감성과학, Vol. 9, No. 3, pp. 243-249. September 2006

A Study on the Synthetic Fabric Design System

합섬직물 설계디자인 시스템에 관한 연구

Seung-Jin Kim*†

김승진*†

School of Textiles, Yeungnam University*
영남대학교 섬유패션학부

Abstract : There are many CAD commercial systems such as fabric design CAD for fabric designers and pattern design CAD including visual wearing system for garment designers. But there is no fabric design system for weaving factory, so the data base system related to the fabric design for weaving factory is needed. Therefore, in this study, as a preliminary study of the data base system for fabric design, easy decision of warp and weft densities according to the various yarn count, weave constructions and materials were surveyed through analysis of design plan for nylon and polyester fabrics from weaving factories
Key words : CAD system, data base, warp and weft density, weave construction, design plan

요약 : 최근 직물 디자이너를 위한 직물 디자인 CAD, 의류 디자이너를 위한 패턴 디자인 CAD와 같은 상업화된 많은 CAD 시스템이 운영되고 있다. 그러나 소재를 제직하는 직물 제직 공장에서 적용할 수 있는 직물 설계디자인 시스템은 아직까지 운영되고 있지 않다. 그래서 본 연구에서는 직물설계에 관한 데이터 베이스 시스템의 초기 연구로서 여러 가지 실의 변수, 직물조직, 원료소재에 따른 직물의 경사와 위사 밀도를 쉽게 결정할 수 있는 직물 디자인 시스템에 관한 연구를 직물공장에서 사용하고 있는 나일론과 폴리에스테르 등의 합섬직물 설계서를 분석하여 수행하고자 한다.
주제어 : 캐드시스템, 데이터 베이스, 경사・위사밀도, 직물조직, 설계서

1. Introduction

There are many CAD commercial systems such as fabric design CAD for fabric designers and pattern design CAD including visual wearing system for garment designers.[4-5] But there is no fabric design system for weaving factories, so the data base system related to the fabric design for weaving factories is needed. Many Korean fabric weaving manufacturers have some issue points

† 교신저자 : 김승진(영남대학교 섬유패션학부)
E-mail : sjkim@ynu.ac.kr
TEL : 053-810-2771
FAX : 053-812-5702

about fabric design of synthetic fabrics such as nylon and polyester. The 1st issue point is that they don't know that how they make fabric design according to various textile materials such as new synthetic fibers, composite yarns, and crossed woven fabrics[1]. And as the 2nd issue point, they also don't know what the difference of fabric design is such as fabric densities on warp and weft directions according to the weaving looms such as WJL, RPL, AJL and domestic and foreign looms[2]. And as the 3rd issue point, there is no data about how the difference of fabric design is among weaving factories even though they have same looms and they use same materials.[3] Therefore, in this study, a data base system which can easily decide warp and weft fabric densities according to the various yarn counts, weave construction and materials is surveyed by an analysis of design plan for Nylon and PET fabrics. Furthermore, the preliminary research for easy deciding of fabric design from new materials and for making data base related to this fabric design is carried out as an objectives of this study.

2. Research Methods

2.1 Theoretical background

Basilio Bona[1] in Italy proposed an empirical eq.(1) for deciding the fabric density on the worsted fabrics.

$$D = K \times \sqrt{Nm} \times C \tag{1}$$

where, D : fabric density

K : density coefficient

Nm : metric yarn count

C : weave coefficient

But, in synthetic filament yarn fabrics such as nylon and polyester, more effective parameter is needed. So, weave density coefficient, WC is made by eq.(2).

$$WC = \left[\frac{d_w + d_f}{25.4}\right]^2 \times D_w \times D_f \times WF \tag{2}$$

where, d : yarn diameter (mm) d_w for warp, d_f for weft

D_w : warp density of fabrics

D_f : weft density of fabrics

WF : weave factor

$$= \left(\frac{R + C_r}{2R}\right)^2$$

R : No. of yarn in 1 repeat weave pattern

Cr : No. of interlacing point in 1 repeat weave pattern

In eq.(2) the multiplication of warp and weft densities of fabrics, $D_w \times D_f$ is constant and is explained as eq.(3).

$$D_w \times D_f = \frac{WC}{WF} \times \left[\frac{25.4}{d_w + d_f}\right]^2 = \text{const.} \tag{3}$$

2.2 Specimens

Design plan sheets of polyester and nylon fabrics woven by various looms were selected as a specimens from various weaving manufacturers such as A, B, C, D, E, and F as shown in Table 1, respectively. Table 1 gives the distribution of these specimens.

