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Development of the Bias-Cut Dress Pattern Making Method by Applying Fabric Draping Ratio

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Abstract

This study aimed to investigate a bias pattern making method with geometrical approach. The bias-cut dress has soft silhouette of drape in the garment. However, the bias cut dress has problem of satisfying the intended garment size spec. This problem occurs from various sources. The main reason is that the bias-cut fabric tends to stretch on longitudinal direction and to shrink horizontal direction when it was hung on the body. The goal of this study was to develop a bias-cut dress pattern making method satisfying the intended garment size spec. The researchers developed the geometrical method of measuring dimensional change by calculating the compensation ratio of the fabric in true bias direction. The compensation ratio was calculated by applying draping ratio of the fabric. Three types of fabrics were used in the experiment. The warp and weft crossing angle of fabric was ranged from 78° to 82°. The fabrics stretched longitudinally 6.9～9.9% and shrank horizontally 7.2～11.0%. The compensation ratio of the bias-cut pattern for sample dress was calculated for each fabric type. Two types of experimental bias-cut dress patterns were developed for each fabric. One pattern was made with applying full compensation ratio and the other one made with applying partial ratio of the fabric. Experimental dresses were made with these patterns. The results of the evaluation showed that the bias-cut dress pattern applying the partial compensation ratio was more appropriate than the pattern applying the full compensation ratio.

Keywords: bias-cut dress, pattern making, draping, compensation

Ⅰ. Introduction

The garment silhouette may look different depending on its material properties, such as thickness, density, weight, and grain line of fabrics (Brown & Rice, 2001). The garment pattern makers consider fabric draping property, elasticity and resilience of fabrics to make a good looking garment. Bias pattern cutting method utilized the draping property of fabric to affect the silhouette of garment. bias-cut clothes can give people comfort without any pressure to body. It allows them to put on and take off clothes without difficulties because the bias-cut clothes stretch well in crosswise direction. The development women's garments using bias-cutting was vitalized by 1920's designer Madeleine Vionnet (1876－1975). She developed a beautiful and elegant silhouette of ladies' dresses using various bias-cutting techniques which make clothes fit the body perfect. The discussion on her bias dress cut from an aesthetic point of view and a history of clothing's perspective has been con-

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tinued. But it did not studied well how to make bias-cut pattern in the perspective of pattern making technology.

bias-cut method using draping property of the fabric for enjoying natural hang of the fabric on the body. It has been widely and consistently used on ladies' dress in clothing industry, which can help clothes to fit human body line more naturally. However, the bias-cut clothes affected by gravity force brings a problem of off-size of the finished garments. The finished garment's length of the bias-cut dress made with on-grain cut pattern become longer than the prepared length when it dressed on the body. Unfortunately, there was no specific solution to eliminate this kind of problem. Holman (2001) suggested make a bias-cut block bodice pattern by taking off at side seam. She suggested take off 5mm at bust line, 6mm at side seam underarm and waist line, and 3mm at hip line. However that method does not considered the draping property of the fabric.

The draping property of the fabric is influenced by fabric density, weight, tension, shearing and bending, but it is very difficult to figure out theoretically the relationship between physical properties of the fabric and draping property. The coefficient of drape determines this kind of fabric draping property objectively (Nam & Shin, 2002). Chung et al. (2003) suggested using an image analysis system to measure fabric draping property with coefficient of drape and status characteristic. They figured out fabric draping property and why node appears and how to deal with that in flare skirt. However there has been almost no study on how to apply fabric draping property to make bias-cut pattern.

Generally, the garment was made to be anon-grain cut pattern. When cut clothes with on-grain pattern, the center of gravity of clothes is matched by fabrics' warp grain direction. However in case of bias-cut clothes, the center of gravity of clothes is not matched by warp or weft direction. The true bias is always 45° from the straight grain of the fabric. One often sees a garment described as bias-cut; strictly speaking this simply means that it is off-grain.

