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INVESTIGATION OF THE INFLUENCE ON ADDITIONAL MOUNTED ON BARREL EDGE CONCENTRATED MASS OVER THE GROUPING OF GUNSHOT HITS IN SINGLE SHOOTING

Conyu Grigorov CONEV*, Krasimir Stoianov DAVIDOV**

***"Vasil Levski" National Military University, Shoomen, Bulgaria,**
****"Nikokola Vaptsarov" Naval Academy, Varna, Bulgaria,**
coni19@abv.bg, krasi_dav@abv.bg

Abstract: *One part of universal tendencies that are connected with armament building now is orientated to creating new models of small arms, that have increased battle effectiveness. The grouping is one of the most important technical characterizations that increase battle effectiveness of small arms. In many cases, adding muzzle devices increases bullet dispersing. In order to avoid this, it is necessary that the grouping in these cases should be investigated. This article presents an experimental investigation on the influence of an additional mounted on barrel edge concentrated mass over the grouping of gunshot hits in single shooting.*

Key words: small arms; grouping, muzzle devices, barrel edge, hits

1. Introduction

The last decade has changed the visions for the main combats. This influences the unit structures, tasks and armaments. The most important thing now is to have quality instead of quantity.

One part of the universal tendencies, that are connected with the armament built nowadays, is orientated to creating new models of small arms, that have increased battle effectiveness. The grouping is one of the most important technical characterizations that increase battle effectiveness of the small arms. In many cases, adding muzzle devices increases bullet dispersing. In order to avoid this, it is necessary to investigate the grouping in these cases.

The article shows an experimental investigation on the influence of an additional mounted on barrel edge concentrated mass over the grouping of gunshot hits the single shooting.

2. Experimental investigation conducting

The purpose of the investigation is to discover the mathematical law that shows the grouping changing at single shooting when the additionally mounted on barrel edge concentrated mass has been changed.

Main tasks:

- to conduct an experimental shooting using barrels with additionally mounted on them concentrated mass with values 0,025; 0,05; 0,075; 0,100; 0,125, 0,150; 0,175; 0,200; 0,225; 0,250; 0,275; 0,300; kg and to measure the grouping of gunshot hits the single shooting;
- using the received results to discover the mathematical law that shows the grouping changing at single shooting when the additionally mounted on barrel edge concentrated mass has been changed. In order to achieve tasks, the following restrictions are established:

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- in order to suppress the other factors that influence the grouping, ballistic barrels are used, mounted on a fixed base, located in covered shooting gallery;
- the bull is located at a standard distance for Republic Bulgaria – 100 m;
- the influence of additionally mounted on the barrel concentrated mass over the grouping is investigated only in cases when it is added to the muzzle.

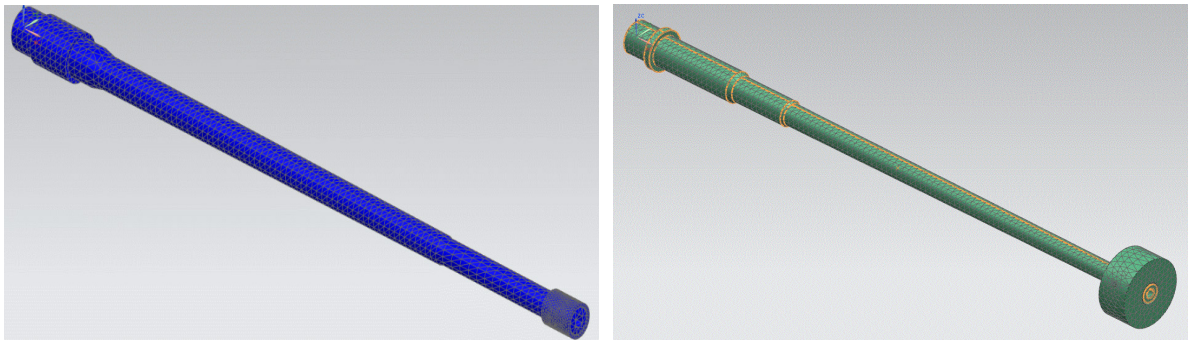
The research was conducted in department "Small Arms and Anti-Air Craft Armament" on Central Artillery Technical Research Firing Ground in Republic Bulgaria [1, 2].

The research is based on "Rules for testing of defense products in Ministry of defense and Bulgarian Army".

Organizations participants: NMU "Vasil Levski" and Central Artillery Technical Research Firing Ground in Republic Bulgaria.

Research object description: two speed ballistic barrels that use cartridges 7,62x39 model 43 year and 7,62x54 model 1908/30 year.