2.3 Calculation

In eq.(2) and eq.(3), for calculating weave density coefficient, yarn diameter is calculated using eq.(4).

Table 1. Distribution of Specimens

Weave	PET						Nylon
	A company	B company	C company	D company	E company	Sub-total	F company
	WJL	RPL	AJL+RPL	WJL+RPL	WJL+RPL		
Plain	26	4	14	46	5	95	516
Satin	10	41	20	4	8	83	24
Twill	60	28	33	4	9	134	113
Others	-	25	51	-	32	108	185
Sub-total	96	98	118	54	54	420	838

※ Note : WJL : water jet loom, RPL : rapier loom, AJL : air jet loom

$$\text{Den} = \rho_f \times \frac{\pi d^2}{4} \times 9 \times 10^5 \quad (4)$$

where, ρ_f : fibre density (g/cm^3)
d : yarn diameter (mm)
Den : yarn count (denier)

For polyester filament, yarn diameter, d is $0.01246\sqrt{\text{Den}}$ and for nylon filament, that is $0.01371\sqrt{\text{Den}}$. On the other hand, weave factor, WF is also calculated using $[(R+Cr)/2R]^2$ on the one repeat weave pattern of fabrics. Through this procedure, yarn diameter, d and weave factor, WF are calculated for all the specimens of nylon and polyester fabrics. Finally weave density coefficient, WC is calculated using d, WF and warp and weft fabric densities, D_w and D_f of the all the nylon and polyester fabrics. And WC is plotted against various yarn counts using eq.(2) and conversely warp and weft density distribution is presented with various weave density coefficients and weave patterns using eq.(3) in results and discussions.

3. Result and discussion

3.1 The distribution of weave density coefficient according to the looms

For four hundreds twenty polyester fabrics, the diameter of warp and weft yarns were calculated using deniers by eq.(4), and weave factor was calculated on one repeat weave construction. The weave density coefficient was calculated using eq.(2). Fig. 1 shows the diagram between weave density coefficient and yarn count for the polyester fabrics woven by water jet loom. And Fig. 2 shows that for rapier loom. As shown in Fig. 1, the weave density coefficient of PET fabrics woven by WJL was widely ranged from 0.2 to 1.8, on the other hand, for rapier loom, was ranged from 0.4 to 1.4 as shown in Fig. 2. And in Fig. 1, the values for satin fabric were ranged from 0.6 to 1.0, which were lower than those for the plain and twill fabrics. Around the yarn count 150d, 300d and 400d for the twill fabrics, it is shown that the weave density coefficient is ranged from 0.4 to 1.0 for 150d, ranged from 0.5 to 1.7 for 300d and also from 0.6 to 1.3 for 400d even though their yarn counts were same. This demonstrates that the weave density coefficient of fabrics woven by water jet loom was widely distributed according to the end use of fabrics for garment. As shown in Fig. 2, the weave density coefficient of those by RPL was ranged from 0.5 to 0.8. Their distribution was relatively narrow comparing to those by WJL. But the weave density coefficient of satin fabrics woven by rapier loom as shown in Fig. 2, showed almost same distribution to those of water jet loom shown in Fig. 1. And also it was shown that many specimens were concentrated around yarn count between 300d and 400d region as shown in Fig. 2.

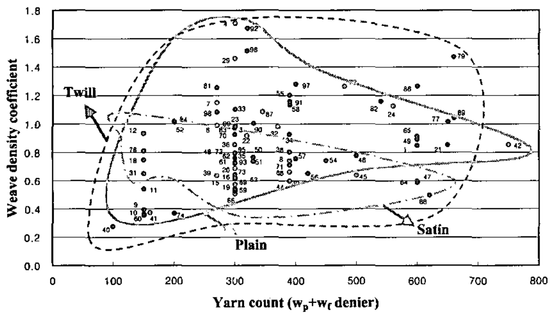


Figure 1. The diagram between weave density coefficient and yarn count for PET fabrics (WJL)

(——— : Plain, – – – : Twill, —·—— : Satin)

