BREAKING CHARACTERISTICS OF WARP KNIT NET FABRIC

O. Kyzymchuk and I. Ermolenko

Kyiv National University of Technologies and Design
Nemirovich-Danchenko str. 2, 01011 Kiev, Ukraine
Kyzymchuk_knutd@ukr.net, Kyzymchuk.o@knutd.com.ua

Abstract. *This paper presents results of an investigation of the braking characteristics (maximum load and strain) of warp knitted net fabric with elastomeric yarn longwise inlaying. In order to undertake the study of the influence of fillet interloping repeat and of in-layed yarn positioning different types of net fabric were produced. The array of data for the various design options provide analytical tool for making comparisons about the mechanical properties of the warp knit structures with hexagonal net. It is observed that the repeat of fillet interloping has some effect only on maximum strain of warp knit structure. In other way, the position of in-laying yarn has effect as on maximum strain, as on maximum load of warp knit net fabric. It is a consequence of a different relaxation of elastomeric yarn in the warp knit structure.*
Key words: *Fillet structure, in-laying yarn, maximum load, maximum strain.*

1 INTRODUCTION

The development of the textile industry in the world is going in the direction of use of its products at all fields of technic and medicine. Net production is one of the leading textile manufacturing. The meshes of net structure have different size and shape. The warp knitting with its fillet interlooping is an undisputed leader in technologies that are used for the production of such textile. The major advantages of warp knitting are its versatility and its high production speed.

The holes in fillet knits are usually formed in loop courses with return loops, and for this reason, an incomplete drawing-in of guide bars is necessary to produce the net structures. Symmetrical nets are produced when two identically-threaded guide bars overlap in balanced lapping movements in opposition. The honeycomb is prevalent among the large variety of net shape. The hexagonal cells are produced on warp knit machine by alternating of tricot and chain courses at the repeat (Figure 1). The vertical ribs of cell are formed by tricot loops and diagonal ribs are formed by chain loops [1].

The size and shape of the cell can be changed by the repeat of an interlooping. If the number of tricot courses has been increase, the vertical rib of cell lengthens, so that the cell extends longwise. When chain courses, which extend the diagonal rib, have been used in the repeat, the cell expands [2].

Modifying the cells shape changes significantly the properties of the fabrics. Thus, when an elastomeric yarn has been fed into the knitting zone at the highest possible tension and has been used in the structure as longwise inlayed yarn, vertical ribs of the cell converge after elastomeric yarn relaxation (Figure 2). The result is auxetic material which is expanding under tension [3].

The using sphere of auxetic materials is expanding with each passing year: from medical bandages and filters for blood to the preforms for composites in the automotive and aircraft industry. The main unique property of auxetic material is showing during its stretching. In this regard, the aim of work is to study the breaking characteristics of warp knit net fabric during the elongation in the direction of the elastomeric yarns inlaying.

