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MANUFACTURING OF TUBULAR LENO FABRICS BY MODIFIED STANDARD SAMPLING LOOM

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Abstract: *Leno fabric pattern was first developed at the beginning of the 1900's. Leno weaving structures, which are net-like porous, also called gauze, cross or doup weave. There are several types of leno fabrics which included plain and fancy lenos. Although, plain leno-weave structures is used mainly to make selvedge in the industrial weaving machineries, the fancy leno-weave fabrics are used for home, industrial, agricultural, medical and geo textiles and civil engineering applications, as well. Leno structures is woven by special manufactured leno weaving to exemplify circular leno looms. In order to produce leno fabrics are used leno heddle types. Essentially, lenos fabric is formed that one warp yarn is raised and passed over from one side of adjacent warp yarn. When the two adjacent warp yarns is twisted, weft yarn is inserted them, as well. Because of porous and entangled structures, they are lighter but stronger than plain structures. In this study, Firstly, we have woven tube-like leno structure by modifying Automatic Sampling Loom. Secondly, it was woven double layered tubular leno fabrics from different types of yarns by modifying standard automatic sampling loom and measured the mechanical properties of resultant. In the last part of study, to investigate surface characteristic feature more closely, we used a stereo microscope.*

Key words: *Leno weaving, loom modification, Mechanical properties*

1. INTRODUCTION

The leno weave, which is also called gauze weave, cross or doup weave is a weave in which two warp yarns cross over each other and interlace with one weft yarn. To produce leno weave special leno heddles are used. The leno heddle picks up or down the pairs of warp yarns [1], [3], [6]. When the parallel two warps are intercrossed by leno heddle on the frame, weft yarn is inserted. The warp yarns thereby firmly hold the weft yarn and prevent the movement of it [2], [5].

The most prominent feature of leno structure is the formation of porous net-like structures. These open structures are extremely stable, strong and have sufficient strength [4], [5]. The weight of the fabric produced with gauze weave is very light because of mesh structure.

Beside of plain leno weaving, it is also possible to weave fancy leno fabrics by various combinations of crossed yarns (Fig.1). While plain leno-weave structures is used mainly to make selvedge in the industrial weaving machineries, the fancy leno-weave fabrics and some plain leno weave fabrics are used for home, industrial, agricultural, medical and geo textiles and civil engineering applications [2], [3].

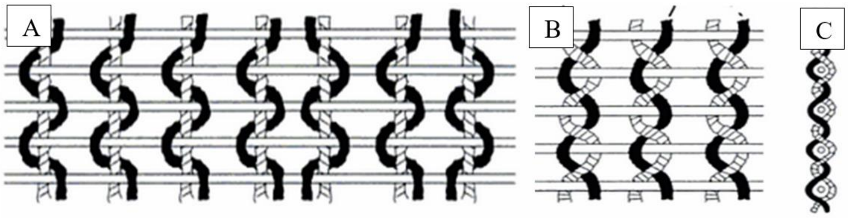

Fig.1: *Plain leno weaving structures: warp yarns white barred: stationary black: crossed, Plain white: weft [1], [3] A: one-twist two gauze B: two-weft gauze C: Crosscut view of leno fabrics.*

The aim of the study is to weave double layer tube-like leno fabrics from three different types of yarns by modifying standard automatic sampling loom (CCI) for leno weaving and to measure the mechanical properties of resultant fabric.

2. EXPERIMENTAL

2.1 Material

The standard sampling loom was used to produce fabrics. In order to produce leno structure LENO Device 330 type Leno heddles were placed on harnesses. As weft and warp yarns for leno weaving, one of the following yarns were used: 200 denier polyester filament yarn (IPET200), 200 denier Vectran staple yarn (VECT200) and 1000 denier high tenacity polyester yarn (HTPET1000) were used. Resultant tubular leno fabrics were subjected to tensile test by Zwick/Roel Z010. The surface morphology of fabrics was investigated by stereo microscope (Olympus SZ).