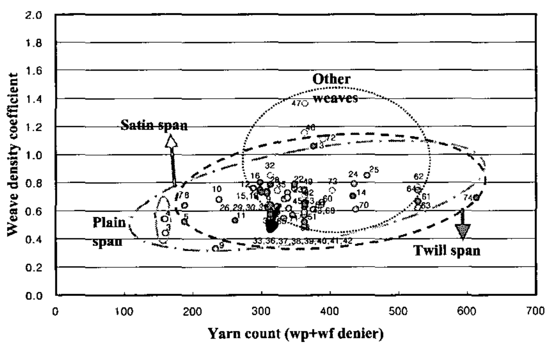
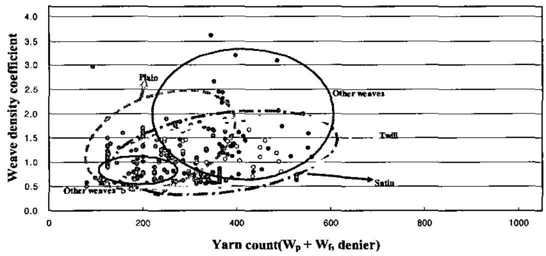


Figure 2. The diagram between weave density coefficient and yarn count for PET fabrics (RPL)

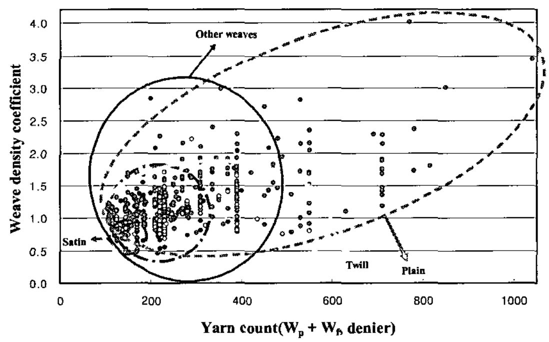
(——— : Plain, – – : Twill, ~~—— : Satin, ---- : Other)

3.2 The comparison of the weave density coefficient between polyester and nylon fabrics.

Fig. 3 shows the diagram between weave density coefficient and yarn count for polyester and nylon fabrics woven by water jet loom for the specimens of higher weft yarn count than warp. As shown in Fig. 3, the weave density coefficient of Nylon fabrics is widely ranged from 0.5 to 3.0, and comparing to polyester fabrics, the weave density coefficients of Nylon fabrics are higher than those of PET fabrics. Especially, in polyester fabrics, plain, twill and satin weave patterns were widely divided to each other on weave density coefficient and yarn count, on the other hand, in nylon fabrics, it was shown that plain was most popular



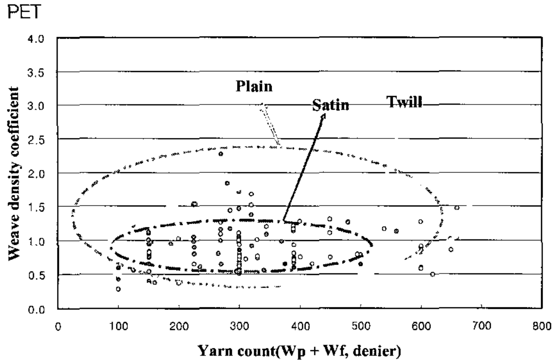
(a) PET



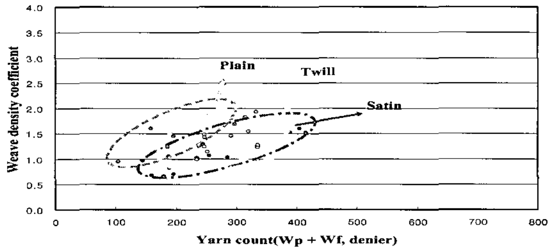
(b) Nylon

Figure 3. Comparison of weave density coefficient between PET and Nylon fabrics (W_p<W_f)

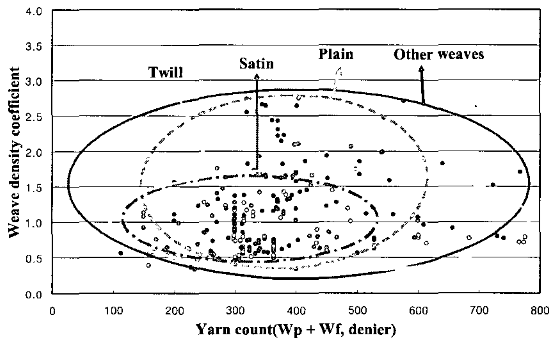
(·--- : Plain, : Twill, – – : Satin, ——— : Other)



