The Effect of Weaving Machine Characteristics on the Mechanical Properties of PET Fabrics

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1. Introduction

Modern Rapier weaving machines are being run in mills at constantly higher speeds with the aim of increasing fabric productivity. High speed weaving machine leads to a higher number of stops occurring per unit of time. End breaks, whether in the warp or the weft, can result in wage costs and a reduction in efficiency of weaving, and can negatively affect the quality of the woven fabric. But the unequal distribution of the warp end tension over the warp width was paid little attention in the past. In many respects, it has, though, a negative effect. So in this paper, the factors which affect to fabric weavability such as range of heald motion, warp and weft tension, warp and weft stop, amount of shed, fabrics weavability, machines efficiency are investigated. And also this paper surveys the relationship between the mechanical characteristics of the loom and the mechanical properties of the fabrics.

2. Experiment

Used loom setting is shown in Table 1. Loom characteristics for specimens are shown in Table 2.

Table 1. Specification of weaving conditions

Fiber Composition		Yarn Count	Fabric Structure	Density/inch		Remark
				Grey	Finished	
Warp	Polyester 100 %	75D / 36F	5 Harness	168	261	42D ×4 =168本/in Pick : 86本/in
Weft	Polyester 93.5 % Polyurethane 6.5 %	100D/192F + 30D span covering		86	98	

Table 2. The characteristics of loom used for the test

Division \ Loom	OMEGA	PICANOL-GTX
Maximum RPM	520	580
Maximum Reed Width	2100 (mm)	1900 (mm)
Harness Motion	Electronic Dobby	Electronic Dobby
Let off Motion	Electronic Let Off	Electronic Let Off
Microprocessor	Pick Find Motion Let Off Motion	Pick Find Motion Let Off Motion

2.1 Measurement of Weaving Tension

Weaving tensions were measured using Defat[1] yarn tension meter (sample rate : 0.125kHz, Test time : 60sec). measured position was between tension roller and drop wire on the loom. Various yarn tensions on the each heald frame from 1st to 10th were measured at the vicinity of the center of loom.

2.2 Measurement of Weaving Efficiency

The weaving efficiency in two loom were measured by number of end breaks both warp and weft per 606,500 picks. For accurate measurement to weaving efficiency it measured 12 hours later from original condition of weaving machine. Checking method of weaving efficiency is shown in Table 3.

Table 3. Checking method of weaving efficiency

Loom	Checking appliance	Check Time	Efficiency check time	Stop Number of Loom	Remark
OMEGA-E4X	Automatic	24 H	24 H	606,500 Pick	75D × 100D
PICANOL-GTX		24 H	24 H		

2.3 Finishing Process

Gray fabrics were processed on the same finishing processes. and it cuts 0.5 yard after each process passing through. Finishing processes and production conditions are shown in Table 4.

Table 4. Finishing process and conditions

Process	Conditions
Cylinder Dryer	Same as conventional method
Scouring	Start : 35℃ / temp. 65 - 95 - 60℃
Pre-setting	210 ℃ × 30mm
Dyeing	130 ℃×40min Camal, dispersion agent 750g Acid 400g
Final set	220℃ × 30mm

2.4 Measurement of warp movement

The warp movement is calculated by the difference between the amount of upper shedding and lower shedding.

2.5 Measurement of fabric mechanical property

The measurement was done by the KES-FB system which can measure a general standard of properties such as tensile, bending, shear, compression and surface.

The KES-FB system itself will not be mentioned in this paper, for it is described in the thesis listed in the reference(2).

