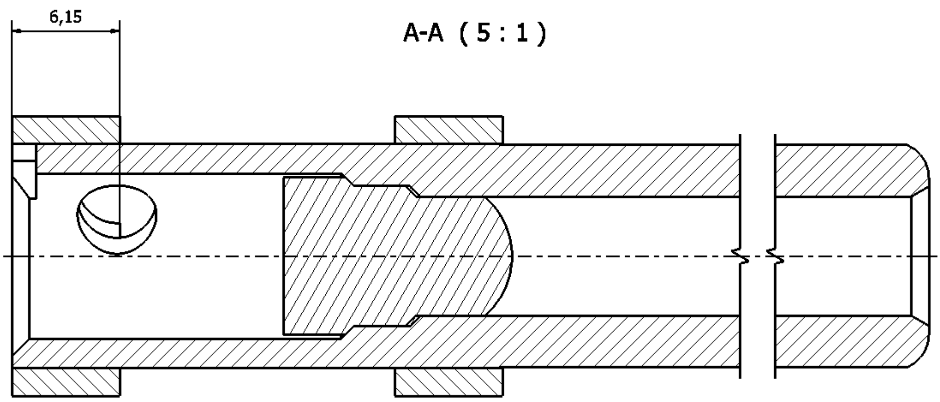

Figure 7 – Cross-section of barrel with discharge hole and projectile pressed into forcing cone
(cartridge case ejected)

Figure 8 – Cartridge 9 mm Browning court
(on the left cartridge before firing, on the right fired cartridge case with a circular hole in its body and two deformed projectiles after their extraction from the barrel)

Increasing pressure causes a deformation of the cartridge case body in position of the circular hole; in critical cross-section tangential and normal stresses arise. At the same time the elastic radial deformation of part of the barrel and also its elastic deformation in axial direction continue. When the pressure that creates in the cartridge case ultimate stress is reached, the circular hole is cut into the cartridge case body and the circle is thrown aside at relatively high velocity. Part of propellant gases discharges from the barrel through the created hole without any benefit, the pressure inside the barrel drops and any damage of the barrel is excluded. The border of the hole in the cartridge case is raised due to plastic deformation of the cartridge case body and it partially reaches into the hole in the barrel. It causes a moderate increase of force necessary to extract the deformed cartridge case from the cartridge chamber. But extraction of the cartridge case does not occur during the functional cycle.

The firing of cartridge 9 mm Browning court, in case of an attempt to misuse the weapon, does not cause any damage to the weapon. After extraction of the projectile from the barrel by means of special tools it is possible to continue in firing with cartridges 9 mm PA Rubber. The only dangerous element during the shot is the brass circle that moves relatively quickly to the right after cut out from the cartridge case body. This circle could wound people in close proximity of the shooter; in case of left-handed shooter that holds the weapon in both hands wounding of his right hand cannot be excluded.

3. Approximate calculation of perforation pressure

For calculation of pressure needed for perforation of the cartridge case the following simplifications were accepted:

- curvature of cylindrical cartridge case body is neglected, wall of cartridge case body is in the area of interest considered as a planar,
- elastic deformation of barrel is neglected,
- friction forces are neglected,
- material of cartridge case wall is considered as homogeneous,
- thickness of cartridge case wall is constant at entire shear cross-section,
- dynamic hardening of material is neglected,
- pressure of propellant gases is considered as a constant continuous load,
- asymmetry of geometric shape of individual design elements is neglected,
- wave processes during burning of propellant charge are neglected,
- the rupture of the cartridge case wall is supposed only by the pure shear because of small ratio of the hole diameter to the thickness of the cartridge case wall at position of the hole (4.5 : 0.6 = 7.5); other types of cartridge case load were neglected.

Shear stress in the planar wall of the cartridge case at the level of the edge of the shearing hole can be expressed as

$$\tau = \frac{F_s}{\pi \cdot d_0 \cdot h}, \tag{1}$$

where:

F_s – force that the propellant gases of pressure p_s acts on the area of cartridge case wall corresponding to the hole of diameter d_0 at barrel wall,

h – thickness of the cartridge case wall at the level of the shearing hole.

