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Mechanical behaviour of polymeric foams with different Shore A hardness

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1 Introduction

The efforts to replace metals with plastic-like materials can be encountered throughout the industry. Composite materials, for example, are finding great applications, as shown in Chung (2010). Unfortunately, the potential of these plastic-like materials is not fully exploited as their mechanical behaviour needs to be sufficiently described.

Selecting a suitable material and its model may be difficult, but identifying its properties poses a significant problem as well. It is not only the raw material that influences the final behaviour but also its structure. This aspect can be seen in foams, see Salvo et al. (2014).

This paper investigated polymeric foams to determine a material suitable for the impact-absorbing components of personal protective equipment. The compression test and drop test were carried out using a various of polymeric foams with different Shore A hardness.

2 Materials

Polymer foams with different Shore A hardness were chosen for testing, namely 8, 10, 14, 17, and 25. The Shore A hardness given by the manufacturer were verified using a Wolpert Wilson hardness tester, as described in Kaňáková et al. (2020). The measured Shore A hardness values correspond to the values reported by the manufacturers.

3 Experiments

3.1 Compression test

The compression test was carried out with presented foams at 23°C. The cylindrical specimens with a height of 15 mm and a base diameter of 40mm were tested on a ZWICK/ROELL Z050 machine. The specimen was compressed to a compressive strain of 0.8 (see Fig. 1), held for 60s, and then relieved. The strain rate was $0.001 s^{-1}$. The nominal stress versus nominal strain is shown in Fig. 2. The maximum of measured forces for each hardness are shown in Tab. 1.

Figure 1: Foam specimen in maximal compression.

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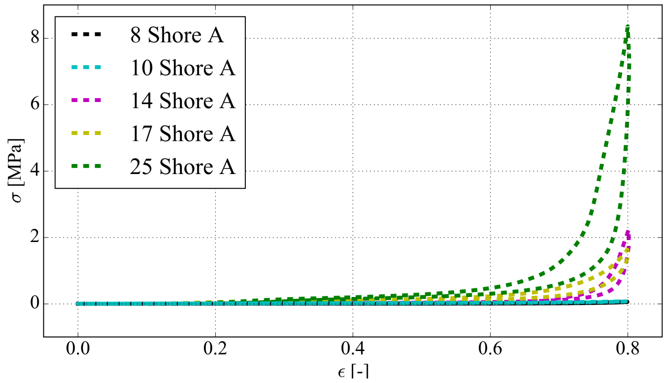

Figure 2: Compression test.

Hardness	Max. force [N]
8 Shore A	77
10 Shore A	95
14 Shore A	2 814
17 Shore A	2 053
25 Shore A	10 499

Table 1: Maximum measured forces.

3.2 Drop test

The drop tests were carried out to evaluate the foams' impact-damping ability. The geometry of the drop tower assembly on which the tests were carried out corresponded to EN 1621-1 standard, which focuses on testing protectors for motorcyclists. Cylindrical foam specimens with a diameter of 55mm and a height of 15mm were placed on a spherical head anvil. A 5kg impactor was used for the test. During the test, the transmitted force was measured with a KISTLER 9351B force cell, and the displacement of the impactor was measured with two Micro-Epsilon optoNCDT 2300-50 lasers.

4 Conclusions

Polymer foams with different Shore A hardness were tested in this work. The foams were subjected to a compression test. Foams with lower Shore A hardness achieved lower stress values. The foams were subjected to drop tests at different heights and temperatures. Of the tests carried out, foams with hardness of 17 and 25 Shore A showed the best potential for use in motorcycle protectors.

The materials will be subjected to further testing. The data obtained will be used to determine the parameters of a material model. In addition, the selected material itself will be used to improve personal protective equipment.

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