XX IMEKO World Congress
Metrology for Green Growth
September 9–14, 2012, Busan, Republic of Korea

THE UTILISATION OF AN IMPULSE OF FORCE IN SELF-DEFENCE

Martin Pospíšilík[a], *Dora Lapková*[b], *Milan Adámek*[b], *Zdeněk Maláník*[b]

[a]Tomas Bata University in Zlín, Faculty of Applied Informatics, Department of Computer and Communication Systems, nám. T. G. Masaryka 5555, 760 01 Zlín, Czech Republic
[b]Tomas Bata University in Zlín, Faculty of Applied Informatics, Department of Security Engineering, nám. T. G. Masaryka 5555, 760 01 Zlín, Czech Republic; dlapkova@fai.utb.cz

Abstract: This article is focused on the utilisation of force, specifically the impulse of force in self-defence. It also points out the fact that this field suffers from a great shortage of specialised measurements and experiments. This results in the general public, professionals and authorities active in criminal proceeding shaving distorted views. Further, the article describes the research focused on the impulse of force of a straight punch. The article consists of the description of the actual experiment, individual elements and equipment employed together with the analysis of the results. The written part is supported by photographs for better illustration.

Keywords: force, impulse of force, self-defence, straight punch

1. INTRODUCTION

Self-defence is a field whose primary focus is on the fair defence of the legally protected interests of a person. It covers various areas from theory and practice of defence, attack and prevention to scientific disciplines such as tactics (e.g. skill in the counter attack), strategy (precautionary action) and operation (behaviour after a conflict situation). Moreover, it includes the knowledge of somatology and the chosen parts of crisis management, especially the phase of the conflict and solutions to conflict situations. The essential component of self-defence is the technical knowledge which includes weapons and defence resource operations. [2]

On the basis of the aforementioned facts the field of self-defence is considered to be quite extensive. The study of this issue is complicated for several reasons. The first and the most significant is the misunderstanding of the issue. By means of the media and general information resources the public is being offered a wealth of information about self-defence which still does not cover the majority of the areas mentioned above. This leads to a biased view of this field and mainly to its great simplification, e.g. focusing on the defence technique only. This assertion is supported by the amount of courses being organised in every large city; the overwhelming majority of these courses offer only the defence techniques without introducing their students to the situation culmination or operation.

A further problem is the quality of available information. Although there is a surplus of information on the Internet the quality is rather low. Also this contributes to an incorrect understanding of the field.

Nowadays, in the Czech Republic there is still the custom for men and women being taught the very same technique of defence with equal requirements placed on them in order to master the technique. Only a few instructors customise the technique of defence for women. It has been proven that women have less physical strength but at the same time they have greater mobility and agility. These facts have to be taken into account when teaching.

As a background for this claim several experiments have been accomplished with a focus on the striking techniques. Striking techniques belong amongst the essential techniques of defence and are the first techniques taught in the courses. Out of the striking techniques, the straight punch (cross) has been chosen as a well measurable technique.

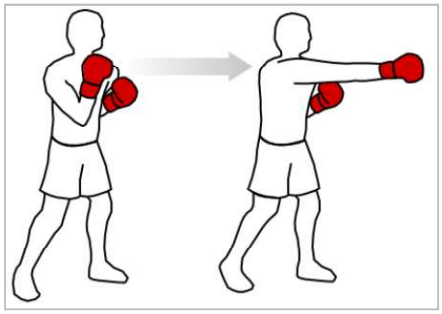

Fig. 1 *Cross* [1]

This article describes one of the experiments focused on the impulse of force. The experiment examined the dependence of the maximum force on gender and whether the measured difference is insignificant or sufficiently distinct.

The article is divided into several sections. Within the first sections a measuring station is described and analysed; further, a strain gauge sensor used for the measurement is described together with an appliance for its connection to the computer. The measurement procedure and its results are examined in the following sections.

2. MEASURING STATION

The measuring station is built from oriented strand boards (OSB). OSB are building boards characterised by their firmness and stiffness; they lack common defects such as knots, bark, cracks, etc. They are made of large flat wood shavings arranged in three layers. Wood chips in the top and bottom layers are laid lengthwise while the middle layer is oriented in the transverse direction (perpendicular to the two marginal layers). Subsequently, the layers are joined together by waterproof resin. [4]

These boards served as material for the construction of the base of a punching bag (impact target) and a facility for mounting of this base. Fig.2 and 3 depict this measuring station together with the punching bag. In its first version hooks for connection of both parts were employed in order to adjust the punching bag as necessary. Later, the station was modified and the hooks were substituted for Velcro fasteners as can be seen in Fig. 4.