It is obtained after the substitution of the force F_s and rearrangement

$$\tau = \frac{p_s \cdot d_0}{4 \cdot h}. \tag{2}$$

The rupture of the cartridge case wall and the consequent cut out of the hole occurs when shear stress τ reaches ultimate shear stress τ_{pshear}. Internal overpressure at the instant of rupture can be expressed as

$$p_{per} = \frac{4 \cdot h}{d_0} \cdot \tau_{pshear}. \tag{3}$$

After substitution of dimensional characteristics and ultimate shear stress for brass (τ_{pshear} = 256 MPa – its magnitude corresponds to 85 % of magnitude of ultimate tensile stress) into equation (3) the theoretical magnitude of the perforation pressure for static load without hardening of material is

$$p_{per} = 136\,\text{MPa}\ ,$$

which can be considered to be the maximum theoretical pressure inside the barrel. Further in this article (Chapter 5) it will be shown that the real perforation pressure will be, due to dynamic hardening of material during fast deformation, slightly higher.

4. Internal ballistic analysis of the system

The aim of this internal ballistic analysis is to determine the pressure-time dependency of propellant gases in the space behind the projectile. This dependency is necessary for the analysis of the behaviour of the cartridge case during the shot.

4.1. System CZ 83 PA Rubber loaded with cartridge 9 mm Browning court

For calculation of the internal ballistic characteristics of the weapon system CZ 83 PA Rubber loaded with cartridge 9 mm Browning court the well-known and widely used thermodynamic internal ballistic model, e.g. [3] was used. But this internal ballistic model had to be modified to properly characterize this unique ballistic system. The effect of resistance against projectile's motion was included and therefore the equation of projectile motion (resistance force) and the energy equation (energy to overcome resistance forces) were modified.

From the previous verbal description of the function of the ballistic system, the internal ballistic cycle can be divided, for purposes of numerical solution, into two stages:

- 1st stage, from beginning of projectile's motion to its stopping at the forcing cone,
- 2nd stage, from stopping of the projectile at the forcing cone to burn out of remaining part of propellant charge (maximum pressure is reached).

1st stage of internal ballistic cycle

The solution of this more complicated stage of the internal ballistic cycle is based on the following simplifications and assumptions:

- motion of the projectile starts, when pressure acting on its base creates a force equal to the extraction force,
- the resistance force *R* increases with increasing impression of projectile into the forcing cone and is proportional to the pressure of propellant gases; the dependency resistance force-time is shown at Figure 9,
- trajectory of "free motion", i.e. trajectory when resistance force *R* is zero, was determined from the drawing of the barrel with a loaded cartridge,

- perforation of the cartridge case and the consequent leak of propellant gases are not considered.

