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EFFECT OF SEAMS ON DRAPE BEHAVIOUR OF COTTON WOVEN FABRICS

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Abstract

Drape of fabric is one of the characteristics which influence significantly on the appearance quality of clothes. The structure of patterns and seams affect the drape behaviour of fabric. Investigating of the influence of seams to the drape behaviour of the fabric can improve apparel design and the selection of the structure, the direction of seams in accordance with the requirements of aesthetic quality as well as the shape of the garment. This article presents the effect of three seams on the drape behaviour of five medium cotton woven fabrics. Experimental fabrics are given diametral seams. Warp, weft and 45^o bias seams were sewn. Three types of seams, which content 301, 401 and 504 stitches, were applied to observe the effect of seams on the drape of fabrics. Drape properties of initial and seamed fabrics were determined using ADS-LAST drapemeter according to BS 5058: 1973 standard. The experimental results indicate that drape profile and number of folds are changed while changing type and direction of seams. There is a significant proportional linear correlation between drape coefficients of seamed and initial fabrics.

Keywords: *Drape coefficient, Seam, Drape profile.*

1. Introduction

Drape describes the ability of a textile material to orient itself into folds in more than one plane under its own weight [1]. Drape is an important property that decides the gracefulness of any garment as it is related to aesthetics of garments. Fabric's drape is a complex mathematical problem involving large deformations under low stresses. Drape shapes of the garments may be affected by many factors such as fabric, structure, pattern details and seams,...

J. Hu and S. Chung presented a fundamental drape analysis of seamed fabrics using Cusick's drapemeter [2]. Seven woven fabrics with various fiber contents of cotton, linen, silk, wool and polyester are given radial and circular 403 seams. Hu et al. studied the effect of a plain seam (lockstitch 301) on the drape structure of a woven fabric [3]. Simona Jevšnik and Darja Žuni Lojen [4], Ashok Itagi, Arindam Basu consided the drape behaviour of silk fabrics with radial seams [5]. Their results showed that the drape coefficient (DC) increases with the number of seams, but it is sightly affected by increases in the seam allowance. Nuray Ucar et al. analyzed the effect of overlock seams (stitch type 516, seam type SSa-1) on the drape behaviour of heavy weight knit fabrics to provide prediction equations for drape using image analysis [6]. Suda & Nagasaka investigated the effect of seams on the drape shape of a skirt [7]. They bonded nonwoven fabric trips onto a circular specimen along the edge and in the radial directions to simulate the drape of the skirt. They concluded that the bending coefficient of the bonded part increased with the width and number of bonded layers of the nonwoven fabric. Kaushal et al. studied the effect of sewing and fusing of interlining on the drape behaviour of men's suiting wool fabrics [8]. Four types of seams, which content 402 and 301 stitches, were applied to observe the effect of type of seam on the drape. Chu et al. studied the effect of the seam 516 on the drape coefficient of vixco fabrics. The results showed that there were a

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significant correlation between the DCs (Drape Coefficients) of seamed and initial fabrics (R = 0.8-0.86). Sidabraite and Masteikaite studied the effect of seams on the drape profile of a narrow skirt [9]. Narrow skirts were made from six lightweight woven fabrics (cotton, polyester, vixco and mixed fabrics).

Initial studies showed that the shapes of the pattern details and the used seams affect greatly the fabric drape. Once the fabric is joined with seams possibly its drape configuration would vary. It is very essential to understand to the change in drape behaviour of fabrics under goes once it is seamed. Thus, investigating the effect of typical seams on fabric drape has a significant value for both the textile and clothing industries.

The aim of this study is to analyze the effect of three seam types, stitches (301, 401 and 504) and directions (warp, weft and 45° bias) on the drape behaviour of medium cotton woven fabrics. Drape profiles of fabrics with seams provide guidance for garment designs, producers in the apparel industry and improve the understanding of drape properties corresponding to different seam features. The results also will be useful in predicting garment drape in further study.

