

## Analysis of Drapability of Men's & Women's Suit Fabrics

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### 남녀 수트직물의 드레이프성 분석

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#### Abstract

Drapability is an important factor determining the end-use of fabrics. In this research, characteristics of drapability of men's and women's suit fabrics were analyzed. The hand and the preference for suit fabrics were measured by the subjective and objective evaluations. To find out the details of the drapability characteristics of suit fabrics, the drape was measured by using Cusick drape tester and was processed by image analysis software. Seasonal difference was obvious both in men's and women's fabrics. The average drape ratio of women's S/S suit fabrics showed the highest value, 0.724, then decreased in the order of men's F/W > men's S/S > women's F/W. Wave amplitude showed the same order to the drape ratio. Men's fabrics were more drapable in spring and summer season rather than in fall and winter season. Women's fabrics showed the opposite trend, in other words, S/S suit fabrics were less drapable than F/W fabrics. There was also a significant difference in drape ratio between men's and women's fabrics regardless of season. For S/S, men's fabrics were more drapable than women's ones, whereas, for F/W, women's fabrics were more drapable.

**Key words:** Drapability, Primary hand factor, Preference, Suit fabric; 드레이프성, 감각평가 요인, 선호도, 수트직물

### I. Introduction

Drape refers to a fabric ability to form 3-dimensional curvatures when bent under its own weight. It is an important factor of the aesthetic appeal of fabrics for both apparel and home furnishings. Drape is also an important factor determining the end use of fabrics because it was affected by the mechanical properties such as fabric weight, stiffness, bending and shear resistance. Assessing and analyzing the complex be-

havior of draped fabrics have been a concern of researchers for a long time. Measuring the drape of fabric is important to predict appearance of a garment and fabric properties. It can be measured by both subjective and objective methods. Subjective measurement judged by visual observation is important because draping qualities pleasing to the human eye are identical(Moore et al., 1995). Ryu et al.(2000) reported that fabric drapability judged by visual observation is significantly correlated with the preference for a certain item of apparel such as blouse. Direct quantitative measurement of fabric drape is also important in apparel design and production for proper selection of fabric. Since an optical

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drapemeter was developed in Research Laboratories (Chu et al., 1950), diverse instruments have been developed. The series of instruments developed by Kawabata(1980) for the evaluation of fabric hand have been widely used to determine the mechanical properties related to drape(Morooka and Niwa, 1976; Collier et al., 1988, Kim and Lee, 1992).

Drape values such as drape ratio, node number, node shape represented by wave amplitude and wave length are used to evaluate the drapability. Recently drapemeter is computerized so that it is fast and precise to obtain the data. Drape ratio can be obtained by comparing the area of image of a draped circular specimen to the area of a reference annular ring. Profile formation of nodes is also utilized to predict the drape and tailorability. Disanto(1988) found skirts from the same fabric showed some affinity toward certain node configuration with little variation within specimens.

The purposes of this research were to investigate the relationship between drapability and end use of fabrics to provide basic information for the planning and fabrication of suit fabrics. To analyze the characteristics of drapability of women's and men's suit fabrics, diverse women's and men's suit fabrics were selected in a market and measured the drape values such as drape ratio, node number, wave amplitude, and wave length. Hand of these fabrics was subjectively evaluated to investigate the factors related to consumer's preference for suit fabrics. To measure the subjective hand of fabrics, the subjective hand evaluation tool for women's and men's suit fabrics was developed. Consumer's preference for suit fabrics is also searched. The characteristics of drapability of preferred and not preferred suit fabrics for women's and men's suit are compared seasonally.

## II. Experimentals

### 1. Specimens

A total of 332 fabrics covering a wide range was obtained from commercial sources. Sixty varieties of fabrics for men's spring & summer season, sixty for men's fall & winter, seventy for women's spring & summer, and one hundred and forty two for women's

Table 1. Fiber type of fabrics

Fiber type	Women's		Men's	
	F/W	S/S	F/W	S/S
Cotton/cotton blend	23	12	-	-
Linen & linen blend	-	16	-	-
Wool & wool blend	48	11	51	50
Silk	-	7	-	-
Rayon/tencel	25	12	-	-
Polyester/polyester blend	40	12	9	10
Nylon	6	2	-	-
Total	142	70	60	60

fall and winter suit fabrics were used. Women's fabrics outnumber men's fabrics. Fiber types of women's fabrics were more diverse than those of men's <Table 1>, because women's garments are complex and a diverse range of fibers and materials are used. Men's fabrics were mainly consisted of wool or polyester fiber.