2.2 Method

2.2.1 Modification of Standard Sampling Loom

In order to produce leno woven fabric, heddle wires of CCI Standard Sampling loom were replaced by LENO Device 330 type Leno heddles and warp yarns were pulled through the heddles (Fig.2A). These two adjacent warp yarns were passed through from each leno heddle's in/out eyes. During leno woven fabric formation, two warps that were placed parallel were twisted by Leno heddle and crossed over each other and then weft insertion was performed to entangle warp yarns. At the same time, one group warp yarns were let off to pass over excessively because yarns of outside of leno heddle were uphold as for that inside of heddle. After changing of frames, holding up warp yarns drops respect to other warp yarn group. This caused tension differences between upper and lower warp (inside and outside) yarn group. Warp yarn tension control mechanism on standard sampling loom for leno selvedge of fabrics, was limited and not sufficient to weave fully leno fabric. Therefore, to create necessary tension during weaving, weights and tension bar were used for each warp yarn (Fig.2B).

In addition, leno structure is generally used for formation of selvedge of woven fabrics and leno warp yarns are supplied from spools under tension control. For production of leno selvedge of standard fabrics, limited number of yarns, which are winded from warp creel (Fig. 2D). However, the loom needs to let off tension controlled warp yarns from bobbins to produce leno weaving fabric. Therefore, the loom was integrated with back separation reed and warping creel (Fig. 2E) that have under tension control to prevent excessive winding problem. The aim of the using two different separation reed between the loom and creel was to prevent yarns from becoming tangled with each other.

2.2.2 Production of tubular Leno woven fabric

A leno heddle type 330 was mounted two sequential frames of the loom. Two frame was used to reinforce selvedge of the pattern for tubular fabric and remaining 16 frames were used to weave the main pattern. Tubular leno fabric, which was formed double layer woven structure, was produced from 32 warp yarns. The draft plan is given in (Fig. 3).

As a part of this study, weave main pattern for leno double layered structure was developed. There are two different warp yarn groups which are called lower and upper warp groups to produce double layers fabrics. The pattern shows that warp and weft directions are columns (bottom to top) and rows (left to right), respectively. In addition tubular leno fabric pattern includes different symbols.

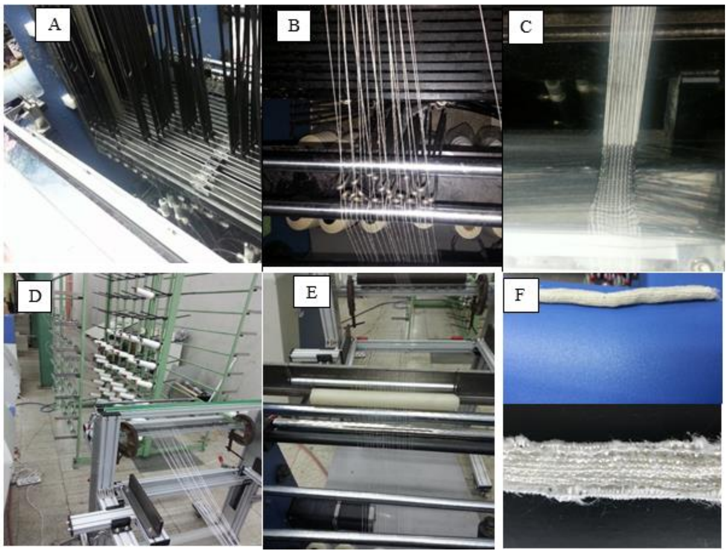

Fig. 2: *Sampling woven loom modifications A: Leno heddles and order, B: weights for tension control, C: Double layer tubular leno fabric on loom D: Creel and parallel feeding warp yarns, E: Separation and orientation reed, F: Tubular leno fabrics.*

8				O		O		O		O		O		O		
7				X		X		X		X		X		X		
6			O		O		O		O		O		O			
5			X		X		X		X		X		X			
4		O													O	
3		X													X	
2	O															O
1	X															X
	1	3	5	7	9	11	13	15	17	19	21	23	25	27	29	31
	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32

Fig. 3: *In order to woven double layer tubular leno fabric, draft plan. X and O: yarns inserted into inside or outside heddle eyes, respectively.*

In pattern, the latter "A" (above) and "B" (below) indicates that warp yarns are woven in the upper or lower warp groups, respectively (Fig. 4).The latter of "X" means that warp yarns including upper groups are replaced with lower warp groups and the latter of "O" indicates reverse motion of "X" with regards to border of pattern (Fig. 4).