1. Method

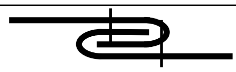
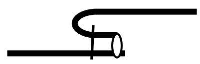
Five cotton woven fabrics were chosen for this investigation. Weight of fabrics are from 115.0 g/m^2 to 164.0 g/m^2. These fabrics are commonly used for shirt, dresses,... For seamed samples, 100% PES thread (Ne 80/3, direction of twist Z) were used to sew seams.

Table 1. *Details of the studied woven fabrics*

Fabric sample	**Composition**	**W (g/m^2) ISO 3801: 1977**
1	100% Cotton	122.20
2	100% Cotton	130.50
3	100% Cotton	115.00
4	100% Cotton	138.95
5	100% Cotton	164.00

A Juki DDL - 5500N sewing machine and Organ DC#90/14 needle were used for sewing 301 stitches. A Protex TY-8805SE and Organ DB#90/14 needle were used for sewing 401 and 504 stitches. Specimens were prepared according to BS 5058: 1973 standard [1]. The diameter D_2 of the test speciment is 30cm. The diameters D_1 of discs are 18cm (Fig. 2). S1, S2, S3 radial seams (Table 2) were sewn on the fabric samples according to the warp, weft and 45° bias directions (Fig. 1).

Table 2. *Experimental stitches and seams*

Stitch type	***Code of seam***	***Figure of seam type***
504, 301	S1	
301	S2	
401, 504	S3	

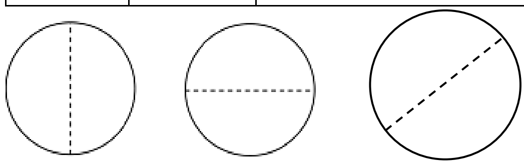


Fig.1. *The directions of radial seams S1, S2, S3 on the samples: a. Warp; b. Weft; c. 45° bias*

The stitch density for stitch type 301 was 5 sitches/cm; the stitch densities for stitch types 401 and 504 were 4.5 stitches/cm. The seam allowances of seams were 1cm; the distance between the two needles of the seam S2 was 0.6 cm.

The samples were prepared according to BS 5058: 1973 standard. Three fabric samples and three seamed fabric samples for each S1, S2 and S3 seam types, each warp, weft and bias directions were prepared on each fabric. A total of 15 fabric samples and 135 seamed samples were prepared for five cotton fabrics. The sewing conditions were maintained constant during the experimental process. The samples were pressed by using an iron at temperature 160°C before and after the sewing. The drapes of specimens were determined using ASD- ATLAS M213 drapemeter in accordance with BS 5058: 1973 standard in lab. in the Textile and Garment Institute (Vietnam). The experiments were taken under the standard testing conditions, i.e. temperature of 20 ± 2 °C and 65 ± 2 % relative air humidity. The drape behaviour is

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determined and compared in terms of the drape coefficient, number of folds and drape profile. The DC of specimen for each test was calculated following [1]:

$$DC = \frac{w_2}{w_1} \times 100 \ (\%)$$

Where, DC is the drape coefficient (%), w_1 is total mass of the paper ring (g), w_2 is the mass of the shaded area of the paper ring (g).

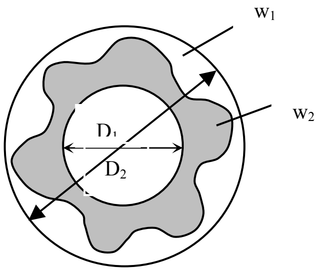

Fig.2. *Determination of DC*

The uniformity of measurement results were assessed by the Bartlett test at 95% confidence level [11].

2. Results and discussion

The results of the DC (%) are showed in table 3. The fold numbers of samples are showed in table 4. The number of folds was determined without confusing as the shaded area of the paper ring was observing. The results of the Bartlett test at 95% confidence level showed that H_o supposition is affirmed, which means there is insignificant difference in the uniformity of the measured results.

A small change in the drape coefficient is indicating that the seams would insignificantly affect the drape coefficient. ANOVA analysis results also showed that in most cases.