3. Result and Discussion

3.1 Relationship between warp and weft tensions and weaving machine movement

3.1.1 Weaving Efficiency

Table 5 shows mean value of efficiency and stop number of the test looms

Table 5. Mean value of efficiency and stop number of the test looms

(each 5 weaving loom, ■ tested loom)

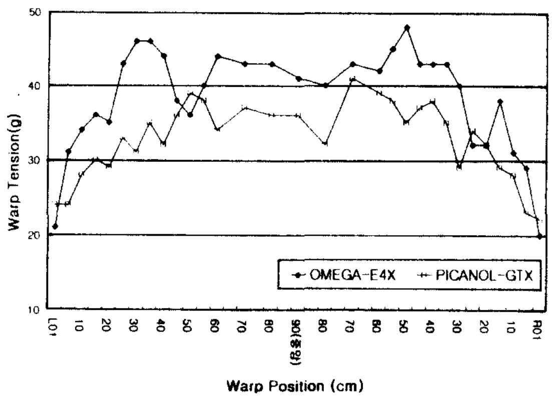
Loom \ Division	RPM	EFF(%)	Stop Number of Loom				Stop (%)		Remark
			Warp	Weft	Other	Total	Warp	Weft	
OMEGA	**470**	**95.62**	**2.8**	**2.8**	**2.8**	**8.4**	**33.3**	**33.3**	WP: 75D
	465	73.74	39	4	27	70	55.7	5.7	
	461	98.57	0	0	2	2	0	0	
	465	97.18	3	0	3	6	50.0	0	
	461	85.26	0	24	14	38	0	63.2	
Mean	**464.4**	**92.07**	**8.8**	**6**	**9.6**	**24.4**	**36.1**	**24.6**	
PICANOL-GTX	**472**	**96.85**	**9.7**	**2.8**	-	**12.5**	**77.6**	**22.4**	WP: 75D
	466	95.85	3	6	1	10	30.0	60.0	
	470	94.62	3	2	1	6	50.0	33.3	
	469	89.44	2	22	2	26	7.7	84.6	
	461	83.64	2	33	1	36	5.6	91.7	
Mean	**467.6**	**92.08**	**3.4**	**13**	**1**	**17.4**	**19.5**	**74.7**	

It is very important that the stops due to breaks in the warp and weft are directly correlated to the quality of the yarn[(3)~(6)]. As shown in table 5, the Picanol loom efficiency is nearly the same as the Omega loom. On the other hand, short stop number of Picanol loom is higher than Omega loom's. In case of Omega loom, short stop numbers were responsible for 4.38% loss in efficiency and that 33.3% of this efficiency loss was the result of warp stops. weft stops, on the other hand, were responsible for 33.3% loss in efficiency and 33.3% loss which was the result of weaving machine itself or the other reason. It is supposed that this result caused by excessive tension is induced on the yarn by the weaving process or yarn in adequate stress capacity to resist this stress.

3.1.2 Distribution of the Warp Tension

Fig.1 shows distribution of the warp tension over the warp width and Fig.2 shows relationship between warp tension and heald motion of the test looms.

As shown in Fig.1 higher tension is measured in the ends on the middle of the warp than those at the sides. This tension variation will be caused to color and weight difference between right and left sides of fabric. These tension variations may be originated from warping tension variation, condition of weaving machine such as method of shed motion, positive or negative let-off, take-up motion, plain, twill and stain woven structure. From Fig.2 it can be seen that warp tension and heald motion of the test looms are different.



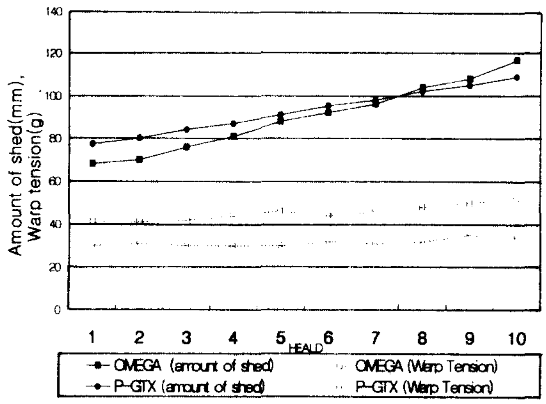


Fig.1 Warp tension according to the warp position

Fig.2 Warp tension and heald motion of the test looms

In order to achieve a clean shed, the warp end tension should rise slightly from first to the last harness frame. As shown in fig.2, the difference of heald motion of Omega loom is higher than Picanol loom's, also warp end tension is 8~10gf high.