To produce Leno tubular fabric with VECT200 yarn, yarns were twisted two ply yarns with a 300 twist per meter in the Z direction, IPET200 and HTPET1000. The Leno tubular fabrics with weft densities of 40, 50 and 60 weft/cm were produced on modified loom (Fig. 2C). In order to reduce yarn-to-yarn friction force which decrease tensile strength of warp yarns, they were coated by paraffin bars (Fig.2E).

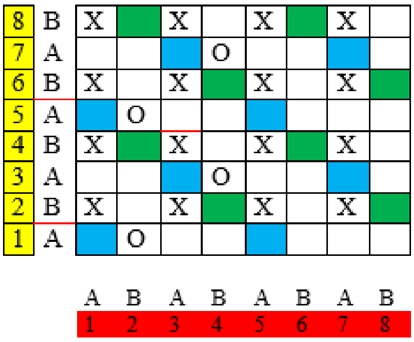

Fig. 4: *In order to woven leno tubular fabric, pattern repeat; A: Above, upper group yarns B: Below, lower group yarns*

2.2.3 Tensile properties Measurement of Tubular Leno Fabrics

The tube-like leno double layer fabrics (Fig. 2F) were conditioned in a standard atmosphere (TS EN ISO 139) for at least 24 hours before tensile test. Tensile test was performed until breaking by using a constant speed gradient dynamometer at the speed of 10 mm/min without pre-load and test sample length was 40 mm. It was used 2500 gram-force load cell and tenacity, breaking elongation and stiffness values were recorded.

2. RESULTS AND DISCUSSION

The breaking load values of the tubular leno fabrics that woven from three different yarn types were measured and compared. The results are given in Fig. 5. The fabric made from HTPET1000 yarns had the highest breaking load. It was also found that weaving density (40, 50 and 60 weft/cm respectively) affected breaking load. In case of HTPET1000 yarn, as the fabric density was increased, breaking load of the fabric was decreased. However, leno fabric made from VECT200 high tenacity yarn showed an opposite trend. On the other hand, the breaking load of fabrics made from IPET200 yarns were not affected from the weaving density.

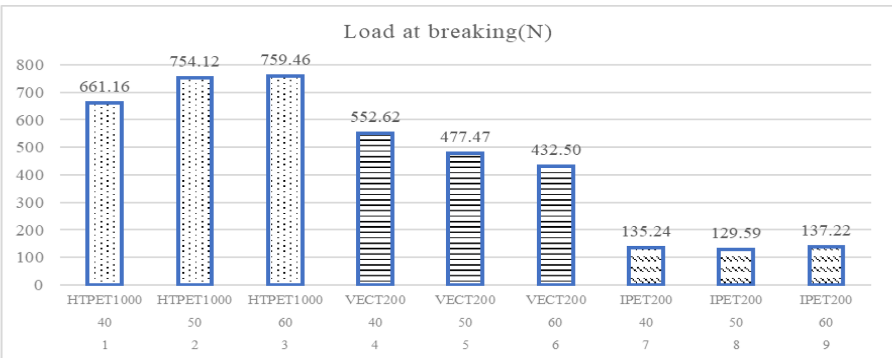

Fig. 5: *Breaking strength of several leno tubular fabrics*

It is seen from the Fig.6 that fabrics made from VECT200 yarns showed the least strain percentage. This could be attributed to high molecular orientations of vectran fibres. Weaving density was inversely proportional to the strain percentage (Fig. 6). Because, during tensile test, the force is applied leno structure longitudinally, twisted warp yarns start to squeeze weft yarns and causes to cut them easily. Therefore, leno fabric number 6 had a breaking strength less than leno fabrics number 4 and 5. It is likely that polyester leno structures were more flexible than vectran ones.