Table 1 Ballistic barrel data



A *B*

Figure 1: Ballistic barrels three-dimensional model.
A- Ballistic barrel that uses cartridges 7,62x39 model 43 year with additionally mounted mass with value 0,025 kg; B- Ballistic barrel that uses cartridges 7,62x54 mm model 1908/30 year with additionally mounted mass with value 0,3 kg.

Ballistic barrel	*Barrel mass [kg]*	*Barrel length [m]*	*External diameter of barrel in the fixing point [m]*
Ballistic barrels that used cartridges 7,62x54 mm 7,62x54 mm model 1908/30.	0,840	0,510	0,026
Ballistic barrels that used cartridges 7,62x39 model 43 year	1,123	0,520	0,026

2.1. Research conditions

- ambient temperature $10^{o} \pm 1^{o}$;
- relative humidity 65 ±5%;
- the shooting was done in covered shooting gallery to eliminate the wind influence;
- the cartridges were the basic, new, trouble-free and produced in the same year and producer, in order to reduce causes that influence on initial bullets velocity;
- the cartridges were kept in a room with permanent temperature 24 hour before shooting;
- distance from the muzzle to the target – 100 m;
- barrel declination - 0^{0} toward horizontal plane;
- the barrel is cooled at every 20 shots.

Used devices:

- base for ballistic barrel;
- ballistic barrel – 2 numbers;
- cartridges 7,62x52 model 1908/30 year – 720 numbers;
- cartridges 7,62x39 model 1943 year - 720 numbers;

- mass with values 0,025; 0,05; 0,075; 0,100; 0,125, 0,150; 0,175; 0,200; 0,225; 0,250; 0,275; 0,300 kg (length - 0,025 m).

2.2. Experimental investigation order

Ballistic barrel and cartridge preparation

- ballistic barrel opening cleaning;
- mounting the ballistic barrel on the base;
- mounting the target in the covered shooting gallery;
- orientating the ballistic barrel into target and locking the mechanisms for orientating.

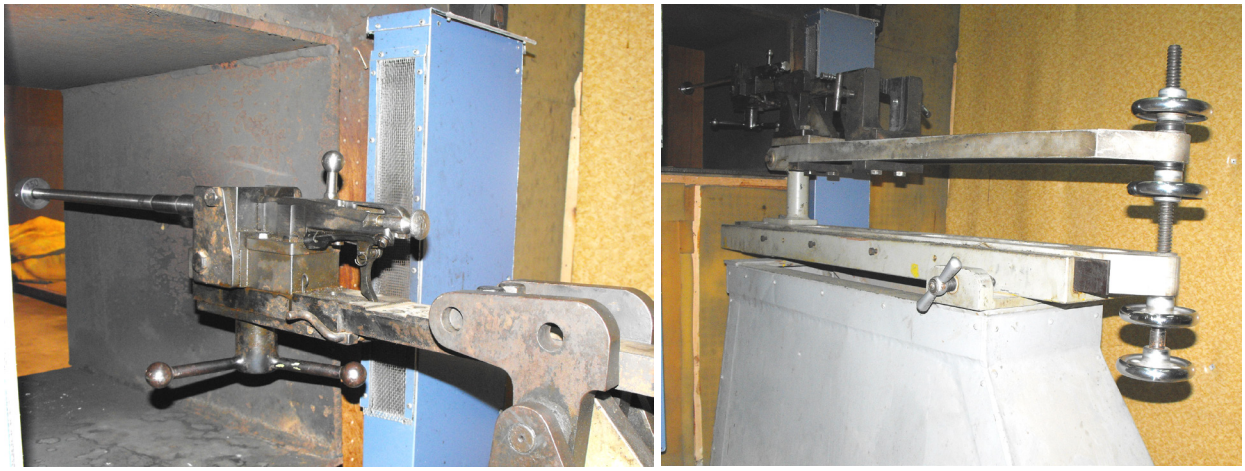


Figure 2: Base for ballistic barrel.

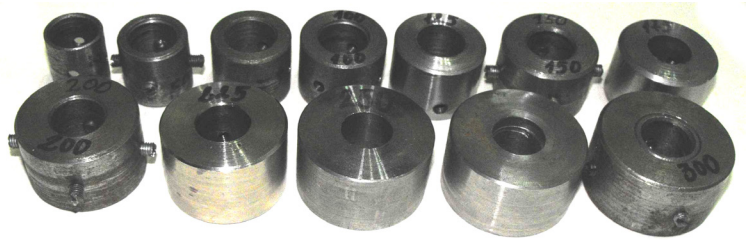


Figure 3: Masses that were mounted on barrel edge with values 0,025; 0,05; 0,075; 0,100; 0,125, 0,150; 0,175; 0,200; 0,225; 0,250; 0,275; 0,300 kg.