30×30cm test samples were prepared for evaluation. Evaluators were allowed to touch fabrics freely during the test.

### 2. Subjective Evaluation

To evaluate the hand of the fabrics subjectively, 9-point semantic differential scale questions were developed with 20 adjective pairs. Most of adjective pairs are unipolar. The reason unipolar adjectives were chosen was that it was not easy to fine out the exact antonym. 7-point scale questionnaire was also developed to evaluate touch and preference for different items such as suit, skirts, and pants.

Total 2,400 non-experts and experts from apparel industry evaluated men's fabric. 4,100 evaluators rated women's fabrics. They were instructed to rate their feelings on selected 20 adjectives(1-9 scale) describing fabric hand. Preference for suit fabric was also assessed using 7 point scale. Subjective evaluation of fabrics was conducted to the season.

### 3. Drape Measurement

To find out the details of the drapability characteristics of suit fabrics, the drape was measured by

using Cusick drape tester installed image analysis software(D&M Technology Co. Ltd.). Drape parameters such as drape ratio, number of nodes, wave amplitude, and wave length were determined.

#### 4. Data Analysis

Factor analysis was performed on the subjective evaluation results by applying the criterion of eigen value of 1 and Varimax orthogonal rotation. To confirm the level of reliability, the value of Cronbach's  $\alpha$  was calculated. Correlations between subjective and objective evaluations category are examined. T test was also conducted to compare the difference between groups.

### III. Results and Discussion

#### 1. Women's Suit Fabrics

For women's fall/winter suit fabrics, five factors were isolated that explaining over 67% of the variance in the data - bulkiness, flexibility, extensibility, drapability, and surface irregularity(Table 2). As we expected, drapability is one of factors explaining subjective hand of fabrics.

To see if fabric drapability affects the consumer to purchase a suit, the relationship between preference

**Table 2. Primary hand factors of women's F/W suit fabrics**

Factor	Eigen Value	Cumul. Prec. Variance
Bulkiness	3.967	22.040
Flexibility	3.212	39.886
Extensibility	2.226	52.141
Drapability	1.479	60.357
Surface Irregularity	1.201	67.031

and drapability was analyzed(Table 3). For women's F/W suit fabrics, drapability was one of the important factors that characterize the fabric hand and was correlated with the preference for suit fabrics. Table 4 shows the difference of drapability between preferred and not-preferred 15 fabrics, respectively. There is a significant difference in drape ratio and wave amplitude between two groups. However, node number and wave length are not differentiated between two groups. Average drape ratio of preferred fabrics is lower than that of not-preferred ones. Fabrics that have around 0.64 of drape ratio were preferred. Too stiff or too soft fabrics were not preferred for F/W suit materials. The curvature of drape is more prominent in preferred fabrics. <Fig. 1> is the typical drape images of preferred and not-preferred fabrics.

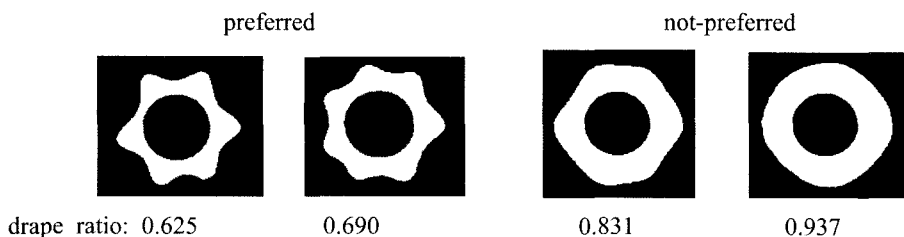
For women's spring/summer suit fabrics, five factors were also isolated(Table 5). Four of them were same

**Table 3. Correlation between factors & preference (women's F/W fabrics)**

Factor Preference	Correlation Coef.
Bulkiness	0.004
Flexibility	-0.010
Extensibility	-0.020*
Drapability	0.019*
Surface Irreg.	0.002

**Table 4. Drape & preference for women's F/W suit fabrics**

	Average		t-test
	preferred 15	not-preferred 15	t-value
Preference Value	4.93	2.33	38.35***
Drape Ratio	0.64	0.75	-3.93**
Node Number	6.73	6.33	0.87
Wave Amp.(cm)	11.56	11.91	-2.37*
Wave length(deg)	54.08	60.43	-1.46