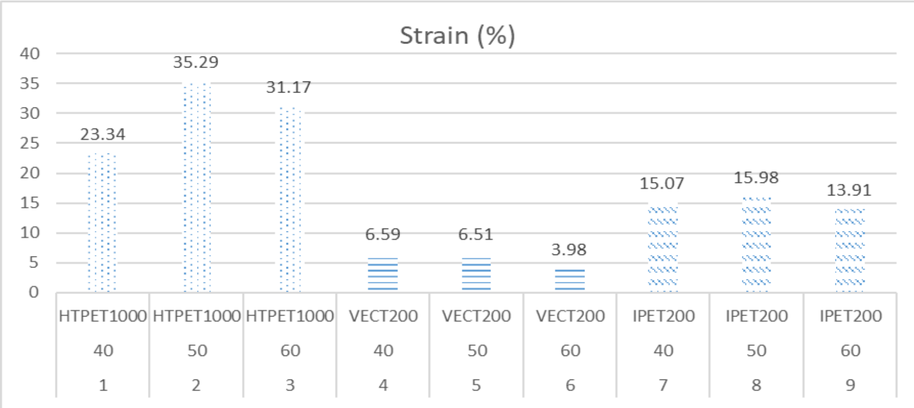

Fig. 6: *Elongation at break percentages of produced tubular leno fabrics*

One of the most important factor for leno fabric mechanical properties was stiffness. It demonstrated that stiffness of fabrics aren't only depended on material type but also fabric density (Fig. 7). Stiffness of number 4, 5 and 6 leno fabrics were extremely high. It means that breaking strength of vectran fabrics were the best against abrupt loads.

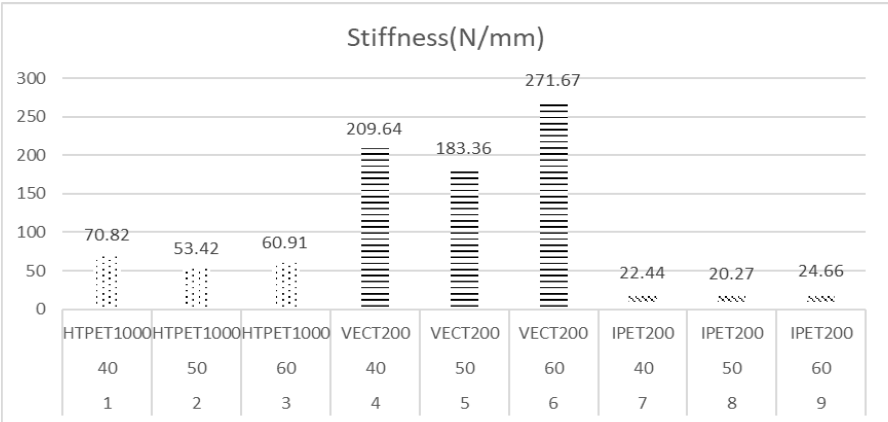

Fig. 7: *Stiffness of leno fabrics*

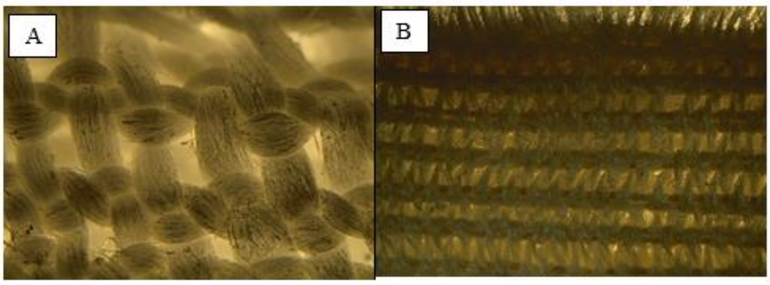

Fig. 8: *Longitudinal surface view of Leno fabrics; A: HTPET1000 B: VECT200.*

Finally, in order to investigate leno fabric surface morphology, it was taken longitudinal images by stereo microscope. Magnification rate was calculated as 10 times. It was seen that if thick count yarns are used to woven leno fabric, they are more porous structure. Using fine yarns has caused the leno fabric surface to be smoother (Fig.8).

3. CONCLUSIONS

Aim of this research was to woven tube-like leno structures from three different type yarns properly by modifying Automatic Sampling Loom and to compare the mechanical properties of these fabrics. Tensile test results show that although leno fabrics consisted of 32 warp yarns and 6-8 mm in diameter, they were durable substantially. It was seen clearly that surface pattern of fabrics are smooth and highly porous. Therefore, it is thought that in the further studies, leno could be used for medical textile for instance, especially artificial ligament or blood vessel implants.

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