Experimental shooting

A) Two shots for barrel heating;

B) Shooting group of twenty shots at single fire.

C) Measuring of the grouping (for value was taken the radius that collect 50% of shots – R_{50}).

D) Steps B and C are repeated until 3 serieses are shot.

E) Calculating the grouping average values – $R_{50\,AVR.}$ (formula1).

$$R_{50\,AVR} = \frac{(R_{50/1} + R_{50/2} + R_{50/3})}{n} \qquad (1)$$

where:

$R_{50\,AVR}$ – average value of radius that collect 50% of shots [m];

$R_{50/1}$, $R_{50/2}$, $R_{50/3}$ – value of radius that collect 50% of shots for first, second and third series [m];

n – number of the serieses.

F) Adding the mass with value 0,025 kg on barrel muzzle;

G) Steps from B till E are repeated.

H) The masses from 0,05 till 0,3 kg are mounted consecutively and steps from B till E are repeated.

I) Steps from A till H are repeated for the second barrel.

3. Experimental investigation results

The results are presented in table 2 and figure 4

Table 2 Experimental investigation data

№	*Mass value [kg]*	*Ballistic barrel that uses cartridges 7,62x39 model 43 year*	*Ballistic barrel that uses cartridges 7,62x54 model 1908/30 year*
		R_{50} *[m]*	R_{50} *[m]*
1.	0	0,049	0,042
2.	0,025	0,045	0,042
3.	0,050	0,047	0,063
4.	0,075	0,071	0,055
5.	0,100	0,051	0,065
6.	0,125	0,040	0,092
7.	0,150	0,034	0,058
8.	0,175	0,049	0,051
9.	0,200	0,056	0,054
10.	0,225	0,045	0,058
11.	0,250	0,036	0,036
12.	0,275	0,053	0,035
13.	0,300	0,035	0,060

The results in table 2 show that the changing of the radius that collects 50% of shots (R_{50}) for the barrel that has less mass, but uses more powerful cartridge is more than 2,6 times. For the second barrel the changing is 1,6 times.

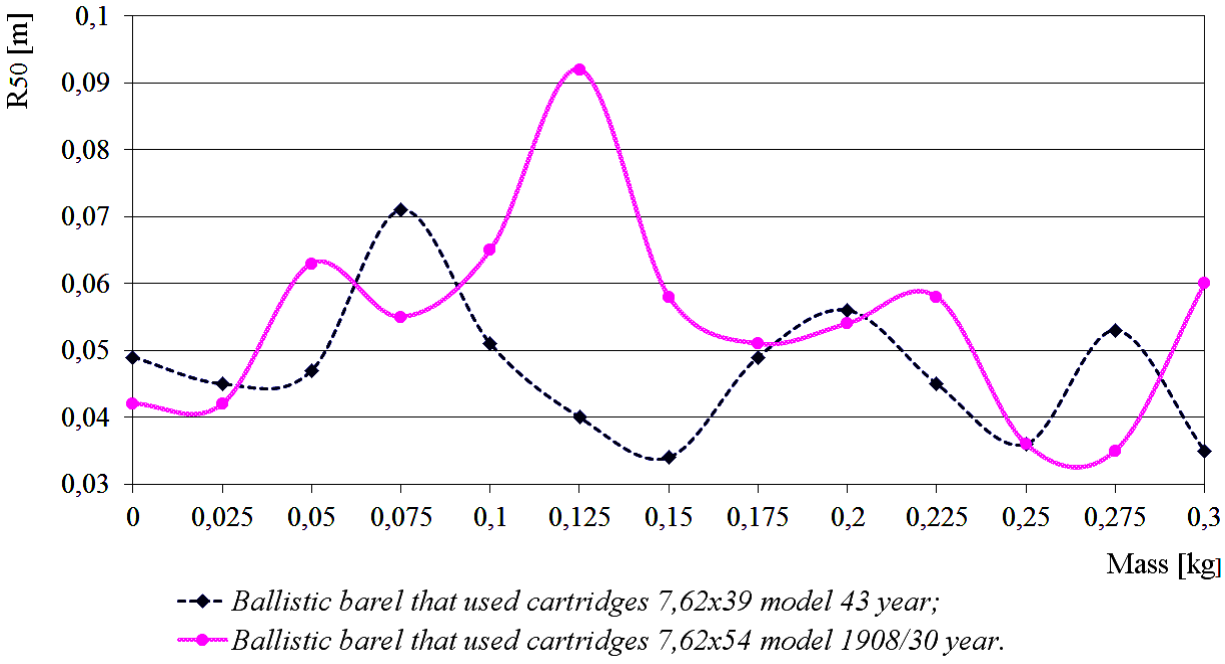


Figure 4: Drawing of the changing of the radius that collects 50% of the shots.