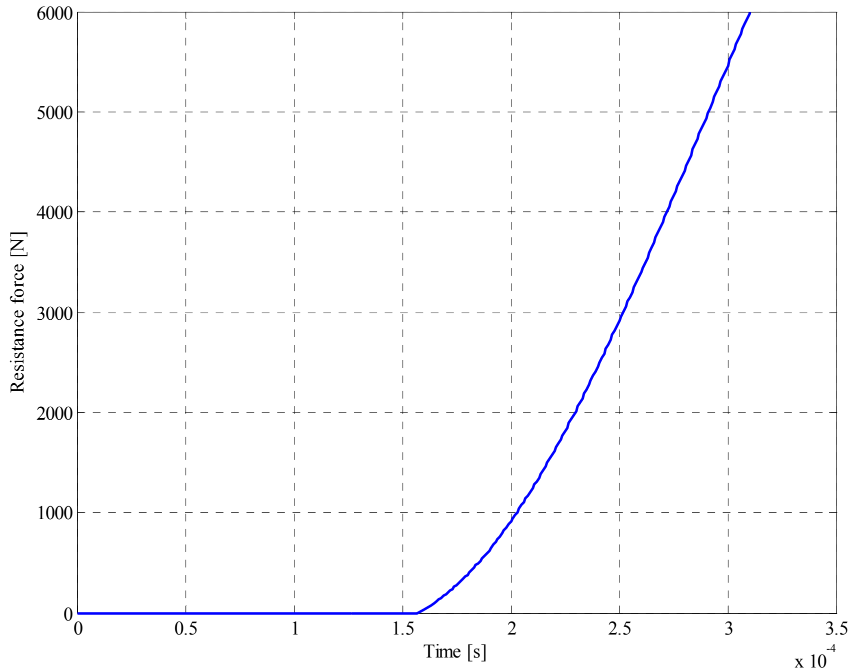

Figure 9 – Dependence of resistance force *R* on time
(time of "free motion" of projectile is 0.16 ms)

The ordinary equation of projectile motion

$$\varphi \cdot m_q \cdot \frac{dv}{dt} = s.p\,,$$

mentioned at internal ballistic model [3] was modified into the following equation

$$m_q \cdot \frac{dv}{dt} = s \cdot p - R(t)\,.$$

The energy equation from the same internal ballistic model

$$p = \frac{f \cdot \omega \cdot \psi - \dfrac{\theta \cdot \varphi \cdot m_q \cdot v^2}{2}}{s \cdot \left(l_\psi + l \right)}$$

was modified into the following equation

$$p = \frac{f \cdot \omega \cdot \psi - \theta \cdot \left(\dfrac{m_q \cdot v^2}{2} + E_{odp} \right)}{s \cdot \left(l_\psi + l \right)}.$$

The initial conditions for solving the system of internal ballistic equations at first stage, $v = 0, l = 0, p = p_0, \psi = \psi_0, z = z_0$, were determined in a usual way according to [3]. Time $t = 0$ belong to the instant when the projectile starts its movement.

2nd stage of internal ballistic cycle

For the solution of this stage of the internal ballistic cycle, when the remaining part of propellant charge burns out at constant volume behind the projectile, is based on the same thermodynamic internal ballistic model [3]. The initial conditions for this part of solution follow from the internal ballistic conditions at the end of 1st stage, i.e. $l = l_{max1}$ = const., $v = 0$ = const., $p_0 = p_{max1}$, $z_0 = z_{max1}$, $\psi_0 = \psi_{max1}$, where index $_{max1}$ means magnitude at the end of 1st stage.

Results

After summarization of the results from both stages of internal ballistic cycle the resulting pressure-time curve can be created, Figure 10. This pressure-time curve is a basis for further investigation of cartridge case behaviour during the shot and also for modelling of cartridge case perforation.