**Fig. 1. Drape image(women's F/W suit fabrics).**

**Table 5. Primary hand factors of women's S/S suit fabrics**

Factor	Eigen Value	Cumul.prec. Variance
Warm/Cool feeling	3.136	14.254
Bulkiness	2.786	26.920
Extensibility	2.579	38.642
Drapability	2.438	49.722
Surface Irreg.	2.241	59.910

**Table 6. Correlation between factors & preference (women's S/S suit fabrics)**

Factor	Preference	Correlation Coef.
Warm/Cool feeling		0.129**
Bulkiness		0.005
Extensibility		0.102**
Drapability		0.118**
Surface Irreg.		0.156**

**Table 7. Drape & preference for women's S/S suit fabrics**

	Average		t-test
	preferred 15	not-preferred 15	t-value
Preference Value	4.75	3.20	14.13***
Drape Ratio	0.72	0.80	-1.76
Node Number	6.20	7.47	-2.16*
Wave Amp.(cm)	12.11	12.40	-1.01
Wave Length(deg)	59.12	51.11	2.19*

as in F/W fabrics. Warm/cool feeling was added instead of flexibility. Drapability was isolated again in S/S fabrics and correlated to the preference (Table 6).

In case of women's S/S fabrics, there was no significant difference in drape ratio between preferred and not-preferred fabrics. However, node number and wave length showed the difference between two groups. It means that even if the drape ratio was not

**Table 8. Difference of drape between preferred women's F/W and S/S fabrics**

	Average		t-test
	F/W	S/S	t-value
Preference Value	4.93	4.75	2.38*
Drape Ratio	0.64	0.72	-3.24**
Node Number	6.73	6.20	1.86
Wave Amp.(cm)	11.56	12.11	-3.92**
Wave Length(deg)	54.09	59.12	-1.87

different, the shapes can be differentiated between two groups.

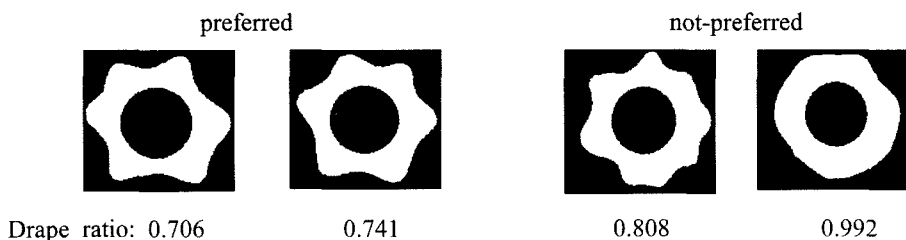
<Fig. 2> shows the typical drape images of preferred and not-preferred fabrics for S/S suit fabrics. Regularly and clearly draped fabrics were preferred to irregularly draped ones.

Seasonal difference was obvious between F/W and S/S women's suit fabrics (Table 8). Women's suit fabrics were stiffer in spring and summer rather than in fall and winter season. S/S fabrics showed the higher drape ratio and wave amplitude. In summer, loose style of garment is preferred because of coolness. Stiff fabrics are widely used in summer because they have a merit to form a loose silhouette.

## 2. Men's Suit Fabrics

Through the factor analysis of subjective evaluation results of men's fall/winter suit fabrics, five factors were isolated. These factors explain over 60% of the variance in the data -bulkiness, flexibility, extensibility, surface irregularity, and drapability (Table 9). These are the same factors that isolated in women's F/W suit fabrics. Drapability turned out to be a factor explaining subjective hand in men's fabrics as in women's ones. It is also correlated to the preference (Table 10).

<Table 11> shows the characteristics of drapability

**Fig. 2. Drape image(women's S/S suit fabrics).**

**Table 9. Primary hand factors of men's F/W suit fabrics**

Factor	Eigen Value	Cumul. prec. Variance
Bulkiness	3.348	16.739
Flexibility	3.098	32.230
Extensibility	2.347	43.967
Surface Irreg.	1.758	52.755
Drapability	1.517	60.339

**Table 10. Correlation between factors & preference (men's F/W fabrics)**

Factor	Preference	Correlation Coef.
Bulkiness		-0.029
Flexibility		-0.055**
Extensibility		0.005
Surface Irreg.		0.031*
Drapability		-0.032*