Table 3. *The drape coefficients of the initial and seamed fabric samples*

Fabric sample	DC of fabric (%)	DC of warp seamed sample (%)			DC of weft seamed sample (%)			DC of 45° bias seamed sample (%)		
		S1	S2	S3	S1	S2	S3	S1	S2	S3
1	68.07	67.84	68.69	67.73	71.40	69.71	68.54	68.63	68.62	67.08
2	73.62	71.60	73.53	75.07	77.24	77.31	74.65	71.87	74.15	69.31
3	72.15	71.98	75.30	71.56	78.16	77.59	73.45	73.57	74.05	70.61
4	74.78	75.18	75.67	74.30	76.20	76.44	76.44	73.39	72.81	74.33
5	81.85	79.26	79.42	78.33	81.02	79.94	75.68	76.68	79.74	81.72

Table 4. *The fold numbers of fabric and seamed samples*

Fabric sample	Fold number of fabric	Fold number of warp seamed sample			Fold number of weft seamed sample			Fold number of 45° bias seamed sample		
		S1	S2	S3	S1	S2	S3	S1	S2	S3
1	10	7	8	8	7	7	8	8	8	8
2	7	5	6	8	9	7	8	8	8	6
3	7	7	6	8	8	8	8	9	9	7
4	7	7	7	7	7	9	7	7	7	7
5	7	8	6	8	8	7	8	6	5	7

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In most cases, the DCs of S1 warp seamed samples were decreased in comparison with the DCs of the initial fabrics (except fabric 4), but the difference is not much. Absolute maximum of the decrease is 2.59%. The DCs of S1 weft seamed samples were significantly increased in comparison with the DCs of the S1 warp seamed samples and initial fabrics (except fabric 5). Absolute maximum of the increase is 6.01%. The DCs of S1 bias seamed samples were decreased in comparison with the DCs of the initial fabrics (except fabrics 1, 3, the differences are small, about 0.56 and 1.42%, respectively). In three directions, S1 weft seams affect mostly the DCs (except fabric 5) (Fig. 3).