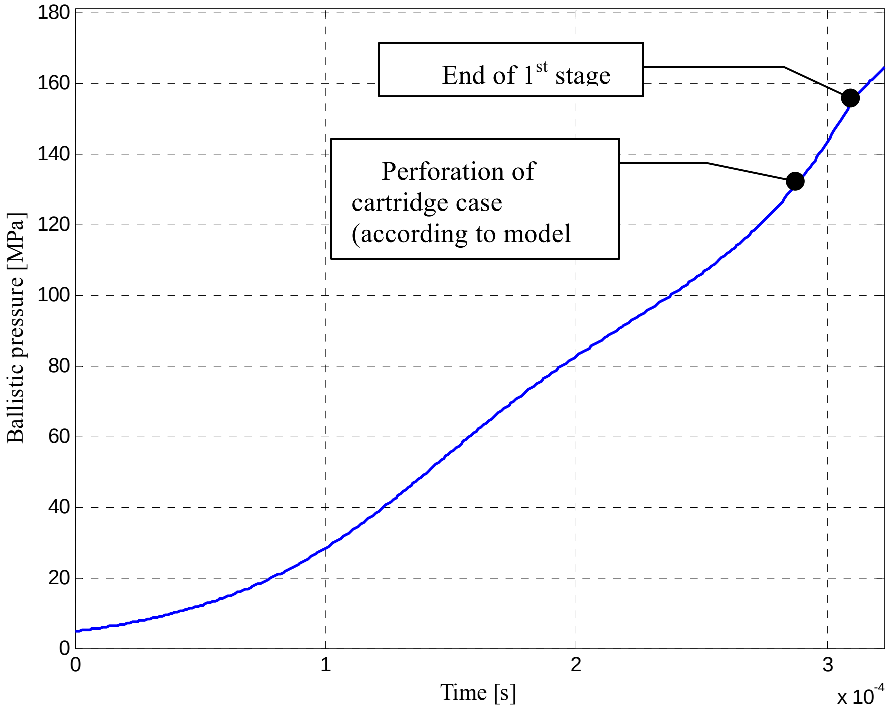

Figure 10 – Pressure-time dependence for cartridge 9 mm Browning court

4.2. System CZ 83 PA Rubber loaded with cartridge 9 mm PA Rubber

Due to the comparison the internal ballistic characteristics of the system CZ 83 PA Rubber loaded with proper cartridge of calibre of 9 mm PA Rubber were also determined. This calculation was carried out with the use of the unmodified thermodynamic internal ballistic model, [3].

At Figure 11 can be seen that the maximum pressure of propellant gases reaches about 90 MPa for temperature of propellant charge +15 °C. An increase of temperature of propellant charge to +50 °C would cause an increase of maximum pressure to 105 MPa.

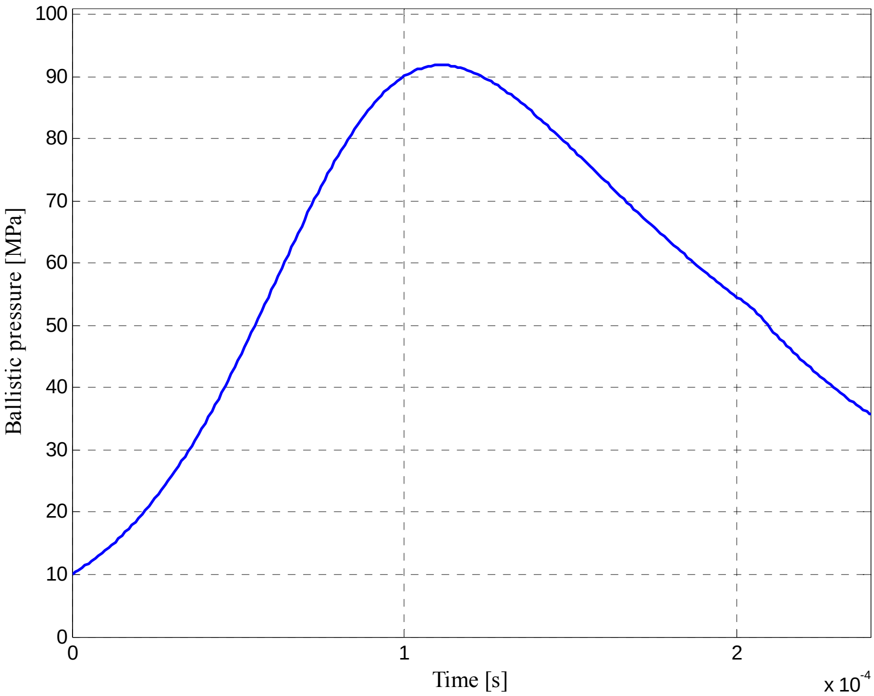

Figure 11 – Pressure-time dependence for cartridge 9 mm PA Rubber

5. Determining optimal size of discharge hole with the use of finite element method

Circular discharge hole in the wall of the cartridge chamber in the barrel of the CZ 83 PA Rubber pistol is a fundamental safety element for the use of non-standard rounds. This opening has to be designed in a way that will ensure a safe and reliable functioning of the weapon system both while using standard non-lethal rounds with a rubber projectile, which are intended for this kind of weapon, as well as in case of an attempt to misuse the weapon with the use of live lethal rounds with metal projectile. The size of this opening will have influence on the character and the amount of stress on the cartridge case in the area which is covering it. The rate of the cartridge case failure and the amount of inner pressure causing the perforation of the cartridge case wall can thus be affected by the size of the discharge hole.