**Table 11. Drape & preference for men's F/W suit fabrics**

	Average		t-test
	preferred 15	not-preferred 15	t-value
Preference Value	5.02	3.39	20.80***
Drape Ratio	0.71	0.69	0.36
Node Number	6.47	6.73	-0.89
Wave Amp.(cm)	12.10	11.88	1.55
Wave Length(deg)	56.74	54.00	1.07

between preferred and not-preferred 15 fabrics. There was no significant difference in drapability between preferred and not-preferred fabrics for men's F/W suit fabrics. Even if drapability was appear to be a factor affecting preference, objectively measured drape parameter was not differentiated between preferred and not-preferred fabrics in men's F/W suit. As shown in <Table 9>, drapability is the weakest factor which explains fabric hand. That could be the reason why measured drape parameter did not show the difference between two groups Anyway, further research is needed to develop a more sensitive analyzing method of drapability which can explain consumer's feeling of drape.

For men's spring/summer suit fabrics, five factors were also isolated(Table 12). Four of them were same as in F/W fabrics. Warm/cool feeling was added instead of drapability. The different factor from women's S/S fabrics was flexibility. Drapability

**Table 12. Primary hand factors of men's S/S suit fabrics**

Factor	Eigen Value	Cumul. prec. Variance
Warm/Cool feeling	2.735	12.433
Extensibility	2.712	24.759
Bulkiness	2.573	36.454
Flexibility	2.425	47.476
Surface Irreg.	2.172	57.349

**Table 13. Drape & preference for men's S/S suit fabrics**

	Average		t-test
	preferred 15	not-preferred 15	t-value
Preference Value	4.91	3.83	11.85***
Drape Ratio	0.65	0.60	1.61
Node Number	6.80	6.53	0.86
Wave Amp.(cm)	11.64	11.57	0.52
Wave Length(deg)	53.08	55.94	-0.81

**Table 14. Difference of drape between preferred men's F/W and S/S suit fabrics**

	Average		t-test
	F/W	S/S	t-value
Preference Value	5.02	4.91	2.17*
Drape Ratio	0.71	0.65	3.19**
Node Number	6.47	6.80	-1.03
Wave Amp.(cm)	12.10	11.64	3.84**
Wave Length(deg)	56.74	53.80	2.17*

was isolated instead of flexibility in women's S/S. Consequently, drapability was not appeared in men's S/S suit materials. To verify the drapability does not affect the preference, the difference of drapability between preferred and not-preferred 15 fabrics was analyzed(Table 13). As expected, the difference between two groups could not find out. That means drapability does not affect the preference for men's S/S suit fabrics.

Even if drape parameter was not differentiated between preferred and not-preferred group in men's suit fabrics, seasonal difference could be in existence. <Table 14> shows an obvious difference between F/W and S/S fabrics. Men's suit fabrics were stiffer in fall and winter rather than in spring and summer season, which is the opposite trend to women's. Silhouette of men's suit is almost same regardless to season, whereas women's silhouette is

diverse. There are many fabrics that can achieve the diverse silhouette for women. However, fabrics for men's suit are less diverse than those for women's. Fiber types for men's S/S and F/W suit are same. That means characteristics for men's suit are not diverse so much as for women's fabrics. Thicker fabrics may be needed for thermal insulation in F/W season. And drape ratio could be increased in F/W fabrics.

### 3. Comparison between Women' and Men's Suit Fabrics

<Table 15 and 16> show the difference between men's and women's fabrics in each season. Seasonal difference was obvious both in men's and women's fabrics. The average drape ratio of women's S/S suit fabrics showed the highest value, 0.72, then decreased in the order of men's F/W> men's S/S> women's F/W. Unlike women's F/W, men's F/W and S/S fabrics, women's S/S fabrics include 16 linen and linen blend fabrics. However, linen type of fabric is rarely used in cold season and for men's suit. That is the reason women's S/S fabrics appear to be stiffest. Wave amplitude showed the same order to the drape ratio. Men's fabrics were more drapable in spring and summer season rather than in fall and winter season.