The drawing on figure 4 is made using the spline interpolation with cubic spline (formula 2).

$$S_3 = \begin{cases} f_1 = a_1 + b_1.(x - x_0) + c_1.(x - x_0)^2 + d_1.(x - x_0)^3, x \in [x_0, x_1] \\ \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots \\ f_i = a_i + b_i.(x - x_{i-1}) + c_i.(x - x_{i-1})^2 + d_i.(x - x_{i-1})^3, x \in [x_{i-1}, x_i] \\ \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots \\ f_n = a_n + b_n.(x - x_{n-1}) + c_n.(x - x_{n-1})^2 + d_{n1}.(x - x_{n-1})^3, x \in [x_{n-1}, x_n] \end{cases} \quad (2)$$

where: $a_i = y_{i-1}$;

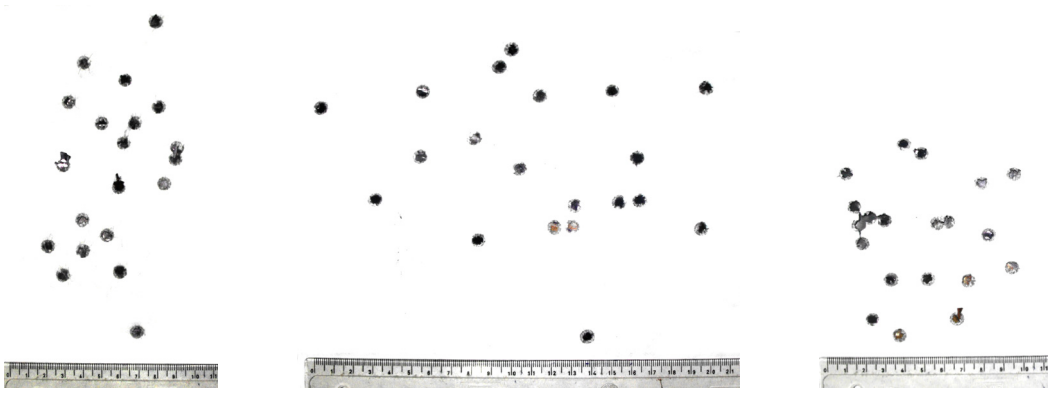
$$b_i = \frac{y_i - y_{i-1}}{h_i} - \frac{h_i}{6}.(l_{i+1} + 2.l_i) \quad i=1 \div n;$$

$$c_i = \frac{l_i}{2};$$

$$d_i = \frac{l_{i+1} - l_i}{6.h_i} \quad i=1 \div n-1;$$

Coefficients l and h can be defined by the system (formula 3).

$$\begin{cases} l_1 = 0 \\ h_1.l_1 + 2.(h_1 + h_2).l_2 + h_2.l_3 = 6.\left(\frac{y_2 - y_1}{h_2} - \frac{y_1 - y_0}{h_1}\right) \\ \cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots \\ h_{i-1}.l_{i-1} + 2.(h_{i-1} + h_i).l_i + h_i.l_{i+1} = 6.\left(\frac{y_i - y_{i-1}}{h_i} - \frac{y_{i-1} - y_{i-2}}{h_{i-1}}\right) \\ l_{n+1} = 0 \end{cases} \quad (3)$$



A *B* *C*

Figure 5: Changing of grouping for barrel that uses cartridges 7,62x39 model 43 year. A- Grouping when mass with value 0,125 kg is mounted; B- Grouping when mass with value 0,200 kg is mounted; C- Grouping when mass with value 0,300 kg is mounted.

4. Conclusions

1. Additionally mounted concentrated mass on barrel edge influences over the grouping of gunshot hits the single shooting. This fact can be used in order to receive better grouping when the small arms are designed.
2. Linear increasing of the additionally mounted concentrated mass on barrel edge does not lead to linear grouping changing. The grouping changing has drops and pikes.
3. The curves for the two barrels are similar, but it is possible to be noted that influence of the additionally mounted mass for the barrel that has less own mass and uses more powerful cartridge is more strongly than the other barrel.

References

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[2] *Правилник за управление на жизнения цикъл на отбранителните продукти*, София, МО, 2011.