The diameter of the opening must be designed in such a way that cartridge case perforation is caused by an allowable increase in pressure over the maximum value of usual operation pressure that is created when non-lethal rounds with a rubber projectile are used. From this point of view, the greatest possible diameter of the opening would obviously be most convenient. This would, however, result in greater stress on the barrel. As a tension concentrator, it would have negative impact on the construction strength of the cartridge chamber, especially in consideration of the cyclical character of the stress. At the same time, too large hole could have a negative influence on the function of the cartridge case for the standard rounds with a rubber projectile, since it is more difficult to eject the cartridge case owing to the local plastic deformation in the area of the opening.

In order to evaluate the effect of the size of the discharge hole on the weapon function, several cartridge case models and weapon components have been created with the finite element method and the calculations of tension and strain during the shot have been carried out. Approximate values of perforation pressure have been determined for individual models.

The models have been created in an MKP COSMOS/M based program. The cartridge case has been modelled by the volume elements SOLID, which are suitable for solving fast dynamic processes and show very good results in the field of tension and strains also while considering nonlinear character of the solved problem. A part of the cartridge chamber has been modelled in a simplified but justified way around the cartridge case, using the SHELL4T shell elements. Considering the nature of the task, it was possible to use axial spring elements SPRING for the contact between the cartridge and the barrel. The element network around the opening has been refined significantly. The element generation was done manually to reduce the number of elements as well as to achieve real results while solving this very complicated calculation.

Generally speaking, the task to be solved has the character of a fast dynamic process and it is combined with a contact task and material and geometric nonlinearity. The cartridge case material properties are influenced by the way of its manufacturing (deep drawing) and dynamic hardening of the material during fast process. Due to this, great demands are made on the correct creation of the model, on the qualified use of the calculation program and, last but not least, on the computing technology. The complexity of the models can be illustrated on the example of the model of the cartridge case for the cartridge chamber with a 4.5 mm opening, which has 32 523 elements and 37 895 nodes. The solution of this model leads to a system of 133 735 equations.

In total, 5 models for optimization of the size of the opening have been created, with cartridge chamber openings whose diameters rank from 2.5 mm to 6.5 mm. The cartridge case model created for the cartridge chamber with a 4.5 mm discharge hole is to be seen in Figure 12.

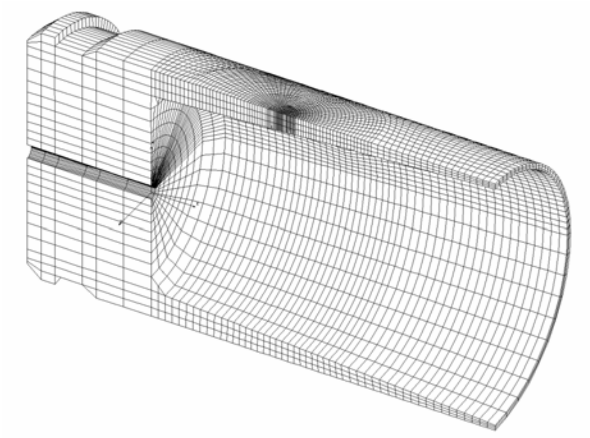

Figure 12- Section of cartridge case model in relation to cartridge chamber with a 4.5 mm opening in the wall

The cartridge chamber is made of SAE AMS 4505H brass with medium amount of copper - 71.5 %. The yield point of this material with a static load is 200 MPa and the tensile strength is 300 MPa. The modulus of elasticity in the elastic area is 100 GPa. The modulus of elasticity in the elastic area is to a great extent influenced by the rate of the process and by the temperature at which the process takes place. That is why it was recalculated in the course of the calculations. The conversion was carried out according to Johnson Cook's constitutive equation, which expresses the relation between tension $\boldsymbol{\sigma}$ and relative plastic deformation $\boldsymbol{\varepsilon}$ depending on the material temperature T and the rate of its relative plastic deformation $\dot{\varepsilon}$.