The bias-cut garment drapes naturally and fits on body well. In other words, bias-cut dresses' size and shape are adjustable to the body shape by stretching longitudinally and shrinking horizontally. To satisfy the expected length or width offer fitting on the human body, garment makers check the length and width of the sample garment using dummy of scanned body of model. As a result, it delayed the production schedule and increased production costs a lot. The best way to solve this problem is to make bias-cut pattern with modifying anon-grain pattern (Armstrong, 2001).

Unfortunately, there was no clear solution how to make bias-cut patterns which can reflect the properties of fabrics. Only few studies suggest the trial method to make bias-cut pattern. There is no definite method how to apply bias-cut strain rate per each point of measurement of the body. Whenever clothes manufacturers make bias clothes pattern, they have to modify a pattern empirically considering fabric and design.

The previous studies show that the draping property of fabric affects the silhouette of garment. The bias-cutting techniques use draping property of the fabric. The bias-cut dress gives beautiful and elegant silhouette, but it may bring many fit problems. The most common fit problem is uneven dress hem line. But the cause was not known well and the bias-cut pattern making technology was not defined either. A reasonable bias-cut dress pattern making method is definitely needed.

This study developed a theoretical method of making the bias-cut pattern using gravity force and drape properties of the fabric. This research has developed the method to measure the drape ratio of the fabric and to make bias dress pattern applying the ratio. This study also suggested the manipulation method how to apply measured drape ratio of fabrics to satisfy bias-cut dress size specification of tech package spec sheet. The drape ratio of fabrics in bias direction was measured and it was used for calculating the correction rate.

Ⅱ. Method

1. Fabric

Three kinds of 100% silk georgette fabrics which were widely used for women's bias-cut dress were used for the experiment. The physical properties of specimen were as follow (Table 1). The fabric type 1 and type 2 were made with same density with hard twisted yarn (TPM 2,500～3,000). They were georgette fabric with plain weave consist of two yarns weaved SSZZSSZZ each warp and weft of lay alternately to prevent fabric torque caused by residual stress. The density of georgette fabric was approximately 132×100～110. The fabric type 3 was heavy and had high density satin weave with low twisted yarn. Fabric types 1 and 2 were constructed in a same construction but they were different in weft density. Fabric type 1 was more shear than fabric type 2. Fabric type 3 had highest density and was the heaviest.

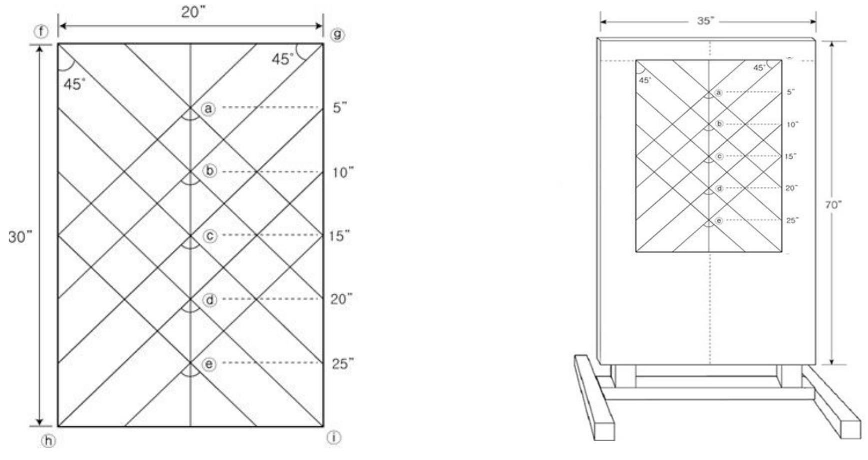
2. Dimensional change of fabric on the true bias direction

To measure dimensional change on the true bias direction the specimen was prepared with 20 inches width and 30 inches long. The size of the specimen was decided by the size of the garment pattern. One half of chest or hip width of body is generally 20 inches. The procedure of the measurement was as follow.