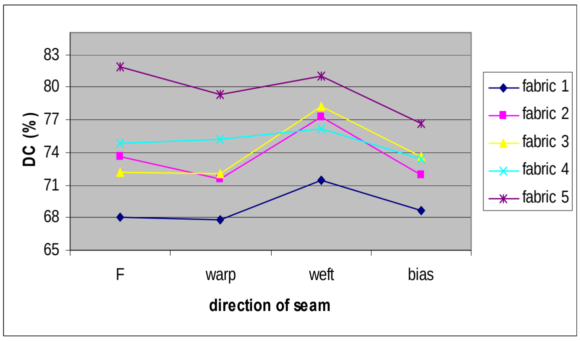

Fig.3. *The DCs of S1 seamed samples*

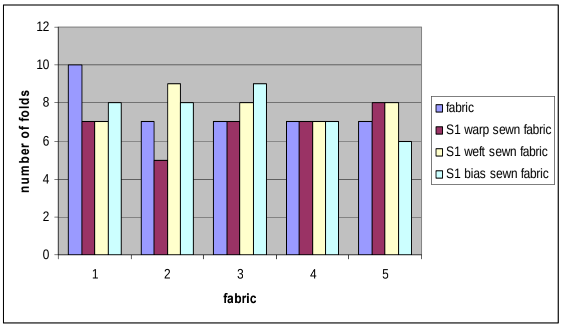

Fig.4. *The fold numbers of the S1 seamed samples*

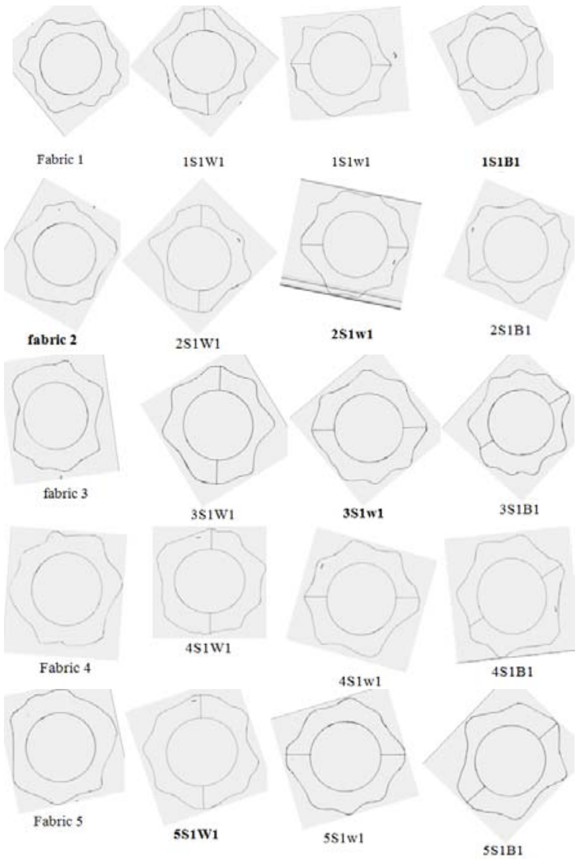

Fig.5. *The drape profiles of the S1 seamed samples. Codes: first number - code of fabric, S1- code of seam, W - warp, w - weft, B- bias, 4th number - ordinal number of sample*

For fabric samples without seams the folds are not regularly distributed. The drape shapes of the S1 bias seamed (fabric 1, 2, 3, 4) and warp seamed samples (fabric 5) are more regularly than another S1 seamed samples (Fig. 5). The fold numbers of the S1 seamed samples vary depending on the type of fabric (Fig. 4).

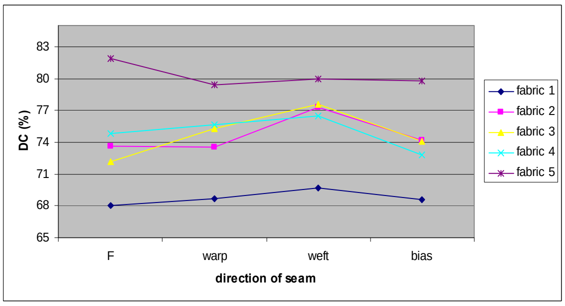

Fig.6. *The DCs of S2 seamed samples*

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The DCs of S2 seamed samples on fabric 5 were decreased in comparison with the DC of the initial fabric. In the remaining cases, the DCs of S2 warp seamed samples were increased in comparison with the DCs of the initial fabrics, but the difference is not much. Absolute maximum of the increase is 3.15%. The number of folds for the S2 warp and weft seamed samples is mostly smaller or equal when compared with fabrics without seam (except S2 weft seamed sample on fabric 1). The DCs of S2 weft seamed samples were clearly increased in comparison with the DCs of the S2 warp seamed samples and initial fabrics. In three directions, S2 weft seams affect mostly the DCs (Fig. 6). The differences of the DCs of S2 bias seamed samples were not much. Absolute maximum of the increase is 2.11%.The drape shapes of the S2 weft seamed (fabric 2, 4) and bias seamed samples (fabric 3, 4) are more regularly than another S1 seamed samples (Fig. 8). The fold numbers of the S2 seamed samples vary depending on the type of fabric (Fig. 7).