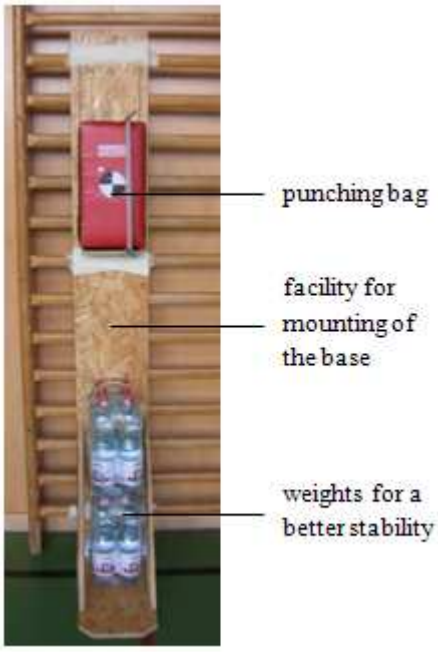

Fig. 2 *Measuring station*

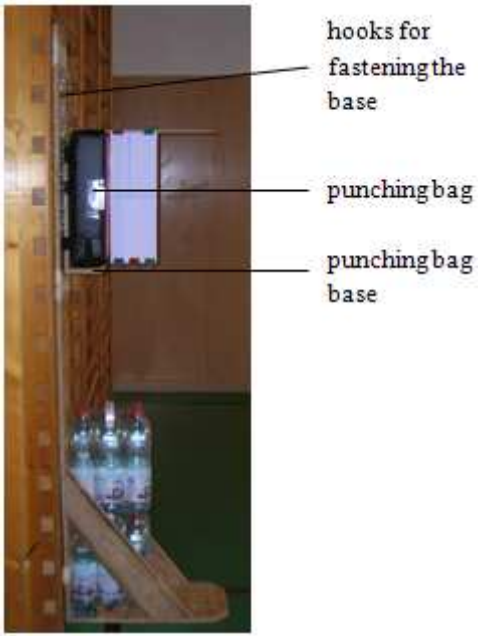

Fig. 3 *Measuring station – side view*

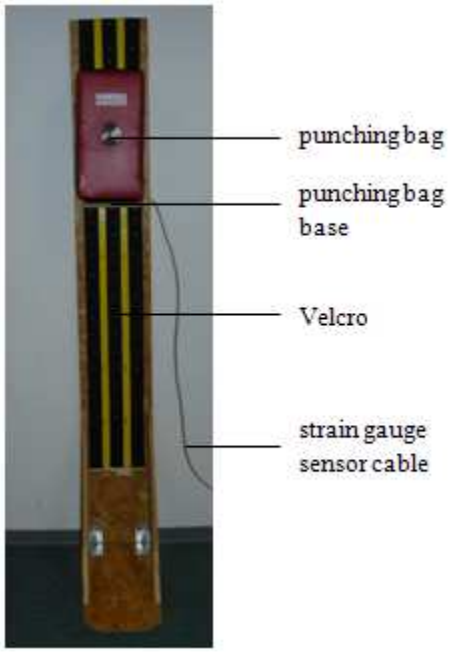

Fig. 4 *The second version of the measuring station*

3. STRAIN GAUGE SENSOR

The strain gauge sensor of the pressure force, type SRK-3/V is a passive electromechanical converter which converts force to a proportional electrical signal. As a mechanical-electrical converter it uses silicon resistive strain gauges because their deformation sensitivity is sixty times higher than that of the film or wire resistive strain gauges. The sensor is sized and calibrated for constant loading of 3 kN force exerted in the axis of

the sensor; nevertheless, it also endures a long-term repeated overload up to 200 % (6 kN) in the axis of the sensor.

The sensor consists of a base in the shape of a short cylinder which verges into a truncated cone in its upper part. The upper base of this truncated cone is formed by a membrane with four silicon resistive strain gauges AP120-3-12 affixed on its inner surface. In the middle of the inner surface of the membrane there is a junctor that connects the membrane to a measuring area in the shape of a spherical cap. All of the described parts of the sensor are made of one piece of dimensionally stable alloy treated steel.

The pressure force exerted on the measuring area is being transmitted to the membrane by means of the junctor and deforms it proportionally to any exerted force. At the same time the force is being transferred to four silicon resistive strain gauges fixed to the membrane by a special tensometric adhesive which converts it to an electrical resistance proportional to the deformation. The connection of the strain gauges to the Wheatstone bridge provides an effective primary compensation of the influence of temperature on the measuring system. [5]

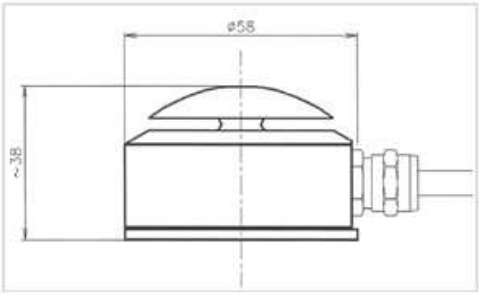

Fig. 5 *Strain gauge type SRK-3/V* [5]