1) Drawing lines parallel with a diagonal line at every 5 inches. The crossing angle at the center was

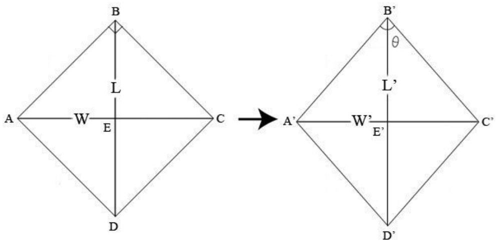
〈Table 1〉 Physical properties of fabric types

No.	Fiber content	Fabric structure	Yarn count	Density	Weight (g/y^2)
1	Silk (100%)	Plain	21d/2×21d/2	132× 96	43.0
2	Silk (100%)	Plain	21d/2×21d/2	131×112	44.0
3	Silk (100%)	Satin	21d/2×21d/2	255×128	96.8



(a) Angle measuring points (b) Placement of the specimen on the angle measuring stand

〈Fig. 1〉 Measuring points for crossing angle at specimen and the angle measuring



〈Fig. 2〉 Dimensional change of the fabric on the bias grain after hanging 24 hours

measured at 5 points (Fig. 1 (a)). 10 specimens were prepared for each fabric type. Draw all lines on the fabric using chalk. Match the center top edge of specimen to the center of the angle measuring stand, and put a tape on center and both side. Measure the angle of specimen after hanging it for 24 hours on the angle measuring stand.

2) Reading the warp and weft crossing angles at five points (Fig. 1 ⓐ, ⓑ, ⓒ, ⓓ and ⓔ).

3) Calculating the changed length from the measured angles.

When the specimen was on flat the angle CBA was 90° (Fig. 2). After specimen was hung on the measuring board, the right angle (∠ABC) of the fabric was changed to Θ(∠A' B' C'). Crosswise strain rate (W_r) was calculated by formula (1), lengthwise strain rate (L_r) was calculated by formula (2).

$$Wr = \frac{W' - W}{W} \times 100 \quad \text{formula (1)}$$

$$Lr = \frac{L' - L}{L} \times 100 \quad \text{formula (2)}$$

Where,

W' (width after hanging) = 2 × sinΘ/2,

L' (length after hanging) = 2 × cosΘ/2,

Θ: angle of the fabric after hanging

3. Calculation of pattern compensation rate for bias-cut dress

Bias-cut dress pattern was drafted to reflect dimensional change of the fabric at bias draping. Pattern compensation ratio was calculated by the formula (3) below.

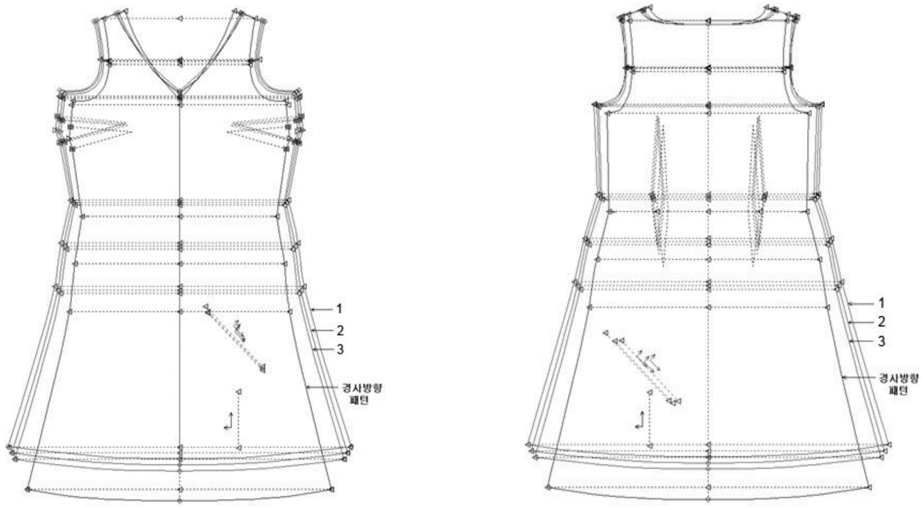
$$\text{Pattern compensation}(\%) = \frac{100}{100 + \text{strain ratio}} \times 100 \quad \text{formula (3)}$$