$$\sigma = \left(A + B \cdot \varepsilon^{n}\right) \cdot \left(1 + C \cdot \ln \frac{\dot{\varepsilon}}{\dot{\varepsilon}_0}\right) \cdot \left(1 - T^{*m}\right),$$

$$T^* = \frac{T - T_r}{T_m - T_r},$$

where:

$\dot{\varepsilon}_0$ – is the initial rate of plastic deformation (the following value was considered in the calculation: $\dot{\varepsilon}_0 = 1\,\mathrm{s}^{-1}$),

T_r – reference temperature (the following value was considered in the calculation: 300 K),

T_m – melting temperature of cartridge case material.

The constants in the above mentioned constitutive equation acquire the following values for brass that has been used in the models:

A = 527 MPa, B= 485 MPa, C = 0.034, n = 0.405, m = 0.97.

While solving the optimization task, it was necessary to determine the tension in the observed area of the cartridge case wall at the moment it touches the cartridge chamber wall and to find out whether the cartridge case material is in elastic or plastic state. That is why the calculation of the cartridge case, whose material was considered nonlinear, was carried out first. Simulation of the inner overpressure load corresponds to CZ 83 pistol of the 9 mm PA Rubber and to the standard 9 mm round Browning court. The initial part of the theoretical dependence of the propellant gases on time (without considering cartridge case perforation) because of internal ballistic analysis, which has been presented in chapter 4, is represented in the left part of Figure 13 for further comparison.

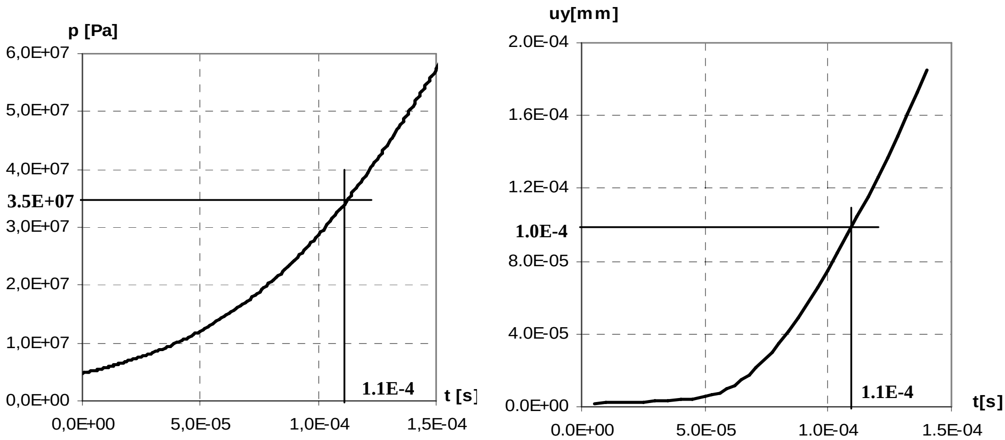

Figure 13 - Time dependence of inner pressure in the cartridge case and radial deformation of cartridge case wall in the area of opening

It was established that at the moment when the cartridge case is distorted in the area of the cartridge chamber opening in such a way that its radius increases by the clearance between the cartridge case wall and the cartridge chamber, the cartridge case material in the area which touches the cartridge chamber wall around the opening is close to plastic state. Moreover, relative deformation rate was established and, based on that, material properties in the plastic area were adjusted for further solution. Through repeated calculations, when modulus of elasticity was in plastic state, it was found out that cartridge case wall touches the cartridge chamber wall in 0.11 ms. The tension in cartridge case wall in the observed area is approximately 250 MPa. The dependence of shift u_y of the characteristic point in the observed area in radial direction on time is figured in the diagram on the right side of Figure 13. By comparing the two diagrams in Figure 13, the value of inner overpressure at the moment of touching was determined 35 MPa.

The cartridge case material failure occurs during a very fast process, if tension reaches the multiple of 2.5 - 3 of the tension at the ultimate stress. The value of tension in the cartridge case wall during failure considered for solution was 750 MPa. The loading of cartridge case is combined, during a failure the shearing stress prevails. That is why tension established according to theory Tresco was taken as a criterion for failure.