The sensor is connected to the computer, which is used for data storage, through the strain gauge. The strain gauge type TENZ2334 is an electronic appliance that converts the signals to data that is stored in memory. Initiation and termination of a measuring cycle is provided by buttons START and STOP. The strain gauge is equipped with a communication interface RS232. It also includes software which enables the subsequent transfer of the acquired data into the computer together with the storage of this data in a format compatible with MS Excel software. The core of the appliance is a single-chip microcomputer that controls all of the activities. The strain gauge sensor is connected to this appliance via four-pole connector XLR by four conductors. The number of values measured by the sensor averages around 600 measurements per second while the data is immediately stored in the memory of a device with a capacity of 512 kB. [3]

Fig. 6 *Strain gauge type TENZ2334* [3]

4. DESCRIPTION OF THE MEASUREMENT

For the purposes of the measurement the punching bag was modified so that some foam from the rear of the bag was removed and replaced by the strain gauge sensor. This prevented persons from hitting the sensor during the experiment and hurting their hands. Therefore, the foam serves as a protective layer.

The punching bag is attached to the base and hung on a device designated for that purpose. The hooks and Velcro are intended for adjusting the height of the punching bag. In order to gain the most accurate results, the strike is performed at shoulder height.

The measurement took place in the gym at Tomas Bata University in Zlín. The strain gauge sensor in the punching bag was connected via a strain gauge meter to a laptop. This made it possible to directly store the measured data. The connection of the devices is shown in Fig. 7.

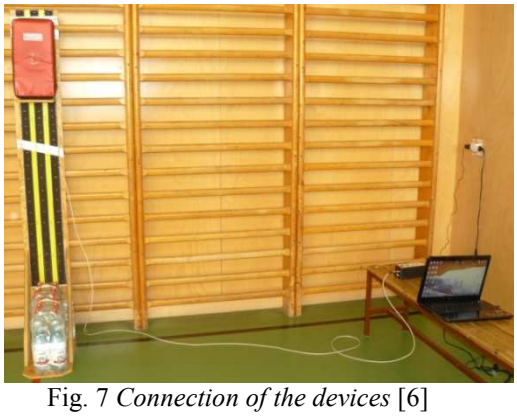

Fig. 7 *Connection of the devices* [6]

The whole measurement consisted of several steps:

A. An experimentee came to the measuring station and reached out his/her hand at shoulder height, which allowed the base with

the punching bag to be adjusted accordingly (Fig. 8).

Fig. 8 *Suspension of the base with the punching bag at the shoulder height*

B. The strain gauge was switched on by pressing the START button.
C. The experimentee performed the straight punch.
D. The strain gauge was switched off by pressing the STOP button.
E. The data was downloaded to the computer.

92 men and 17 women from the ranks of university students participated in the experiment. These persons can be classified as moderately trained. They all know the theory of the straight punch owing to it being one of the subjects in the university curriculum.

4. RESULTS OF THE MEASUREMENT

On the storage in the computer the results could have been further processed by MS Excel software. The final charts are depicted in Fig. 9 and 10.

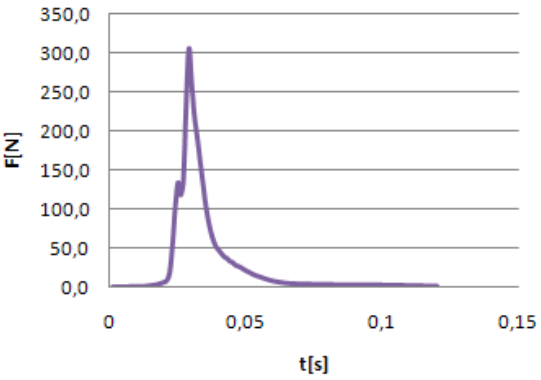

Fig. 9 *Dependence of force on time – men*

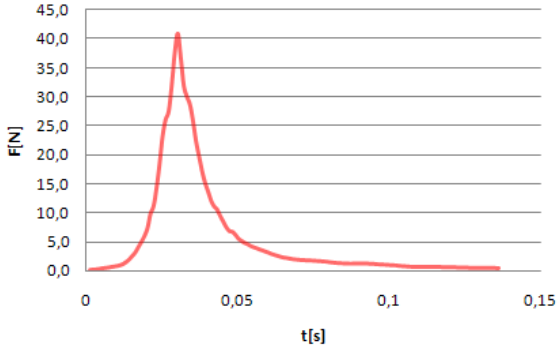

Fig. 10 *Dependence of force on time - women*

The main issues were examined in detail and thanks to the successful experiments satisfactory answers could be found. The force impulse charts clearly indicate that the difference in maximum force between a man and a woman is distinctive. The maximum force was 305.6 N for men and 41 N for women. Therefore, the maximum force of the straight punch of men is 7.5 times higher than that of women. This also suggests that any injuries caused would be quite different. Moreover, the time period of the force exertion can be considered as interesting data. The average length of the straight punch is 0.1 s and there is not much difference between the sexes.