4. Pattern making for experimental garment

The bias-cut dress pattern was drafted by apply the pattern compensation ratio. Two sets of the sample patterns were drafted (Fig. 3 and Fig. 4). The first bias-cut pattern (A) was modified by applying full compensation ratio. The other one (B) was made by applying the partial compensation rate. The partial compensation rate of each part of body was determined by an expert who had over 10 years of experience on bias-cut dress pattern making. 70% compensation rate was applied at across shoulder. 30% compensation rate was applied at across front. For across back and chest 70% compensation rate was applied. 50% compensation was applied for waist circumference. For high and low hip 100% compensation rate were applied. 20% compensation rate

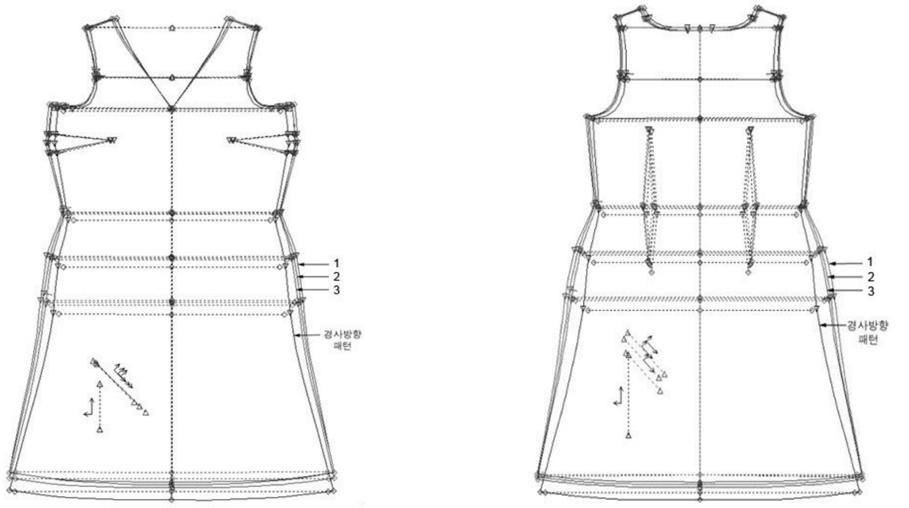
〈Table 2〉 Compensation rates (CR) applied for pattern B

Dimensions	CR (%)
Across shoulder	70
Across front	30
Across back	70
Chest width	70
Waist width	50
High hip width	100
Low hip width	100
Skirt hem width	20
Front neck depth	20
Arm hole depth	30
Waist depth	50
High hip depth	100
Low hip depth	100
Skirt length	70



(a) Front (b) Back

<Fig. 3> Dress pattern A applying full compensation ratio for three fabric types



(a) Front (b) Back

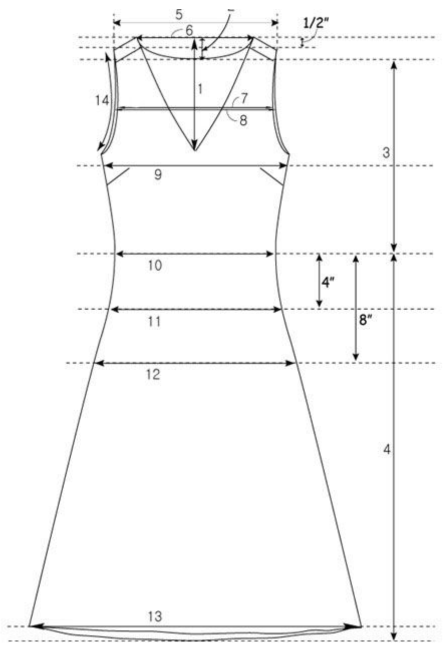
<Fig. 4> Dress pattern B applied partially differential compensation ratio for three fabric types

was applied skirt hem because that part was not affected by force of gravity. Front neck depth was applied 20% compensation rate. Armhole depth was applied 30% compensation rate. Waist placement was applied 50% compensation rate. Skirt length was applied 70% compensation rate (Table 2).