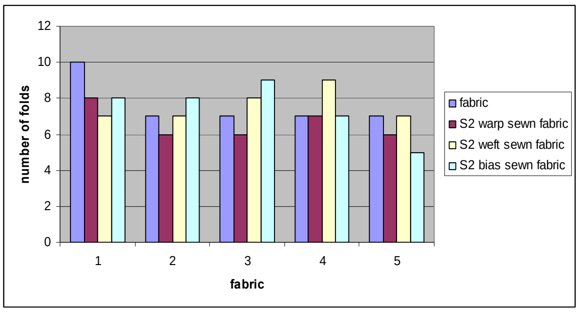

Fig.7. *The fold numbers of the S2 seamed samples*

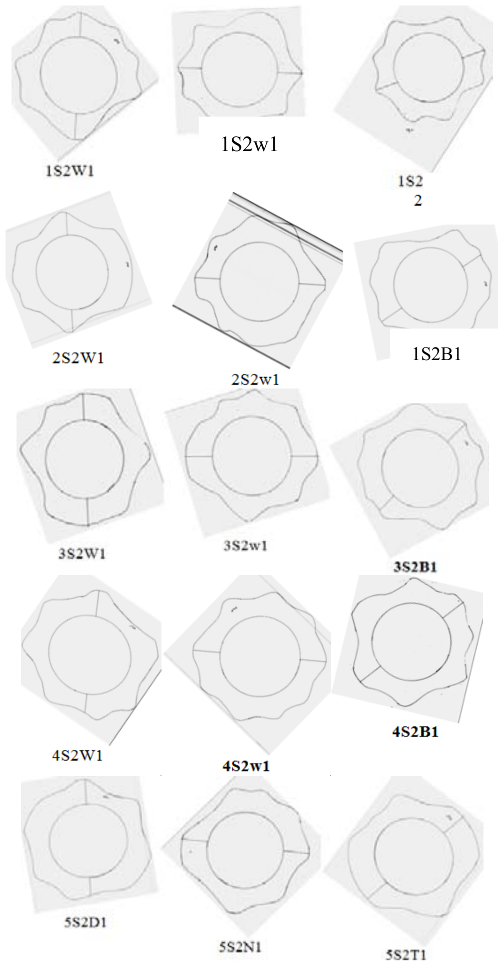

Fig.8. *The drape profiles of the S2 seamed samples*

In most cases, the DCs of S3 warp seamed samples were decreased in comparsion with the DCs of the initial fabrics (except fabric 2), but only the difference is significantly on fabric 5 (3.52%). The DCs of S3 weft seamed samples were increased in comparison with the DCs of the S3 warp seamed samples and initial fabrics, but the difference is not much, except the DC of the S3 weft seamed sample of fabric 5 was significantly decreased (6.17%). In three directions, S3 weft seams affect mostly the DCs (except fabric 2) (Fig. 9). The numbers of folds for the S3 warp and weft seamed samples were equal when compared with fabrics without seam.

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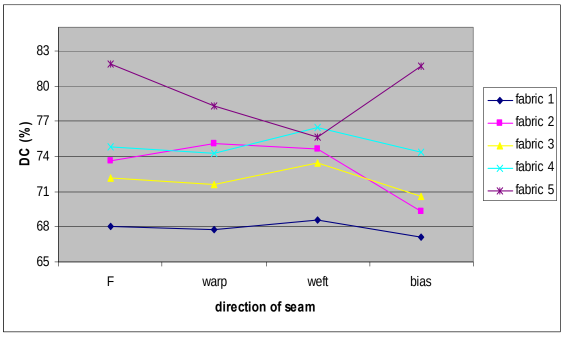
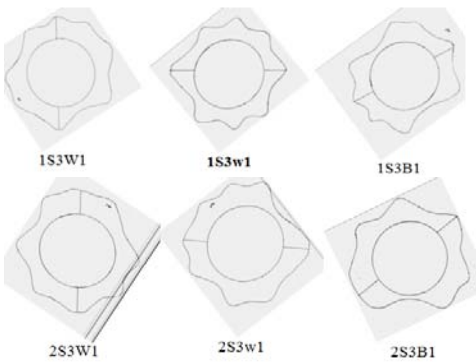


