ENERGY ABSORPTION IN FRICTION-BASED STAB-PROOF FABRICS AND THE PUNCTURE RESISTANCE OF NANOFIBER MEMBRANE

by

Ping WANG[a,c,d], Zhu-Xin ZHAO[a], Yan ZHANG[a,b,c] *, Fu-Juan LIU[a], and Mei-Qi ZHU[a]

[a] National Engineering Laboratory for Modern Silk, College of Textile and Clothing Engineering, Soochow University, Suzhou, China
[b] Jiangsu Wangong Technology Group Co., Ltd., Suzhou City, Jiangsu Province, China
[c] Nantong Textile & Silk Industrial Technology Research Institute, China
[d] Wujiang Xinfeng Weaving Co., Ltd., China

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Stab performance is one of the most important mechanical characters for textile structure, especially for geo-textiles. This paper gives an energy approach to studying the effect of friction on the stab property of woven fabrics. Both results show that the stab performance enhances when the friction between warp and weft yarns increases. This paper concludes that nanofiber membrane is the best candidate for stab-proof application.

Key words: *friction coefficient, stab performance, woven fabric*

Introduction

Weaved structure with mutually orthogonal sets of warp and weft yarns is the basic property of technical textile materials which have been widely applied in civil engineering, transportation, military equipment, and aerospace engineering. Fabrics will suffer from many destroyers such as sharp gravels, rocks, and stones which may result in stab or puncture damage on the reinforced textiles.

There are a lot of literature sources focusing on the stab or puncture behaviors of textile structures. Decker *et al.* [1-3] reported the stab resistance of shear thickening fluid (STF)-treated kevlar® and nylon fabrics utilizing a drop tower stab test. Koerner *et al.* [4] and Koerner and Koerner [5] investigated the puncture resistances of geo-textiles with different structure parameters. Li *et al.* [6-8] simulated the static and dynamic puncture behaviors of textile structure *via* finite element methods. Some authors applied an ancient Chinese algorithm and finite element method to investigate the stab performance of woven fabrics [9-13].

In present research, the effect of friction coefficient between warp and weft yarns on the stab performance of weaved structure is investigated.

Experiments

The tension behavior of the woven fabric, which was textured with 2/L twill, was firstly tested by MTS 810.23 with tension velocity of 100 mm/min. The load-displacement curve during axial tension is shown in fig. 1. It can be seen from fig. 1 that the tension performance in the warp direction is much higher than that in the weft direction.

* Corresponding author; e-mail: yanzhang86@suda.edu.cn

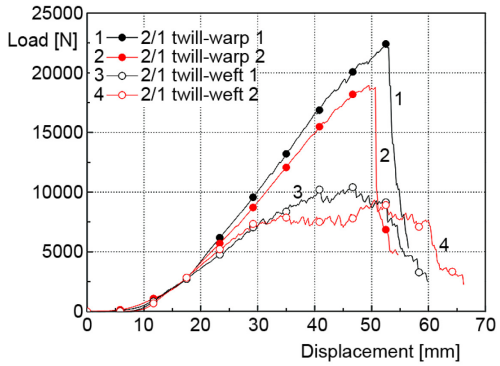

Figure 1. The axial tension load-displacement curve of the woven fabric

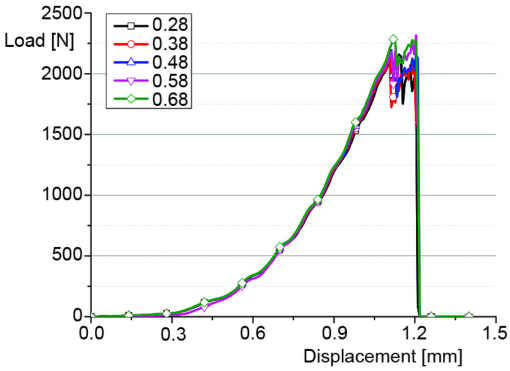

Figure 2. The stab load-displacement curves of woven fabrics with different friction coefficients

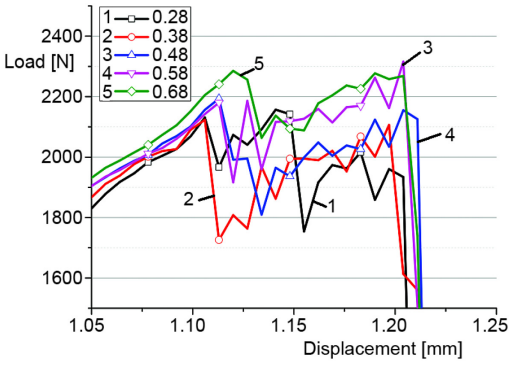

Figure 3. The local magnification of the load--displacement curves of woven fabrics with different friction coefficients

Model and results

How to exactly describe the stab performance keeps an open problem. Previous researches used maximal breaking strength as a main index, however, as illustrated in fig. 1, the maximal breaking strength of the sample weft 1 is higher than that of the sample weft 2, but the stab performance of the sample 2 is better than that of the sample 1. In this paper, we will give an energy approach to describing the stab performance, the more energy is absorbed by the fabric, the better is its stab performance. This energy-based stab performance can be exactly calculated by the area of stab load-displacement curve.

In present research, samples with different friction coefficients between warp and weft yarns are simulated [11], and the results are demonstrated in figs. 2 and 3, and the area of the energy-based stab performance is given in tab. 1.

Table 1. The integral area of load-displacement curves with different friction coefficients

Friction coefficient	Absorbed energy
0.28	791.74
0.38	802.59
0.48	822.83
0.58	817.83
0.68	846.96

It can be seen from the results that the stab strength increases slightly with the increase of the friction coefficient, but the stab performance enhances by the friction, which plays a main role when the fabric tends to be ruptured.

Conclusions

In this paper, the stab performance of woven fabrics with different friction coefficients are simulated, based on the previous research, to analyze the effect of friction coefficient on the stab behavior of textile structure. It shows that the stab strength increases slightly with the increase of the friction coefficient. This

result will benefit for the structure design of textile products. Furthermore, the energy absorption method can also be extended to the analysis of the stab resistance of nanofiber membrane. Due to extreme increase of fiber layers of the nanofiber membrane, the friction among the nanofibers rockets dramatically.

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