An approximate calculation of the perforation pressure for 5 different diameters of safety opening has been done. At the moment of touching, the pressure in the observed area of the cartridge case is 250 MPa. There is, therefore, the difference of 500 MPa in respect to the ultimate stress. An opening in the cartridge case is created when the criterion of failure in the cartridge case elements that are copying the perimeter of discharge hole is fulfilled. That is why the pressure causing the tension increase in these elements of minimum 500 MPa has been established for each model. The values of such increases in tension are presented in Table 2. This chart also includes the resulting perforation pressures, which correspond to the considered ultimate stress of 750 MPa.

Table 2 - Perforation pressures for different sizes of the perforation opening in the cartridge case wall

Diameter of opening [mm]	Tension increase after touching [MPa]	Perforation pressure [MPa]
2.5	180	215
3.5	135	170
4.5	116	151
5.5	110	145
6.5	105	140

The distribution of tension values from the moment the cartridge case touches the chamber wall to the moment of its failure are illustrated for the observed area of the cartridge case in Figure 14. The figure presents the stress distribution for each of the 5 models starting from those with the smallest opening to those with the biggest.

From the figure it is clear that in openings of at least 5.5 mm significant tension is created also outside the edge of the opening. In the relevant area of the cartridge case wall, therefore, not only shearing stress but also normal stress is created. That means, in practice, that if the exhaust port in the cartridge chamber wall is enlarged to 5.5 mm and more, the cartridge case wall can be expected to bulge into the opening.