Fig.9. *The DCs of S3 seamed samples*

The DCs of S3 bias seamed samples were decreased in comparison with the DCs of the initial fabrics and S3 weft seamed samples (except fabric 5, the DC of bias seamed sample increased about 2.11% in comparison with the DCs of the S3 weft seamed sample). The fold numbers of the S3 bias seamed samples were decreased or remained the same. The drape shapes of the S3 weft (fabric 1), S3 warp (fabric 2, 3, 4) and bias seamed samples (fabric 5) are more regularly than another S3 seamed samples (Fig. 10). The DCs of the seamed samples on fabric 5 differ in trends because the bending rigidity of this fabric (0.152g.cm^2/cm) is clearly higher than the other fabrics (0.066 to 0.08 g.cm^2/cm). The DCs of all seamed samples on fabric 5 were decreased in comparison with the initial fabric. The warp bending rigidity of fabric 5 is clearly higher than the weft bending rigidity (0.176 and 0.127 g.cm^2/cm, respectively)*.



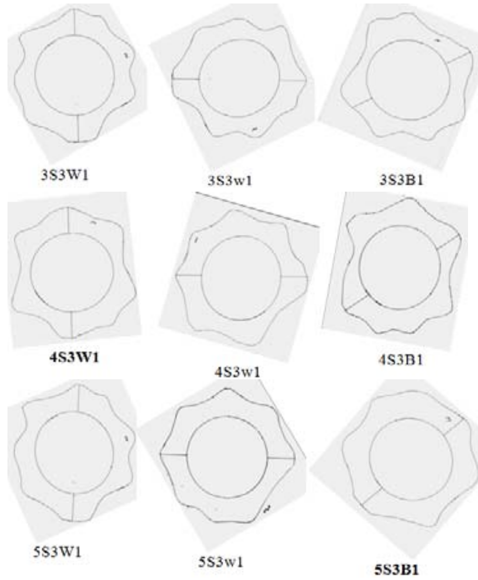


Fig.10. *The drape profiles of the S3 seamed samples*

**The authors of this article had measured bending rigidities B of studied fabrics using KES-FB2 in another investigation.*

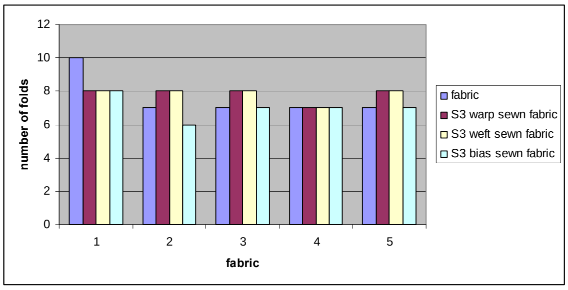


Fig.11. *The fold numbers of the S3 seamed samples*

The linear proportional relationships between the DCs of initial fabrics and the seamed samples were found. Most correlation coefficients are significant (Fig. 12, 13, 14). The factors of variable showed that S1 warp seams have more the effect on the DC than S1 bias and followed by S1 weft seams.

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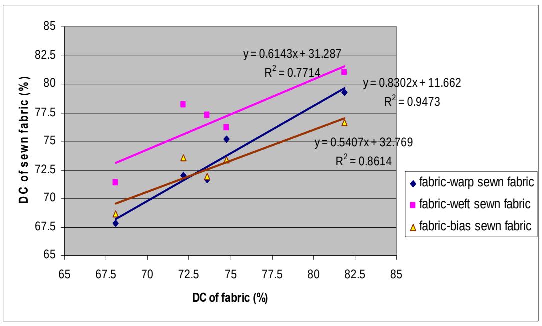