The results are so conclusive that it is impossible to doubt the large difference in maximum force of straight punch between a man and a woman. This fact is crucial in several ways:

1. It is confirmed that a man and a woman do not have a same strength, when they are using the same technique and that is why they cannot cause the same injury.
2. The results contribute to the theory, that it is necessary to differentiate techniques of defence by gender.
3. The measurement confirmed the physiological differences between the sexes, however, in this field; this fact is not taken too seriously. Just only few self-defence instructors adjust their techniques according to physiological laws of sex.

4. CONCLUSION

The actual research involved persons considered as moderately trained only. In the future, further experiments are to be performed involving untrained persons with no knowledge of the straight punch as well as with trained persons consistently engaged in this issue. The acquired data will be used for comparison of force impulses of individual groups.

A further step is to determine the attenuation of foam in the punching bag. The initial experiments

did not deliver plausible results and thus other possibilities of attenuation determination are being examined.

The possibility of scientific research within this field is extensive; however, it is hardly ever employed. This research builds on the previous one which was focused on the speed detection of the straight punch. Similarly, the previous research proved substantial differences between the sexes.

The results of both experiments can be used in many fields concerned with self-defence, primarily for the adjustment of the contents of the public courses. In particular, they can serve for the differentiation of the active defence techniques between men and women. The experiments demonstrated that it is impossible to treat the sexes in the same way and expect equal results.

Another field of results utilisation are for occupations which involve professional defence. For instance, bodyguards, store guards or carriers of valuables must undergo training that should be closely focused only on those techniques and actions that are effective and efficient in practice. With reference to this research they can better assess the effectiveness of the straight punch.

The following experiments are to be focused on other striking techniques, such as slaps and kicks of various kinds. Until now, only the straight punch has been experimented on. Other interdependences are to be determined in the future, for example those of height and weight.

The overall aim of the research is to examine striking techniques as a whole and create a methodology for instructors, trainers, teachers and others, which would help to compile the contents of courses, seminars or training camps. The purpose of the research is to gradually increase the level of self-defence and to provide persons engaged in this issue with experimentally-based data for better quality teaching. The demonstration of the efficiency dependence of individual techniques on the sex is an important step towards the progressive differentiation of all defence techniques. Undoubtedly, it is the failure in mastering the techniques being taught that causes women to lose their motivation for further training and increases the possibility of their losing confidence in the effectiveness of this defence. To sum up, the more people who practice self-defence, the less will be the number of victims of various crimes.

Dora Lapková

5. ACKOWLEDGEMENTS

This paper is supported by the Internal Grant Agency at TBU in Zlín, project No. IGA/FAI/2012/012, and by the European Regional Development Fund, project No. CZ.1.05/2.1.00/03.0089 (CEBIA-Tech).

6. REFERENCES

[1] BOROVIAN, Michal. *Intenzita obrany z hlediska fyzikálního účinku (Intensity of defence in term of physical action of a technique)*. Zlín, 2009. Diplomová práce. Univerzita Tomáše Bati ve Zlíně. Vedoucí práce Ing. Zdeněk Maláník, DCv.

[2] LAPKOVÁ, Dora. *Sebeobrana ženy (Self-defence of a woman)*. Zlín, 2007. Bakalářská práce. Univerzita Tomáše Bati ve Zlíně. Vedoucí práce Ing. Zdeněk Maláník, DCv.

[3] MATULÍK, Radomír. *Tenzometrické měřidlo s pamětí*: *typ TENZ2334 (The strain gauge with memory: type TENZ2334)*. Otrokovice, 2010.

[4] OSB Desky. *OSB Desky (OSB boards)* [online]. [cit. 2012-01-20]. Dostupné z: http://osb-desky.stavbaonline.cz/

[5] VTS ZLÍN. *Tenzometrický snímač síly*: *typ SRK-3/V (The strain gauge sensor: type SRK-3/V)*. Zlín, 2010.

[6] ŽALMÁNKOVÁ, Petra. *Hodnocení intenzity útoku (Attack Intensity Assessment)*. Zlín, 2012. Diplomová práce. Univerzita Tomáše Bati ve Zlíně. Vedoucí práce Ing. Zdeněk Maláník, DCv.