5. Experimental garments

Five experimental garments were made with patterns A & B for 3 types of fabric. 30 pieces of sample were made in total. The sample garment was size 8 of the model body of Ann Taylor® 2003. The style was a V-neckline and sleeveless dress with bust darts at side seam. Two pointed waist dart at the back.

The size of 30 experimental garments made with patterns A and B were measured by 25 experts who in charge of pattern making and size specification inspection in apparel industry. The bias-cut dresses were measured at 14 dimensions (Fig. 5). The length measurements were front and back neck depth (1 & 2), waist length at CB (3), skirt length (4). The width measurements were the across shoulder (5), neck width (6), across front (7), across back (8), chest circumference (9), waist circumference (10), high hip circumference (11), low hip circumference (12), sweep circumference (13) and AH circumference (14). The experimental garments were placed on the flat table and measured each dimension with tape measure. The sample was accepted if measurement was satisfied the tolerance.



<Fig. 5> The measuring dimensions of the sample garment

<Table 3> Size specification and tolerance of sample dress

(Unit: inch)

Dimensions			Size spec.	Tolerance
Length	1	Front neck depth	1	1/4
	2	Back neck depth	1	1/4
	3	Waist length at CB	15 1/2	1/4
	4	Skirt length	24	1/2
Width	5	Across shoulder	14	1/4
	6	Neck width	10	1/4
	7	Across front	12 1/2	1/4
	8	Across back	13 1/2	1/4
	9	Chest	37 1/2	3/4
	10	Waist	33	3/4
	11	High hip	38	3/4
	12	Low hip	41	3/4
	13	Skirt hem	56	2
	14	Arm hole	18 1/2	3/8

Ⅲ. Results

1. Dimensional change and pattern compensation ratio

The warp and weft crossing angle of specimen was different by fabric type and it was ranged from 78° to 82° (Table 4). The fabric type 1st retched longitudinally 9.9% and shrank horizontally 11.03%. The fabric type 2 stretched longitudinally 8.35% and shrank horizontally 9.05%. The fabric type 3st retched longitudinally 6.79% and shrank horizontally 7.21%. The compensation ratio (CR) of the bias-cut pattern for sample dress made with the fabric type 1 was 0.91 in lengthwise direction and 1.12 in crosswise direction. The compensation ratio of the bias-cut pattern for sample dress made with the fabric type 2 was 0.92 in lengthwise direction and 1.10 in crosswise direction. The compensation ratio of the bias-cut pattern for the fabric type 3 was 0.94 in lengthwise direction and 1.08 in crosswise direction (Table 5).

〈Table 4〉 The warp and weft crossing angle of three fabric types (Unit: %)

Fabric types	ⓐ 5" below	ⓑ 10" below	ⓒ 15" below	ⓓ 20" below	ⓔ 25" below	Total Mean (SD)
1	75.6 (1.35)	76.3 (1.25)	76.9 (1.37)	77.8 (0.63)	81.7 (0.95)	77.7 (0.47)
2	78.8 (1.48)	78.6 (1.17)	78.5 (1.51)	81.1 (1.60)	83.1 (0.88)	80.0 (0.55)
3	81.5 (0.97)	81.1 (1.45)	82.1 (1.97)	82.5 (1.78)	85.4 (1.17)	82.5 (0.93)

〈Table 5〉 Dimensional change ratio (DCR) and compensation ratio (CR) (Unit: %)

Fabric types	Crosswise ratio		Lengthwise ratio	
	DCR	CR	DCR	CR
1	−11.03	1.12	+9.90	0.91
2	−9.05	1.10	+8.35	0.92
3	−7.21	1.08	+6.79	0.94