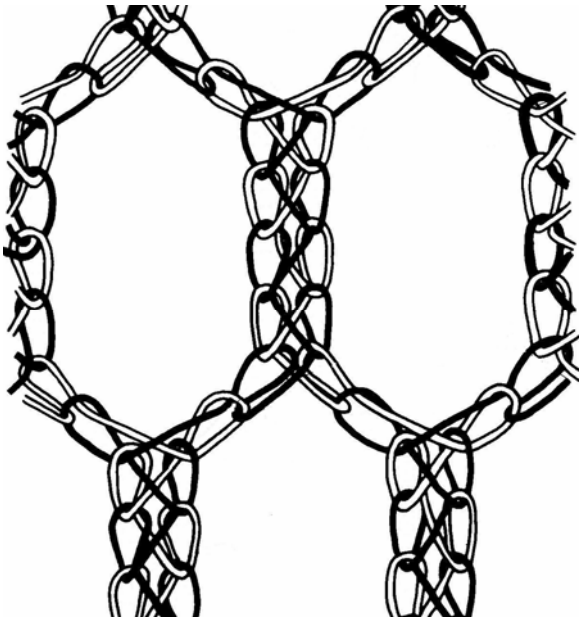

Figure 1 Fillet structure with hexagonal net

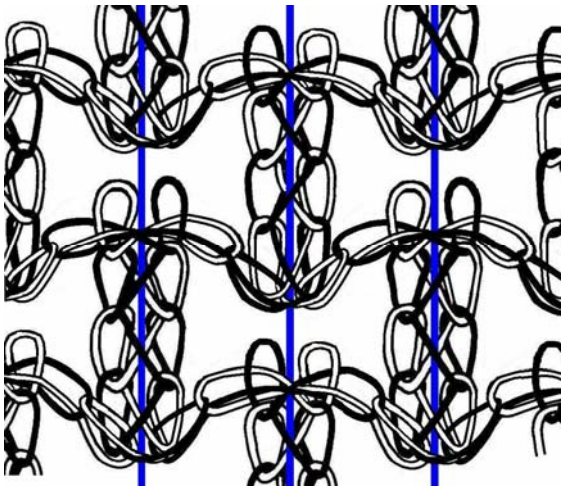

Figure 2 Structure with longwise inlayed elastomeric yarn

2 EXPERIMENTAL SAMPLES

Two-factor experiment according to plan Kono have been planned and implemented in approach to research the breaking characteristics of honeycomb net warp knit fabric. Number of tricot courses n_t (3, 5 and 7) and number of chain courses n_c (0, 1 and 2) in a repeat of fillet interlooping have been selected as an independent factors. In approach to study the effect of the inlay yarn position in the knit structure the eight variants have been selected: the elastomeric yarn is wrapped the junctures of tricot loops of one or two guide bars in one or two courses of repeat or is located between tricot loops without wrapping [4].

The warp knit fabrics were made from 250 denier polyester yarn as ground. The linear density of the polyester yarn is 250 den x 2. It is manufactured by Du Pont and its tenacity is 1.454 gf/den based on a test gauge length of 25.4 cm (10 in), and a crosshead speed of 10.16 cm/min (4 in/min). The 150 denier (96 filaments) polyester sheath serving as the cover yarn for polyurethane core yarn provided a high elastic in-lay component. The yarn is supplied by Unifi Inc. and the linear density of polyurethane core yarn is 70 deniers. Fabrics were made on a 10 gauge warp knitting machine with one needle bed.

3 METHODOLOGY

Experimental studies have been conducted according to GOST 16218.9 on tensile test machine with clamping length 50 ± 1 mm and a constant speed of clamp 150 mm/min. 5 specimens for each fabric variant have been studied, on which base the average value is determined. Coefficient of data's variation does not exceed 5%.

4 RESULTS AND DISCUSSIONS

Research results of breaking characteristics (maximum load and maximum strain) of fillet warp knitted net fabric with elastomeric in-laying yarn are shown in the Table 1.

Table 1 Breaking characteristics of warp knit net fabric

The position of inlayed yarn in fillet warp knit structure		Fabric designation	Maximum load, N	Maximum strain, %
Basic fillet structure		B	L_{max}=157.1±4.8	S_{max}= 75.7-2.9n_t
In-laying yarn turns from the back to the front side	at one course of repeat	T1	L_{max} =125.0±10.3	S_{max} = 181.1+20.0n_c
	at two courses of repeat	T2	L_{max} =110.3±6.8	S_{max} = 145.8+20.4n_c
In-laying yarn is between the tricot's junctures	at one course of repeat	L1	L_{max} =133.9±5.8	S_{max} = 211.5+15.6n_c
	at two courses of repeat	L2	L_{max} =132.4±7.1	S_{max} = 154.8+7.2n_T+14.9n_c
In-laying yarn wraps one tricot's juncture	at one course of repeat	W1-1	L_{max} =135.6±6.8	S_{max} = 235.0+13.2n_c
	at two courses of repeat	W1-2	L_{max} =135.6±7.8	S_{max} = 154.8+15.1n_T+55.0n_c-7.5$n_t n_c$
In-laying yarn wraps two tricot's junctures	at one course of repeat	W2-1	L_{max} =134.0±12.6	S_{max} = 116.8+15.0n_t+58.2n_c-7.4$n_t n_c$
	at two courses of repeat	W2-2	L_{max} =136.4±7.6	S_{max} = 134.9+16.4n_t+18.8n_c

It is observed that the maximum tensile load does not depend on the repeat of fillet interlooping. The introduction of elastomeric yarn into warp knit structure reduces the value by 15 ÷ 25% depending on the variant of the inlaying. This indicates that the tensile load of net fabric is a function of strength of elastomeric yarn.