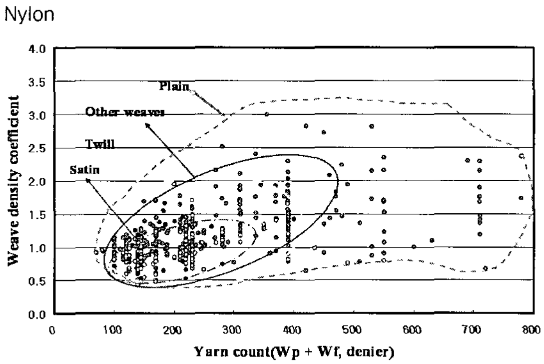
(a) WJL



(b) AJL



(c) RPL



(d) WJL

Figure 4. The weave density coefficient of polyester and nylon fabrics according to the weaving looms

(·---- : Plain, : Twill, — — : Satin, —— : Other)

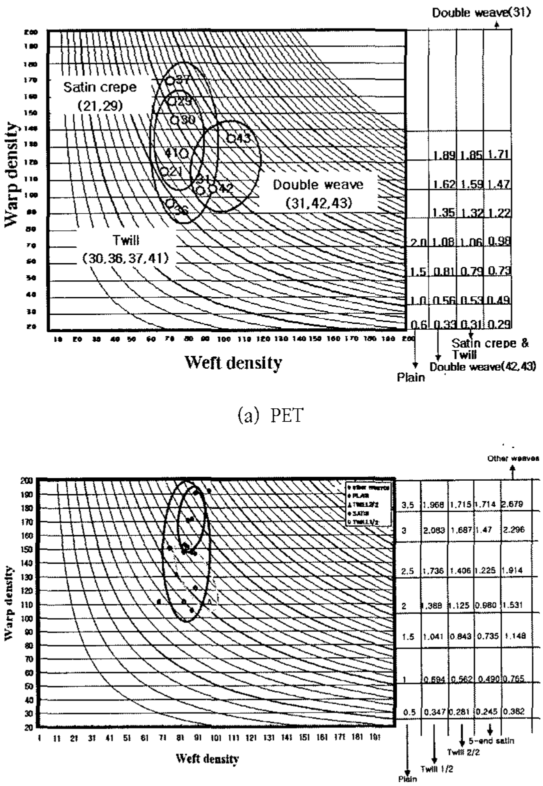
and many specimens were concentrated around yarn count 200d region.

Fig. 4 shows the weave density coefficients of polyester and nylon fabrics according to the weaving looms.

As shown in Fig. 4 (a), (b) and (c), the weave density coefficient of polyester fabrics woven by water jet loom was ranged from 0.4 to 1.5, those woven by air jet loom is ranged from 0.7 to 2.0 and woven by rapier loom was ranged from 0.5 to 2.8. And yarn count also showed wide distribution in water jet and rapier looms, but air jet loom showed a little narrow distribution. This phenomena demonstrates that the versatility of rapier loom was the highest comparing to the other weaving looms. On the other hand, comparing Fig. 4 (a) with Fig. 4 (d), the weave density coefficient of nylon fabrics was ranged from 0.5 to 3.0, while in polyester fabrics it was ranged from 0.4 to 1.5. Nylon fabric showed much wider distribution and much larger values of the weave density coefficient.

3.3 The density distribution

Fig. 5 shows fabric density distribution calculated and simulated by eq.(3) for polyester and nylon fabrics with 2 kinds of yarn counts. Fig. 5 (a) shows warp and weft density distributions of polyester fabrics with various weave density coefficients and various weave patterns with warp and weft yarn count 150 deniers. As shown in this Fig. 5 (a), specimen no. 21 and 29, satin crepe fabrics, have almost same weft density of fabrics to each other, but warp density of fabrics were different according to the end use of fabric for garment. And as shown in Fig. 5 (b), many specimens of plain fabrics have same weave density coefficient, but it was shown that warp and weft densities were different to one another according to the end use of fabric for garment. It was shown that it was very convenient to decide warp and weft fabric densities for good hand of fabrics.



