EAN 2017
55th conference on experimental stress analysis

# Drop Test of Foams used in Motorbike Protectors

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**Keywords:** drop test, foam materials, protectors, acceleration, motorcycle rider

**Abstract.** This article is focused on the experimental drop testing of foam materials which are used in motorbike protectors. The EN 1621-1 standard, which describes the test methodology of motorcycle protectors, determines only one type of the drop test. Every protector is tested only once [4], however, there is a high probability of multiple hits to the same spot during motor rider fall. Every sample of the motorcycle protector was tested ten times with 60 seconds pause, using methods described in this article. Three impact velocities 1 $m \cdot s^{-1}$, 2 $m \cdot s^{-1}$ and 3 $m \cdot s^{-1}$ were applied. The experiment showed that, in many cases of the impact, protectors are not destroyed.

## Introduction

In the year 2014, there were 4570 motorcycle accidents in the European Union countries. A large amount of them were fatal [1, 2]. Many motorcycle riders consider the motorcycle protective clothing only as a protection against the bad weather conditions [3]. In our experiment, two types of foam materials were compared. First type of samples was cut out from the motorcycle protectors SAS-TEC SC-1/42 (Fig. 1, black color), second type of samples was cut out from motorcycle protectors SAS-TEC SLC 2 (Fig. 1, gray color). The size of black samples was 19.5 mm x 20.2 mm x 10.8 mm. The target area was 395.7 $mm^2$. The size of gray samples was 19.2 mm x 20.8 mm x 13 mm. The target area was 40 $mm^2$.

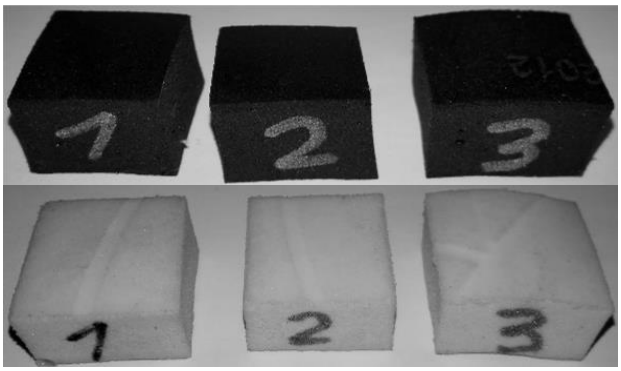


Fig. 1: Experimental samples.

Both types of protectors were classified according EN 1621-1 standard as class 2. In the protector verification test described by EN 1621-1 standard, the impactor falls with the weight of 5 kg from 1m height. The maximum ground reaction force must be equal or less than

20 kN [4]. In this article unstandardized test for motorcycle protectors was applied. Compared to the standard test, every sample was tested ten times. While the ground reaction forces were not compared but only acceleration and compression during impact was measured. A lot of motorbike protector manufacturers recommend change of all protectors after a motorbike fall [5].

**Experimental methodology**

The experiment was performed on the device developed by our institution. This machine was designed to simulate free fall and its functionality was verified by leaser sensors. Mass of impactor used in the experiment was 2.4 kg. Dimensions of rectangular shaped impactor were 30 mm x 30 mm. By application equation

$$y = \frac{v^2}{2g} \tag{1}$$

three impact heights (51 mm, 204.1 mm and 459.2 mm) were calculated from which the impactor was released. These three heights represented impact speeds 1 $m \cdot s^{-1}$, 2 $m \cdot s^{-1}$ and 3 $m \cdot s^{-1}$. The measuring apparatus is showed on figure 1. Measuring chain was composed from piezo-ceramic accelerometer KISTLER 8702B500 with range ±500 g and optical distance sensor optoNCDT2300-500 with rage ±50 mm. The first of sensors was connected to measuring card NI 9215 by coaxial cable, the second sensor was also connected by coaxial cable to measuring card NI 3234. Both cards were connected to NI eDAQ-9178 bus. The sampling frequency was set to 25.4 kHz. Data acquisition was performed in Nation Instruments Signal Express environment and post processed in MATLAB software.