It should be noted that net fabric, in which an elastomeric yarn turns from the front to the back side (T1, T2), has decreasing of load at break on 8 ÷ 18% as compared with other elastomeric yarn positions. At such variants value decreases with increasing number of inlay transitions from the front to the back side. It can be attributed to the increasing of friction between the ground and the inlaying yarns.

Maximum strain at break of basic fillet fabric with hexagonal cell (B) has back proportion to the number of tricot courses at a repeat of fillet interlooping, which can be explained by the increase of lengths of vertical ribs which orient at the direction of stretching.

The inlaying of elastomeric yarns leads to 2-3 times increase of strain value, which is associated with the properties of the elastomer. The highest value at break has been indicated at warp knit net fabric, in which structure the elastomeric yarn wraps tricot junctures from one guide bar only (W1-1, W1-2). The value decline is at variants of warp knit, in which an elastomeric yarn turns from the front to the back side (T1, T2). This is due to the degree of elastomer's relaxation in fabric's structure primarily.

It is observed, the maximum strain at break is directly proportional to the number of chain courses at the repeat of the fillet interlooping (Figure 3). It is associated with the length of the diagonal ribs of cell and with them re-orientation during pulling. It should be noted effect of the tricot courses at the repeat on the maximum strain at some variants (L2, W1-2, W2-1, W2-2) of net fabric (Figure 4). Tricot loops form vertical ribs of cells and they bend in the structure of these variants of net fabric [5]. Such turn is a consequence of the complete relaxation of the elastomer in knit structure.

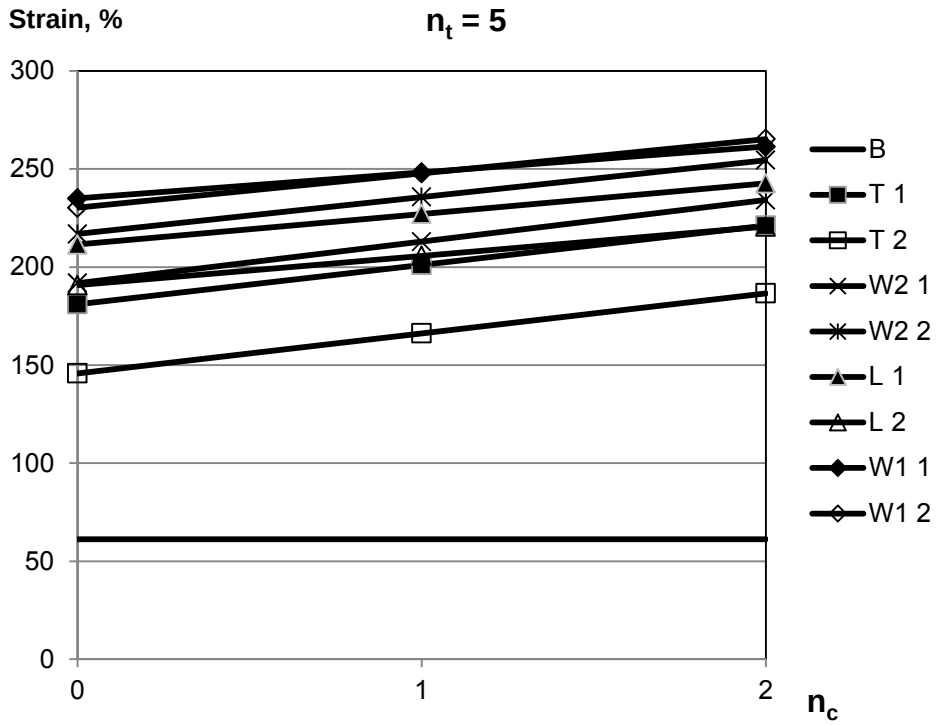

Figure 3 Dependences of maximum strain of warp knit net fabric on number of chain courses at repeat