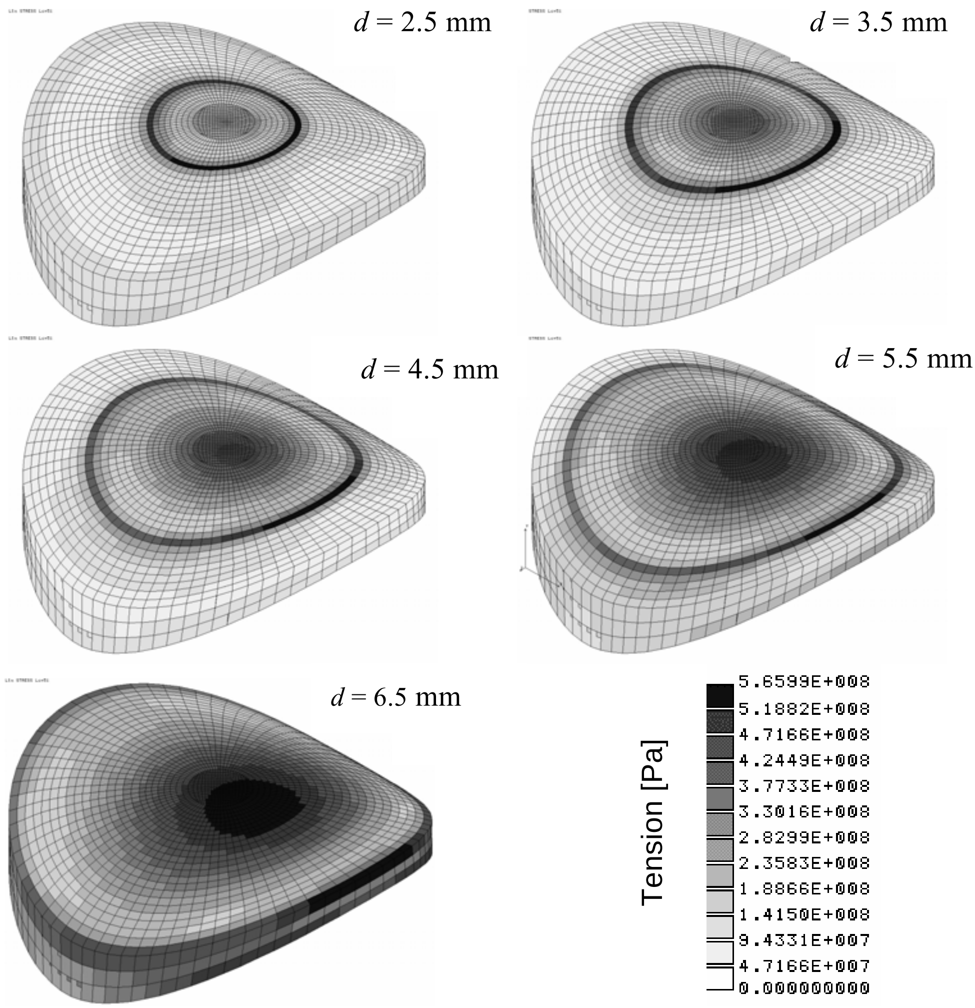

Figure 14 - Process of tension increase from the moment of touching to the moment of rupture

The dependence of the perforation pressure on the diameter of the opening is presented in the diagram in Figure 15. The diagram shows that with respect to the value of the perforation pressure, the diameter of 4 mm - 5 mm can be considered as optimal. If the diameter is between 2.4 mm - 3.5 mm, great perforation pressures are created that can put excessive load on the functional units of the weapon. Enlarging the opening to more than 5 mm, on the other hand, brings about small effect of perforation pressure decrease and it could lead to problems with cartridge case wall bulging into the opening of the chamber when standard non-lethal rounds with rubber projectiles are used. Therefore, an opening diameter of approximately 4.5 mm seems to be optimal. The opening diameter of 4.5 mm is, in fact, used for the weapon barrel. The producer has arrived at this value intuitively by way of experimentation when developing the weapon.

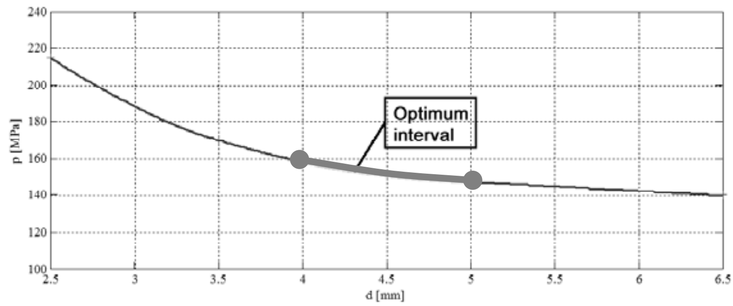

Figure 15 – Dependence of perforation pressure *p* on diameter of discharge hole *d*

6. Discharge of propellant gases through the hole

After cut out of the hole in the cartridge case the space of cartridge chamber is opened and propellant gases discharge through the hole in the cartridge chamber and ejection window of weapon at high velocity into atmosphere. For the first phase of the discharge the critical flow is typical, discharge velocity is equal to the critical velocity that corresponds to local velocity of sound. In case of decrease of pressure in the barrel to 1.9 multiple of the atmospheric pressure, the critical flow would change into under-critical flow. It does not occur during the use of weapon because the hole is closed too soon.

The discharge of gases through the cut out hole has no significant effect on the function of the weapon with dynamic breech. From the high-speed camera record of function of the weapon during a shot it follows that the discharge hole is opened only for a very short time (about 0.4 ms) because it is quickly closed by backward movement of the cartridge case carried by the breech. Majority of propellant gases leaks from the cartridge chamber not through the cut out hole but through the gap between cartridge case and wall of the cartridge chamber during the extraction of the cartridge case. The short-time discharge of propellant gases through the discharge hole decreases the pressure inside the barrel and reduces the impulse of gases on the breech that moves backwards at a lower velocity and is safely stopped and does not cause any damage to the weapon. It can be expected that the recoil will be significantly higher in case of firing with cartridge 9 mm Browning court than 9 mm PA Rubber.

7. Conclusion

The theoretical analysis and experimental firings excluded the possibility of misuse of non-lethal weapon system CZ 83 PA Rubber for firing with lethal cartridges. The safe functioning of the system in case of attempt to fire the cartridge 9 mm Browning court was also verified. But this use of analysed system cannot be recommended.

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