3.2 Fabric shrinkage in the dyeing & finishing process

Fig.3 and 4 show the differences between warp and weft density on the fabrics which processed in dyeing and finishing. And also it explains the relation between shrinkage of fabrics after weaving process on the test looms and weaving machine effect.

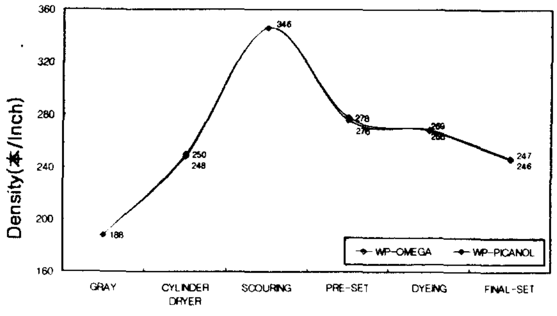


Fig. 3 Density(Warp) of fabrics

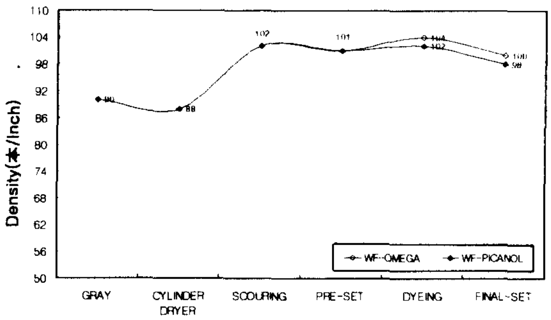
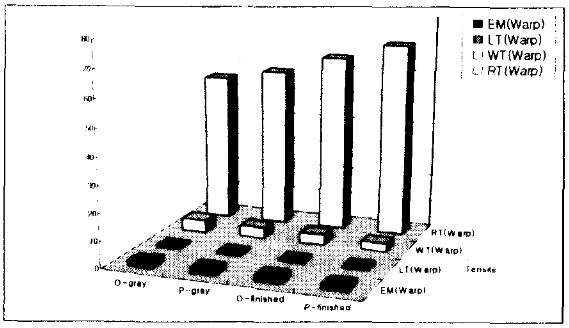


Fig. 4 Density(Weft) of fabrics

As shown in Fig.3 and 4, warp and weft densities of the fabrics on passing the process were almost same. But on passing the process shrinkage was different. In processing condition of dyeing and finishing, it's difficult to find how weaving condition is affected by fabric on the dyeing and finishing process. But the percentage of shrinkage will be affected by the tension, potential stress and frictional force in the weaving process.

3.3 Relationship between mechanical properties and weaving machine movement



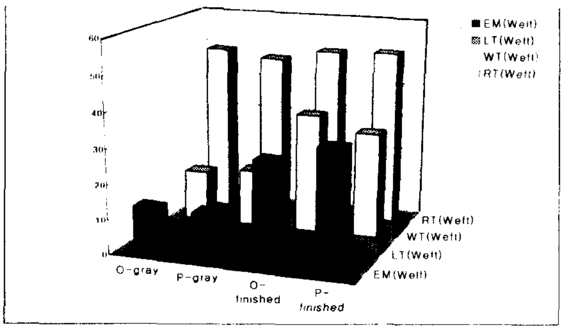


Fig.5 Tensile properties of finished fabrics on the warp direction

Fig.6 Tensile properties of finished fabrics on the weft direction

Fig.5 and 6 show tensile properties of gray and finished fabrics on the warp and weft directions. As shown in Fig.5, warp extensibility of finished fabrics woven by Omega loom shows high value, then these looms show high warp tension. especially the values at center are high both of looms. Generally fabrics mechanical hysteresis are affected by warp and weft friction and cohesion. So warp yarn tensile resilience woven by Picanol loom has higher value than Omega loom's which is caused by relatively lower tension and low value of shed amount.