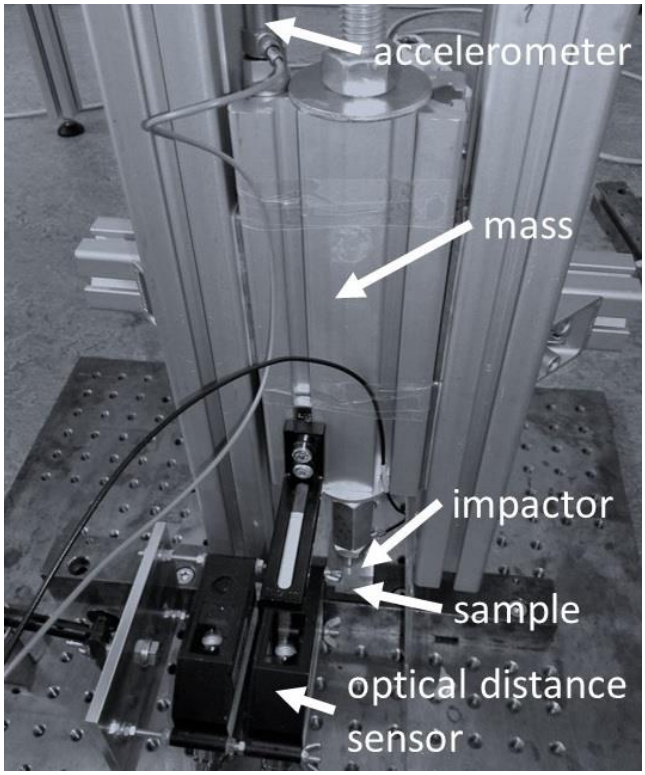


Fig. 2: Measuring apparatus.

**Experimental results**

Fig. 3 shows the maximal values of acceleration during the impact. In the first impact velocity 1 $m \cdot s^{-1}$, the difference in the acceleration between black and gray samples was very small 0.47 g ± 1.34 g (Fig. 3, the bar markers). The differences were increasing with rising impact velocity. At impact speed 2 $m \cdot s^{-1}$, the difference between the black and gray samples was 13.25 g ± 1.39 g (Fig. 3, the circular markers). The maximal difference 28.46 g ± 3.98 g was detected at the impact speed 3 $m \cdot s^{-1}$ (Fig. 3, the square markers). The minimum acceleration 19.45 g was measured on gray sample G1 in first impact at impact speed 1 $m \cdot s^{-1}$. Also, the maximum acceleration 184.7 g was recorded on gray sample G3 during the tenth impact at speed 3 $m \cdot s^{-1}$.

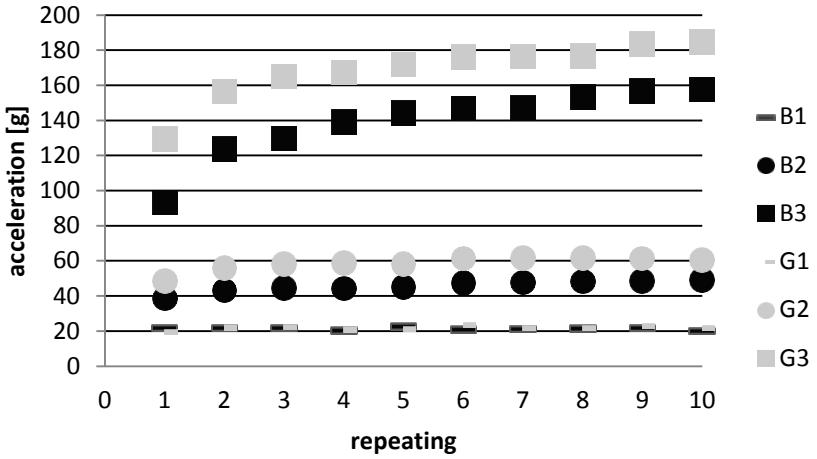


Fig. 3: Results of accelerations from drop tests with different speed of impact.