Fig.12. *Relationship between the DC of the fabric and S1 seamed sample*

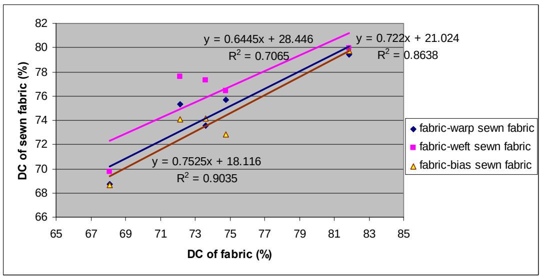

Fig.13. *Relationship between the DC of the fabric and S2 seamed sample*

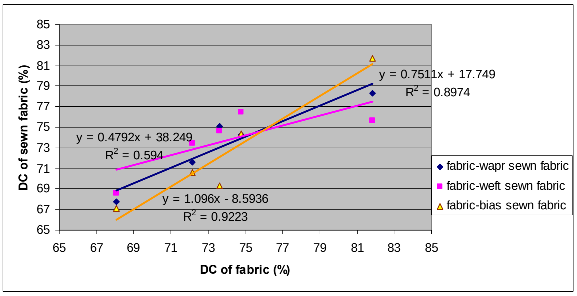

Fig.14. *Relationship between the DC of the fabric and S3 seamed sample*

S2, S3 bias seams have more the effect on the DC than warp and followed by weft seams. In three studied seam types, the factors of variable also showed that the DC was mostly affected by the S3 bias seams, followed by the S1 warp and S2 bias seams. The S3 weft seams affect at least the DC.

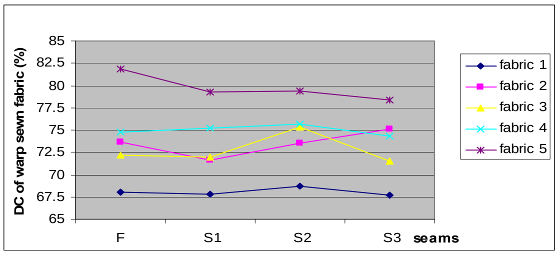

Fig.15. *The DCs of warp seamed samples*

In comparison with the DCs of the initial fabrics, the DCs of S1 warp seamed samples were decreased, except fabric 4, the increase of the DC is not much (0.4%), the DCs of S2 warp seamed samples were increased (except fabric 5) and the DCs of S3 warp seamed samples were decreased (except fabric 2) (Fig. 15). The drape shapes of the S1 warp (fabric 1, 5) and S3 warp (fabric 2, 3, 4, 5) samples are more regularly than initial fabrics and another warp seamed samples. In most of cases, the fold numbers of the warp seamed samples were decreased or remained the same when compared with fabrics without seam, except the S1 and S3 warp seamed samples on fabric 5.

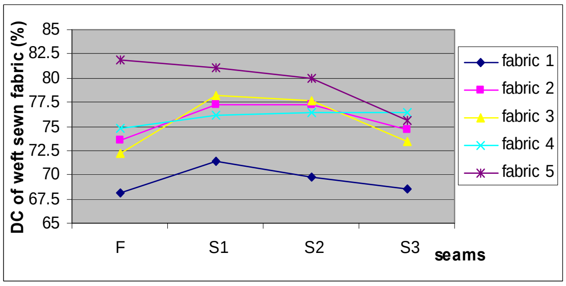

Fig.16. *The DCs of weft seamed samples*

The DCs of S1 weft seamed samples were highest, followed by S2 and S3, except fabric 5 (Fig. 16). Absolute maximums of the increase are 6.01; 5.44 and 1.3%, respectively. The drape shapes of the S1 (fabric 2, 3, 5), S2 (fabric 2, 4) and S3 (fabric 1) weft seamed samples are more regularly than initial fabrics and another weft seamed samples. The fold numbers of the weft seamed samples were increased or remained the same when compared with fabrics without seams on five studied fabrics.

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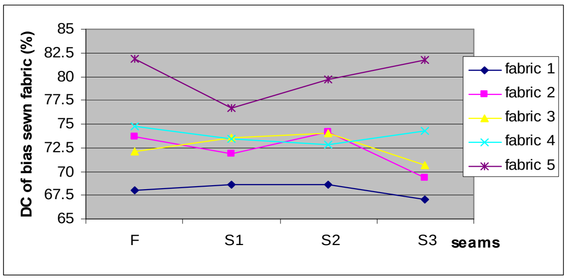

Fig.17. *The DCs of bias seamed samples*

The DCs of the S1 bias seamed samples on fabric 5 were mostly varied (5.17%). The DCs of S2 bias seamed samples were varied not much. The maximum variation is 2.11%. The DCs of S3 bias seamed samples were decreased (Fig. 16). Absolute maximum of the decrease is 4.31%. The drape shapes of the S1 (fabric 1, 4), S2 (fabric 4) and S3 (fabric 5) bias seamed samples are more regularly than another bias seamed samples.