2. Size of the experimental pattern

The across front measurements of type A pattern were 0.98～1.55 inches larger than that of on-grain pattern. The front chest width measurements were 1.48～2.36 inches larger than that of the on-grain pattern. The front low hip width measurements were 1.5～2.39 inches larger than that of the on-grain pattern. The front skirt hem length measurements were 2.11～3.35 inches larger than that of on-grain pattern. Waist length at CB measurements were 1.06～1.49 inches shorter than that of on-grain pattern. The skirt length measurements were 1.54～2.16 inches shorter than that of on-grain pattern (Table 6).

The across front measurements of type B pattern were 0.30～0.45 inches larger than that of on-grain

〈Table 6〉 Measurement of pattern A made for three fabric types (Unit: inch)

Dimensions		Size spec. of on-grain pattern	Fabric 1 (difference)	Fabric 2 (difference)	Fabric 3 (difference)
Front width	Across front	12.50	14.05(+1.55)	13.75(+1.25)	13.48(+0.98)
	Chest	19.00	21.36(+2.36)	20.90(+1.90)	20.48(+1.48)
	Waist	17.00	19.11(+2.11)	18.70(+1.70)	18.33(+1.33)
	High hip	18.62	20.93(+2.31)	20.48(+1.86)	20.07(+1.45)
	Low hip	19.26	21.65(+2.39)	21.19(+1.93)	20.76(+1.50)
	Skirt hem	27.00	30.35(+3.35)	29.70(+2.70)	29.11(+2.11)
Back width	Across shoulder	14.00	15.74(+1.74)	15.40(+1.40)	15.09(+1.09)
	Across back	13.50	15.17(+1.67)	14.85(+1.35)	14.55(+1.05)
	Chest	18.76	21.09(+2.33)	20.64(+1.88)	20.22(+1.46)
	Waist	16.00	17.98(+1.98)	17.60(+1.60)	17.25(+1.25)
	High hip	19.50	21.92(+2.42)	21.45(+1.95)	21.02(+1.52)
	Low hip	21.76	24.46(+2.70)	23.94(+2.18)	23.46(+1.70)
	Skirt hem	29.00	32.60(+3.60)	31.90(+2.90)	31.26(+2.26)
Length	A/H depth	8.50	7.74(−0.77)	7.85(−0.65)	7.96(−0.54)
	Waist length at CB	16.50	15.02(−1.49)	15.23(−1.27)	15.44(−1.06)
	High hip placement	4.00	3.64(−0.36)	3.69(−0.31)	3.74(−0.26)
	Low hip placement	8.00	7.28(−0.72)	7.38(−0.62)	7.49(−0.51)
	Skirt length	24.00	21.84(−2.16)	22.15(−1.85)	22.46(−1.54)

<Table 7> Measurement of pattern B made with three fabric types (Unit: inch)