The maximal values of the compression during the impact was in the Fig. 4 showed. At the first impact velocity 1 $m \cdot s^{-1}$, the difference of the compression between black and gray samples was 0.26 mm ± 0.14 mm (Fig. 4, the bar markers). At impact speed 2 $m \cdot s^{-1}$, the difference between the black and gray samples was 0.79 mm ± 0.11 mm (Fig. 4, the circular markers). The maximal difference 1.63 mm ± 0.51 mm was detected at the impact speed 3 $m \cdot s^{-1}$ (Fig. 4, the square markers). In contrast with accelerations, the minimum compression 1.51 mm was measured on the black sample B1 at impact speed 1 $m \cdot s^{-1}$ in the sixth and the eighth falls. The maximal compression 6.55 mm was measured on the gray sample G3. This value was measured during the fifth drop at impact speed 3 $m \cdot s^{-1}$.

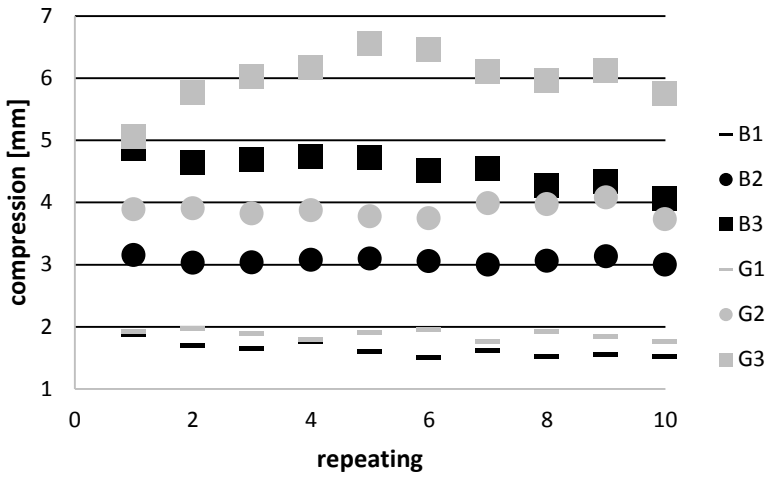


Fig. 4: Results of compression from drop tests with different speed of impact.

## Conclusions

All of experiments showed that protectors were not at first impact destroyed. During slow speed impact were increasing the acceleration and deformation of both samples on minimum. The effect of the increasing acceleration was on the maximum impact speed 3 $m \cdot s^{-1}$ of both samples (B3, G3) measured. Unusual date of the G3 sample was found. This foam sample show significantly increasing acceleration but the deformation during the maximal impact speed 3 $m \cdot s^{-1}$ was decreased.

## Acknowledgment

The research leading to these results has received funding from the People Programme (Marie Curie Actions) of the European Union's Seventh Framework Programme FP7/2007-2013/ under REA grant agreement no 608092. This work was supported by the internal grant project SGS-2016-059 and by the project LO1506 of the Czech Ministry of Education, Youth and Sports under the program NPU I. The authors would like to thank PSí Hubík for providing foam samples.

## References

[1] Information on: http://ec.europa.eu/transport/road_safety/sites/roadsafety/files/pdf/statistics/dacota/bfs2016_motomoped.pdf

[2] Information on: http://ec.europa.eu/transport/road_safety/specialist/statistics_en

[3] L. de Rome, R. Ivers, M. Fitzharris, W. Du, N. Haworth, S. Heritier, D. Richardson, Motorcycle protective clothing: Protection from injury or just the weather?, Accident Analysis and Prevention, Volume 43, Issue 6, Pages 1983-1990, (2011)

[4] Motorcyclists' protective clothing against mechanical impact - Part 1: Motorcyclists' limb joint impact protectors - Requirements and test methods, EN 1621-1

[5] Information on: http://www.motojomax.cz