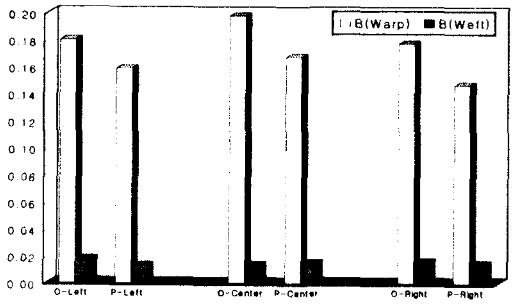


Fig.7 Bending rigidity of the finished fabrics

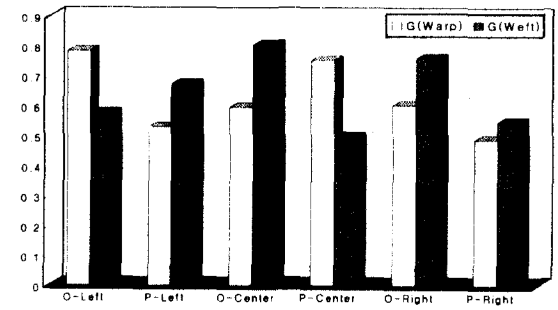


Fig.8 Shear stiffness of the finished fabrics

Fig.7 shows bending rigidity of finished fabrics. Bending rigidity of finished fabrics woven by Omega loom, which was shown high warp tension as shown in fig.1, shows high values comparing with Picanol loom. The variation of bending rigidity among right, center and left sides on the fabrics woven by Omega loom was shown high value on the center because in weaving process the weft is woven in a little less formly in the middle as at the selvedges. This phenomena illustrates, in respect of the warp ends, that they must bind more firmly at the center than at the edges. Fig.8 shows the shear stiffness of the finished fabrics. Although Omega warp tension is higher than Picanol loom as shown in Fig.1, weft tension, on the other hand, shows opposite tendency[7]. As a result of distribution of tension, warp shear stiffness in the middle of fabric woven in Omega shows low value.

4. Conclusions

The results of the investigation are explained as belows.

1. Picanol loom efficiency is nearly the same as the Omega loom. On the other hand, stop number of Picanol loom is higher than Omega loom's. In case of Omega loom's stop numbers were responsible for 4.38% loss in efficiency and that 33.3% of this efficiency loss was the result of warp stops. weft stops, on the other hand, were responsible for 33.3% loss in efficiency and 33.3% loss which was the result of

weaving machine itself or the other reason. It is supposed that this result caused by excessive tension is induced on the yarn by the weaving process or yarn in adequate stress capacity to resist this stress.

2. The distribution of the warp end tension over the warp width is not uniform. In the middle of the warp the tension is distinctly higher than at the edges. and comparing with distribution of left and right edges, it is shown that right edge is slightly higher than left one.
3. Warp extensibility of finished fabrics which woven by Omega loom shows high value, then these looms show high warp tension. especially the values at center are high both of looms.
4. The variation of bending rigidity among right, center and left sides on the fabrics woven by Omega loom was shown high value on the center because in weaving process the weft is woven in a little less formly in the middle as at the selvedges. This phenomena illustrates, in respect of the warp ends, that they must bind more firmly in the center than at the edges.

Reference

1) Helmut Weisdorfer, Jorgen Woolfrum, Ulrich Stark, The Distribution of the warp End Tension over the Warp width and How it is influenced by the weaving machine settings, Melliland, 11, 1991.
2) Sueo Kawabada, "The standardization and analysis of hand evaluation", 1980
3) Y.Huh, 'A Study on the Tension Variation of Warp Yarn Group as a Process Parameter in Accordance with the Initial Loading', .Korean Fiber Soc., v27, 49~55(1990).
4) S.J.Kim and G.D.Yeo, "Fabric weavability and machine efficiency in the various weaving machines such as projectile, rapiers and air-jet, CITC, Brazil, 1999
5) H. Weinsdorfer, A. Lange, U. Scholze, Weft Thread Tensions on a Rapier Weaving Machine, Melliland, 7, 1990.
6) Y.Huh, S.T.Lee, W.Y.Ryu, J.L.Woo, 'Effect of Starting up Condition on the Product Quality in the Weaving Process', J.Korean Fiber Soc., v31, 111~118 (1994).
7) S.J.Kim, G.D.Yeo, J.Y.Jo, J.H.Son, G.H.Jaon, Korean Fiber Soc. proceeding, 152~156 (1999)