**Table 15. Difference of drape between preferred women's and men's FW suit fabrics**

	Average		t-test
	Women's	Men's	t-value
Preference Value	4.93	5.02	1.69
Drape Ratio	0.64	0.71	3.05**
Node Number	6.73	6.47	0.89
Wave Amp.(cm)	11.56	12.10	4.61***
Wave Length(deg)	54.09	59.74	0.99

**Table 16. Difference of drape between preferred women's and men's S/S suit fabrics**

	Average		t-test
	Women's	Men's	t-value
Preference Value	4.75	4.91	2.15*
Drape Ratio	0.72	0.65	3.31**
Node Number	6.20	6.80	1.91
Wave Amp.(cm)	12.11	11.64	3.30**
Wave Length(deg)	59.12	53.80	1.87

The Silhouette of man's suit remains almost unchanged unlike that of women's. Fiber types which can be used for men's suit is not diverse. To control the coolness, thin fabrics are essential. Thickness could be one of influential factors on high drapability of men's S/S suit fabrics. Women's fabrics showed the opposite trend, in other words, S/S suit fabrics were less drapable than F/W fabrics.

There was also a significant difference in drape ratio between men's and women's fabrics regardless to season. For S/S, men's fabrics were more drapable than women's ones, whereas, for F/W, women's fabrics were more drapable.

## IV. Conclusions

Drapability affects the preference for women's suit fabrics, whereas, rarely affects the preference for men's suit fabrics. The seasonal difference of drape ratio among men's and women's fabrics is as follows: women's S/S> men's F/W> men's S/S> women's F/W. Men's suit fabrics are more drapable in S/S rather than in F/W season, whereas, women's fabric showed the opposite trend. Women's fabrics are more drapable than men's in F/W and stiffer in S/S.

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## 요 약

드레이프성은 직물의 최종용도를 결정하는데 매우 중요한 요소이다. 본 연구에서는 남녀 수트직물의 드레이프 특성을 분석하여 수트직물로서의 선호도와와의 관계를 연구하였다. 본 연구에 사용된 직물은 남자 수트직물 중 봄/여름 용 60가지, 가을/겨울 용 60가지, 여자 수트직물 중 봄/여름 용 70가지, 가을/겨울 용 142가지로 총 332종류를 사용하여 이들의 주관적인 태, 수트직물로서의 선호도를 조사하였다. 주관적인 태는 자체 개발한 9점 척도의 질문지를 사용하여 측정하였으며 이 때 7점 척도를 사용하여 직물선호도도 함께 조사하였다. 주관적인 태는 질문지를 구성하는 20개의 대표현 형용사를 요인분석을 통하여 용도에 따라 5가지의 요인으로 표현하였다. 용도에 따른 수트직물의 드레이프 특성을 분석하기 위하여 직물의 드레이프성을 Cusick 드레이프 측정기를 사용하여 측정하였다. 드레이프계수, 굴곡수, 굴곡의 높이, 굴곡의 파장 등을 측정하여 통계적으로 분석하였다. 이러한 드레이프 특성치들의 계절에 따른 차이와 남자와 여자직물의 차이를 살펴보았다. 남녀 수트직물 모두에서 드레이프성은 태 표현 요인으로 나타났으며 여성용 수트직물에서는 직물선호도와 관계가 있는 것으로 나타났다. 여성 춘하용 직물에서는 선호되는 직물과 선호되지 않는 직물간에 드레이프 계수에 통계적인 유의한 차이는 없었으나 굴곡수와 굴곡의 파장에는 차이가 있어 드레이프의 형태에는 차이가 있었다. 여성 추동직물에서는 선호되는 직물의 드레이프 계수가 0.6-0.7로 너무 부드러거나 뻣뻣한 직물은 선호하지 않는 것으로 나타났다. 남자의 수트직물에서는 주관적인 태를 나타내는 주요요인으로 추동직물에서는 드레이프성이 추출되었으나 춘하직물에서는 추출되지 않았다. 추동직물에서 선호되는 직물과 선호되지 않는 직물간에 측정된 드레이프특성에 차이가 나타나지 않아 소비자들이 느끼는 드레이프성을 좀더 민감하게 대변할수 있는 드레이프 측정 방법의 개발이 필요하다. 계절에 따른 차이로 남녀 모두에서 유의한 차이가 나타났으며 드레이프 계수는 여성 춘하직물이 가장 높아 0.72였으며 남성 추동> 남성 춘하> 여성 추동의 순으로 감소하였다. 굴곡의 높이도 드레이프 계수와 같은 경향을 나타냈다. 남성복에서는 춘하직물이 추동직물보다 드레이프성이 좋았으며 여성복은 반대의 경향을 나타냈다. 남녀 직물간에도 차이가 있어 춘하직물은 남성 수트직물이 여성직물에 비하여 드레이프성이 좋았으며 추동직물에서는 여성 직물의 드레이프성이 더 좋았다.