3. Conclusions

Three types of stitches 301, 401 and 504 have been employed on five cotton woven fabrics. The drape coefficients differ between the fabrics also between the diametral seam types and directions but the differences are not significantly. For the samples of fabrics 1, 3, the DC was mostly affected by the S1 weft seam (absolute maximums of the increases are 3.33 and 6.01%, respectively), and was affected least by the S1 warp seam. For the samples of fabric 2, the DC was mostly affected by the S3 bias seam (4.31%), and was affected least by the S2 warp seam (0.09%). For the samples of fabric 4, the DC was mostly affected by the S2 bias seam (1.97%), and was affected least by the S1 warp seam (0.4%). For the samples of fabric 5, the DC was mostly affected by the S3 weft seam (6.17%), and was affected least by the S3 bias seam (0.13%).

Linear proportional significant relationships exist between the DCs of studied initial fabrics and the seamed samples in the warp, weft, bias directions and S1, S2, S3 seam types. The R-squared value is highest as the S1 warp samples were considered ($R^2 = 0.947$). This coefficient is lowest as the S3 weft samples were considered ($R^2 = 0.590$). If the DC of initial fabric increases, the DC of studied seamed sample increases in trend.

The drape shape and the number of folds for the seamed samples were varied depending direction and seam type. The drape shapes of seamed samples were regularly adjusted by S1 warp (fabrics 4, 5), S1 weft (fabrics 2, 3, 5), S1 bias (fabric3, 4), S2 weft (fabric 4), S2 bias (fabrics 3, 4), S3 warp (fabric 3), S3 weft (fabrics 3, 5) and S3 bias seams (fabric 5).

Understanding the influence of seam types and their directions on fabric drape behaviour would be important for incorporating into the computer simulation of cloth. Further research is required to predict the drape of garments.

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ẢNH HƯỞNG CỦA ĐƯỜNG MAY TỚI ĐẶC TÍNH RỦ CỦA VẢI BÔNG DỆT THOI

Tóm tắt

Rủ là một trong những đặc tính quan trọng của vải có ảnh hưởng đáng kể đến chất lượng của trang phục. Cấu trúc các chi tiết mẫu và các đường may có ảnh hưởng nhiều đến độ rủ của sản phẩm sau khi may. Xác định được ảnh hưởng của đường may đến đặc tính rủ của vải góp phần xây dựng cơ sở cho việc lựa chọn cấu trúc, hướng của đường may liên kết phù hợp với yêu cầu thẩm mỹ và chất lượng hình dáng của sản phẩm may. Bài báo này giới thiệu ảnh hưởng của 3 loại đường may liên kết phổ biến lên đặc tính rủ của 5 vải bông dệt thoi có khối lượng trung bình. Ba loại đường liên kết được hình thành từ các mũi may thắt nút 301, móc xích 401 và 504, được may theo đường kính của mẫu vải hình tròn cùng hướng sợi dọc, ngang và thiên 45^o. Các đặc trưng rủ của vải ban đầu và vải có đường may được xác định theo tiêu chuẩn BS 5058:1973 trên thiết bị ADS-LAST. Kết quả thực nghiệm cho thấy sự khác biệt của hệ số rủ của mẫu sau khi may không nhiều, hình dạng rủ và số nếp uốn của mẫu thay đổi khi thay đổi loại và hướng đường may. Tồn tại quan hệ tuyến tính đáng kể giữa hệ số rủ của mẫu trước và sau khi may trên các vải đã nghiên cứu.

Từ khóa: *Hệ số rủ, đường may, hình dạng bóng rủ*