(a) PET

(b) Nylon

Figure 5. The diagram between fabric density of PET and Nylon fabrics

3.4 Data base system for fabric design for the fabric manufacturer

Even though a lot of commercial CAD systems for both fabric and pattern[1-3] have been introduced, any system for weaving factories has been not developed. Therefore, a data base system related to the fabric design for weaving factory is needed to be explored. The yarn count, weave pattern and fabric density of 420 polyester fabrics and 838 nylon fabrics were used for making data base system, which were divided by weave patterns, weaving looms and weaving manufacturers. The reason why makes data base system according to the weaving manufactures is explained as due to the difference of fabric design according to each weaving factory.

Fig. 6 shows the diagram from data base between weave density coefficient and yarn count according to the weaving manufacturers.

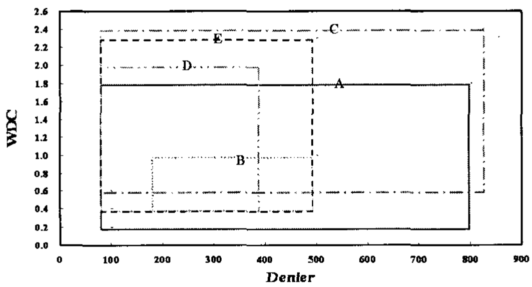


Figure 6. Diagram between weave density coefficient and yarn count according to the weaving company

※ Note: A : ———— B : - - - - - - C : —·—·— D : —··—··— E : — — — —

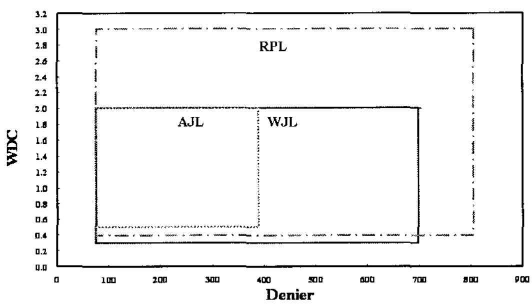
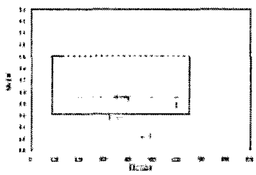


Figure 7. Diagram between weave density coefficient and yarn count according to the looms

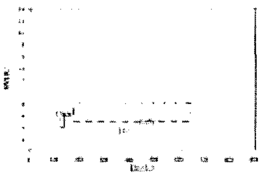
※ Note: WJL: ——— AJL: - - - - RPL: — — —

Fig. 7 shows the diagram from data base between weave density coefficient and yarn count according to the looms.

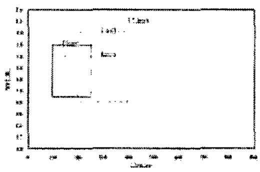
Fig. 8 shows the diagram from data base between weave density coefficient and yarn count according to the weave pattern of each weaving manufactures.



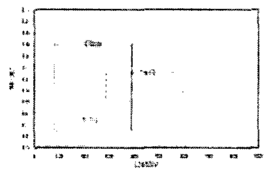
(a) A company



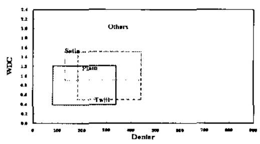
(b) B company



(c) C company



(d) D company



(e) E company

Figure 8. Diagram between weave density coefficient and yarn count according to the weave patterns of each weaving manufacturers

※ Note: Plain : ———— Twill : — — — —
Satin : -------- Other : · · · · ·

4. Conclusion

The various synthetic fabrics such as polyester and nylon fabrics were selected in order to analyze the relationship between weave density coefficient and yarn count according to the weave factor. As results, it was confirmed that the fabric density range was able to be estimated with given warp and weft yarn counts and weave construction for weavers, and it was easily applied for new fabric design to estimate the weavable fabric density according to the various type of looms for loom machinery makers.

References

[1] Kim, S. J., Park, S. H, Shin, B. J., Lee, M. H. (2000). Theory and Application of Woven Fabric Design for Garment, ic Associates Co. Ltd, Seoul.

[2] Kim, S. J. (2002). Data Base System and Its Application of PET Woven Fabric Design, Proceedings of 2nd International Fibre Symposium in FUKUI.

[3] Kim, S. J. (2005). The Preliminary Study for Data-Base System of The Various Fabrics Design, 3rd International Conference on Advanced Fiber/Textile Materials 2005 in Ueda.

[4] http://www.i-designer.co.kr, i-Designer.

[5] http://www.texclub.com, Texpro.

원고접수 : 2006. 7. 21
수정접수 : 2006. 9. 1
게재확정 : 2006. 9. 11