Dimensions		Size spec of on-grain pattern	Fabric 1 (difference)	Fabric 2 (difference)	Fabric 3 (difference)
Front width	Across front	12.50	12.95 (+0.45)	12.88 (+0.38)	12.80 (+0.30)
	Chest width	19.00	20.60 (+1.60)	20.06 (+1.33)	20.06 (+1.06)
	Waist width	17.00	18.02 (+1.02)	17.82 (+0.82)	17.68 (+0.68)
	High hip width	18.62	20.85 (+2.23)	20.26 (+1.84)	20.11 (+1.49)
	Low hip width	19.26	21.57 (+2.31)	21.30 (+1.94)	20.80 (+1.54)
	Skirt hem width	27.00	27.65 (+0.65)	27.30 (+0.30)	27.43 (+0.43)
Back width	Across shoulder	14.00	15.18 (+1.18)	14.98 (+0.98)	14.78 (+0.78)
	Across back	13.50	14.63 (+1.13)	14.45 (+0.95)	14.26 (+0.76)
	Chest width	18.76	20.34 (+1.58)	20.06 (+1.32)	19.81 (+1.05)
	Waist width	16.00	16.96 (+0.96)	18.82 (+0.82)	16.64 (+0.64)
	High hip	19.50	21.84 (+2.34)	22.02 (+1.57)	21.06 (+1.56)
	Low hip	21.76	24.37 (+2.61)	23.80 (+2.04)	23.50 (+1.74)
	Skirt hem	29.00	29.70 (+0.70)	29.58 (+0.58)	29.46 (+0.46)
Length	A/H depth	8.50	8.27 (−0.23)	8.30 (−0.20)	8.35 (−0.15)
	Waist length at CB	16.50	15.76 (−0.74)	14.84 (−0.66)	16.00 (−0.50)
	High hip placement	4.00	3.64 (−0.36)	3.68 (−0.32)	3.76 (−0.24)
	Low hip placement	8.00	7.28 (−0.72)	7.36 (−0.64)	7.52 (−0.48)
	Skirt length	24.00	22.49 (−1.51)	22.66 (−1.34)	22.99 (−1.01)

pattern. The front chest width measurements were 1.06～1.60 inches larger and the front low hip width measurements were 1.54～2.31 inches larger than on-grain pattern. The front skirt hem width measurements were 0.43～0.65 inches larger than on-grain pattern. Waist length at CB of bodice was 0.5～0.74 inches shorter than that of on-grain pattern (Table 7).

3. Size evaluation of sample garments

Thirty experimental garments were made with pattern A and B and three fabric types (5 garments for each fabric types). The fit of sample garment was evaluated according to size spec evaluation test. The results of the evaluation show that the experimental garments made with the pattern B, which was applied partially differential compensation, were well fit to the size spec (96.2%). The experimental garments made with the pattern A, were not fit well to the size spec (39.9%) (Table 8). The width measurements for the experimental garments made by pattern A were bigger than the size specifications. Across front and skirt hem measurements were all bigger than the measurements of the on-grain pattern measurements on the size spec. 80% of the samples had larger measurements at waist and hip width than the on-grain pattern measurements on the size spec. On the other hand all the skirt length measurements were shorter than the size spec.

The samples made by pattern B generally met the spec although neck width and chest circumference for type A were smaller than the spec. These results imply that the measurements of the experimental garment B made with partial compensation ratio were close to the size specification requirement (Table 8). The measurements of front/back neck depth and armhole of experimental garment A were much smaller than the size specification requirement. On the other hand, all measurements on width appeared bigger than

<Table 8> Size evaluation test results of experimental dresses made with pattern A (Unit: %)

Specification		Fabric 1			Fabric 2			Fabric 3		
Point of measurement		(−) Fail	Pass	(+) Fail	(−) Fail	Pass	(+) Fail	(−) Fail	Pass	(+) Fail
Length	Front neck depth	61.6	38.4	-	48.0	52.0	-	55.2	44.8	-
	Back neck depth	54.4	45.6	-	54.4	45.6	-	55.2	44.8	-
	A/H circ.	55.2	44.8	-	23.2	76.8	-	23.2	76.8	-
	Skirt length	100.0	-	-	100.0	-	-	100.0	-	-
Width	Neck width	-	82.4	17.6	-	83.2	16.8	-	76.8	23.2
	Across shoulder	-	26.4	73.6	-	32.8	67.2	-	32.0	68.0
	Across front	-	-	100.0	-	-	100.0	-	-	100.0
	Across back	-	70.4	29.6	-	76.8	23.2	-	76.8	23.2
	Chest circ.	-	51.2	48.8	-	56.0	44.0	-	50.4	49.6
	Waist circ.	-	1.6	98.4	-	-	100.0	-	-	100.0
	High hip circ.	-	12.8	87.2	-	20.0	80.0	-	19.2	80.8
	Low hip circ.	-	6.4	93.6	-	12.8	87.2	-	-	100.0
	Skirt hem circ.	-	-	100.0	-	-	100.0	-	-	100.0