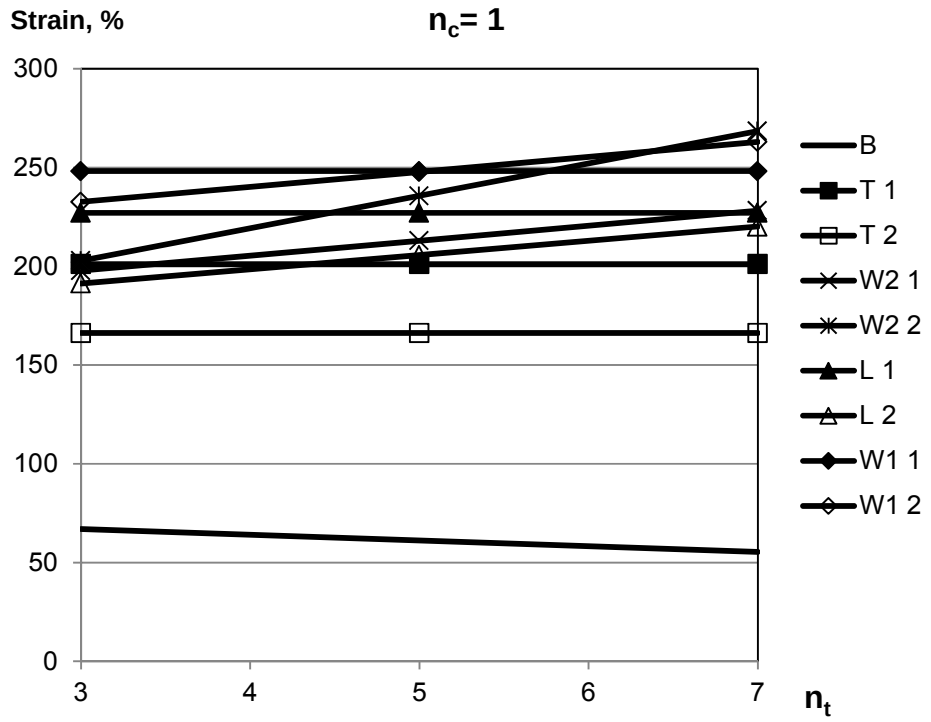

Figure 4 Dependences of maximum strain of warp knit net fabric on number of tricot courses at repeat

5 CONCLUSION

Researches of the break characteristics of warp knit net fabric indicate, that:

- the maximum tensile load does not depend on the repeat of fillet interlooping and it is function of elastomeric yarn, which is use as longwise inlay in warp knit structure;
- the maximum strain depends as on repeat of fillet interlooping as on the degree of elastomer's relaxation in the net fabric's structure.

Thus, the different positions of the inlaid yarn within the structures and the different number of tricot and chain courses on repeat of fillet interloping offer other possibilities that could be explored when designing warp knit net structures.

6 REFERENCES

1. Ermolenko I.V., Kyzymchuk O.P.: The creation of hexagonal cells in fillet knitted fabric, [In Ukrainian], Bulletin of Kyiv National University of Technologies and Design, №.1, 2011, 97-100
2. Kyzymchuk O.P.: Structure parameters of the filets knitted fabric, [In Ukrainian], Bulletin of the Kiev National University of Technologies and Design, №3, 2008, 58-62
3. Ugbolue S.C., Kim Y.K., Warner S.B., Fan Q., Yang Ch.L., Kyzymchuk O., Feng Y.: The formation and performance of auxetic textiles. Part I: Theoretical and technical considerations, Journal of the Textile Institute, 1754-2340, Volume 101, Issue 7, 2010, 660-667
4. Kyzymchuk O., Ugbolue S.C.: The effect of positioning of inlaid yarns in fillet warp knit structures, In:.46th International Federation of Knitting Technologists Congress (IFKT-2012) 6-8 May 2012, Sinaia, Romania, Symposium procee-dings, 764-769
5. Kyzymchuk O.P. Savchenko V.: Cells' size soft recombined warp knitted fabric depend on the inlay model, [In Ukrainian], Bulletin of the Kiev National University of Technologies and Design, №1, 2010, 106-111