<Table 9> Size specification evaluation results of experimental dresses made with pattern B (Unit: %)

Specification		Fabric 1			Fabric 2			Fabric 3		
Division	Point of measurement	(−) Fail	Pass	(+) Fail	(−) Fail	Pass	(+) Fail	(−) Fail	Pass	(+) Fail
Length	Front neck depth	-	100.0	-	-	88.0	12.0	-	84.8	15.2
	Back neck depth	-	100.0	-	-	100.0	-	-	100.0	-
	A/H circ.	-	100.0	-	-	93.6	6.4	-	74.4	25.6
	Skirt length	-	100.0	-	-	100.0	-	-	100.0	-
Width	Neck width	24.8	75.2	-	6.4	93.6	-	-	100.0	-
	Across shoulder	-	100.0	-	-	100.0	-	-	100.0	-
	Across front	-	100.0	-	-	100.0	-	-	100.0	-
	Across back	-	100.0	-	-	100.0	-	-	100.0	-
	Chest circ.	19.2	80.8	-	19.2	80.8	-	-	100.0	-
	Waist circ.	-	100.0	-	-	93.6	6.4	-	94.4	5.6
	High hip circ.	-	100.0	-	-	100.0	-	6.4	93.6	-
	Low hip circ.	-	100.0	-	-	100.0	-	-	100.0	-
	Skirt hem circ.	-	100.0	-	-	100.0	-	-	100.0	-

specification requirement. These results showed that the experimental garment A, which made with bias-cut dress pattern applying 100% compensation rate, was stretched longitudinally, but it shrunk horizontally.

Ⅳ. Conclusion

The draping property of fabric affects the silhouette of garment. The bias-cutting techniques using draping property of the fabric for enjoying natural hang of the fabric on the body. The bias-cut dress gives beautiful and elegant silhouette, but it may bring many fit problems. The most common fit problem is uneven dress hem line and the other problem is off-size of the finished garments. In general, the bias-cut dress stretches longitudinally and shrinks horizontally, so it is hard to satisfy the deformed size spec at every part of the clothes. It has not been clearly solved. They only depend on pattern maker's skill.

The goal of this study was to develop a bias-cut dress pattern making method satisfying the intended garment size spec. This study suggested a theoretical bias-cut pattern making method using the gravity force and draping properties of the fabric. The researchers suggested an empirical method of measuring draping ratio of the fabric. They also developed the geometrical method of measuring dimensional change by calculating the compensation ratio of the fabric in true bias direction by applying draping ratio of the fabric.

Three types of fabrics were used in the experiment. The warp and weft crossing angle of fabric was ranged from 78° to 82°. The fabrics stretched longitudinally 6.9～9.9% and shrank horizontally 7.2～11.0%. The researchers drafted the bias-cut dress pattern from the on-grain dress pattern by applying the dimensional change of fabric in bias grain. Two types of experimental bias-cut dress patterns were developed for each fabric. One pattern was made with applying full compensation ratio and the other one made with applying partial ratio of the fabric.

The results of the test show that the bias-cut pattern applied full compensation amount had off size problem at waist and hip width and skirt length. It can be concluded that the method applying full compensation amount was not right method. The method applying partial compensation amount gave the expected dimension in the spec sheet. The partial compensation ratio was decided by considering the constructional characteristics of dress such as darts or the human body shape.

The suggested drape ratio measuring method and bias-cut pattern making method are much easier to follow and more definite than the other method presented by the previous studies. The result of the size evaluation test shows that the suggested bias-cut pattern making method satisfies the size specification. This suggested method has strengths and weaknesses. The strength is that this bias-cut pattern making method can apply many other styles since it modifies the on-grain pattern with compensation amount measured from the draping ratio of the fabric. The weakness of this method is that it does not show the general rule for how to apply bias-cut strain rate per each point of measurement of the body.

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